2010 Sequence K–2 DRAFT Knowledge Maps for Science

With this file, we are happy to share with you the ***working draft*** Knowledge Maps for grades K–2. While the forthcoming CK Science (CKSci) curriculum will not be directly based on these Knowledge Maps, we offer them as guidance to schools seeking to compare the 2010 Core Knowledge Sequence domains to the NGSS expectations and goals.

For each topic, the Knowledge Map:

- Organizes content from the 2010 Core Knowledge Sequence.
- Includes alignment information and rationale for addressing the relevant Next Generation Science Standards.
- Articulates common misconceptions to support teachers as they help children overcome obstacles to understanding.
- Lists recommended content objectives for student mastery.
- Outlines several possible activities and assessment ideas for each domain of study.

These maps offer support to educators as they work to bridge any gaps between the 2010 CK Sequence and the Next Gen. Standards.

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Core Knowledge Science Program—Domain Map

Science Content	
• Five senses and the associated body parts: Sight: eyes Hearing: ears Smell: nose Taste: tongue Touch: skin	
• Basic needs and taking care of your body: Healthy foods and water Air Shelter and clothing Rest Cleanliness Exercise	
This unit contributes to meeting or exceeding the following Next Generation Science Standards:	
K-LS1-1. Use observations to describe **patterns of what** plants and **animals (including humans) need to survive**.	***Rationale:*** This first unit of the CK Science program lays the early foundation for the developing understanding of what animals (including humans) need to survive (DCI LS1.C). This will be expanded in later Kindergarten units (Unit 2 *Animals & Their Needs* and Unit 3 *Plants & Farms*) as well as across the grades (e.g., Grade 1 Unit 4 *Living Things & Their Environments* and Grade 3 Unit 3 *Human Body: Cells & The Digestive System*).
This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	

1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.	***Rationale:*** This unit directly contributes to a student's developing understanding of DCI PS4.C, which is the core idea central to this Grade 1 standard. PS4.C begins its progression with the idea that "people use their senses to learn about the world around them. Their eyes detect light, their ears detect sound, and they can feel vibrations by touch." (*Framework*, page 137) This core idea will be further supported by the later study of telescopes (Grade 3 Unit 3 *Light & Optics* as well as Grade 3 Unit 5 *Astronomy*) and the study of telephones (Grade 3 Unit 4 *Sound* and the biography of Alexander Graham Bell).
1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or **animals use their external parts to help them survive, grow, and meet their needs**.	***Rationale:*** As modeled by this Grade 1 standard, this Kindergarten unit "bundles" the disciplinary core ideas of LS1. A (Structure & Function) and LS1. D (Information Processing) to foster early learning about the cross-cutting concept of structure and function. This concept will be extended in Grade 1 through Unit 4 *Living Things & Their Environments* when there is also the opportunity to connect and apply these core ideas while addressing ESS3.A (Natural Resources) which addresses the question, "*How do humans depend on Earth's resources?*"

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. *(K-LS1-1)*

MP.5 Use appropriate tools strategically. *(1-PS4-4)*

POTENTIAL CCSS ELA Connections

W.K.7 Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). *(K-LS1-1)*

POTENTIAL Cross-Curricular Connections

ELA: Poetry—"Time to Rise," "Early to Bed," and "My Nose"

Sayings & Phrases—"Look before you leap" and "Better safe than sorry"

Visual Arts: Elements of Art—Pablo Picasso, *Le Gourmet*

Looking and Talking about Works of Art—Mary Cassatt, *The Child's Bath*

Music: Songs—"The Hokey Pokey"

Prior Knowledge

The Core Knowledge Preschool Sequence
Scientific Reasoning and the Physical World
Goal: *Demonstrate an initial understanding of the living world*

- Humans learn through their senses
- Human bodies are made up of many different parts
- Humans need to do certain things to grow and stay healthy
- Humans need to protect themselves in different ways

CKLA Preschool

- State that the five senses are sight, hearing, smell, taste, and touch
- State how each of the five senses helps us to experience the world
- Name human beings' three basic needs: water, food, and shelter
- State that a body can heal itself when it is hurt or sick
- State that people stay healthy by exercising, resting, eating good foods, and staying clean

CKLA Kindergarten Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

Domain Anthology, *The Five Senses*

- Identify and describe the five senses: sight, hearing, smell, taste, and touch
- Identify the body parts associated with the five senses
- Provide simple explanations about how the eyes, ears, nose, tongue, and skin work
- Describe how the five senses help people learn about their world

- Describe some ways people take care of their bodies
- Describe some ways the five senses help protect people from harm
- Describe the experiences and challenges of someone who is blind or deaf
- Explain the contributions of Ray Charles
- Explain the contributions of Helen Keller

What Students Will Learn in Future Grades

Core Knowledge Sequence

Grade 1 *The Human Body*

- Body Systems:Skeletal, Muscular, Digestive, Circulatory, and Nervous Systems
- Germs, Diseases, and Preventing Illness

Grade 2 *The Human Body*

- Cells, Digestive and Excretory Systems, and a Healthy Diet

Grade 3 *The Human Body*

- The Muscular, Skeletal, and Nervous Systems
- How the Eyes and Ears Work

Grade 4 *The Human Body*

- The Circulatory and Respiratory Systems

Grade 5 *The Human Body*

- Changes in Human Adolescence

Core Vocabulary

*The following list contains the Core Vocabulary words suggested for purposeful integration across this Kindergarten unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Basic Needs of Your Body

***needs**, survive, alive, health(y), food, **shelter**, clothing, **air**, water, protect, **rest**, sleep, tired, exhausted, grow, age, temperature, huddle*

Sight

*eye, **vision**, light, color, brightness, shade, look, seeing, sight, iris, pigment, **pupil**, eyeball, eyelid, lens, blink, squint, **blindness**, focus, image, visual, visible, **reflection**, **glasses**, eye doctor, contact lens, nearsighted, farsighted*

Taking Care of Your Body

***exercise**, pulse, sports, sweat, **cleanliness**, bath(e), hygiene, disease, germs, harm, organ, **nutrients**, fat, protein, carbohydrate, **senses,** brain, **system,** habits, aware, sometimes, often*

Hearing

***sound**, ear, hearing, vibrate, movement, **eardrum**, inner/outer ear, invisible, **waves**, echo, volume, soft, quietly, whisper, loud, shout, yell, voice, vocal, deafness, hearing aid, **audio**, radio, stereo, speaker, microphone*

Smell	Taste
nostrils**, nose, **scent**, smell, **inhale**, odor, sweet, sour, smoky, perfume, sniff, **stench**, stink, receptors, molecules, mucus, nasal* **Touch** *skin, touch, feel, **sensation**, sensitive, nerves, grab, **texture**, rough, smooth, soft, bumpy, furry, slippery, sharp, dull, hot, cold, grab, push, rub, **numb	***taste buds**, **flavor**, sweet, salty, sour, bitter, flavorful, **bland**, digest, tongue, mouth, throat, palate, saliva, teeth, **swallow**, pucker, congested, chemical, reaction, prefer*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "There is a 'map' of taste buds on the tongue. For example, taste buds for sweet tastes are on the tip of the tongue and bitter taste buds are at the back of the tongue."
Specialized taste buds for all tastes are actually spread all throughout the tongue, not necessarily grouped together. And, contrary to popular belief, taste buds are not just on the tongue—they also line the soft palate at the roof of the mouth, as well as the epiglottis, the flap in your throat that blocks food from entering the windpipe.

Misconception: "There are only four tastes: sweet, salty, sour, and bitter."
Scientists agree that there is at least one additional taste called "umami" for the savory taste of glutamate, a substance common in Japanese foods as well as in meats such as bacon. Umami can be translated from Japanese as "good taste" or "deliciousness."

Misconception: "Humans have only five senses."
Scientists define anywhere between nine to twenty different human senses depending on the scope of their investigation. Examples beyond the five senses we typically think of include the sensation of thirst; the sensations of pain and itchiness (which actually involve two different mechanisms than those involved in the generalized senses of touch and pressure); the sensation of color (cone cells in the eye send color information to the brain); and the sensation of brightness (rod cells in the eye send information to the brain about shade/brightness).

Key points for instruction:
It is important for teachers to remember that the nervous system—the brain in particular—plays an important part in all human senses. For example, the eye captures light from your surroundings, but it is the brain that processes this information. The importance of the brain relative to sight can be highlighted using optical illusions.

	During research studies, fourth-graders have been shown to understand that the brain helps the body, but they do not always realize that body parts help the brain (Johnson & Wellman, 1982).

Potential Objectives for this Kindergarten Unit

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the assessment should take place.

Beginning

- Distinguish between needs and wants
- Identify the basic needs of human beings
- Identify habits that keep our bodies healthy (K-LS1-1)
- Describe how we can keep our bodies safe from germs
- Describe how we can take care of our bodies

Middle

- Identify which organs allow us to see, hear, smell, taste, and touch
- Describe how the sense of sight helps us learn
- Describe how the pupil changes in bright light compared to little light
- Describe how the sense of hearing helps us learn
- Describe how the sense of hearing keeps us safe from harm (1-LS1-1)
- Identify devices that support people with limited vision and/or hearing
- Describe how the sense of smell helps us learn
- Classify scents as sweet or sour

End

- Describe how the sense of taste helps us learn
- Predict another sense that can also help us taste
- Classify foods as tasting sweet, salty, bitter, or sour
- Describe how the sense of touch helps us learn
- Describe how the sense of touch keeps us safe from harm (1-LS1-1)

Potential Big Guiding Questions

Essential Questions:

- **How can we keep our bodies healthy?**
- **How do our senses help us meet our needs?** (1-LS1-1)
- **How do our senses help us learn about the world around us?** (1-PS4-4)

RE: Basic Needs

- What do you need to survive?
- What is the difference between a need and a want?

RE: Taking Care of Your Body

- What activities do people in your area do to stay healthy?
- What food do you eat that is healthy/unhealthy?
- Why is cleanliness important?
- How do germs spread?

RE: The Senses

- Which parts of your body help you to (see, hear, smell, taste, or touch)?
- How does your sense of (sight, hearing, smell, taste, or touch) help to keep you safe from harm?
- How does the pupil change in bright light versus low light?
- What tools can be used to help people with limited vision and/or hearing?
- How do your senses work together (e.g., taste and smell)?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective or NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted to indicate the approximate point in time the assessment would take place.

Example #1: (Beginning of Unit 1; also see Potential Activities Example #3)

{**Evaluates Student Mastery of Objective:** Describe how we can keep our bodies safe from germs}

Advance Preparation: This assessment requires a bag of glitter and several sheets of paper towels, wipes, and bowls for groups of 2–3 students.

Task Assessment: Sprinkle small amounts of glitter on students' hands and on their tables. This glitter represents "germs." When provided with paper towels, wipes, and a bowl of soapy water, students will work in groups of two or three to problem-solve how to remove the "germs" on their table and on their hands. As students share their solutions, ask them to describe how quickly they were able to remove the "germs" (e.g., "Were you able to wipe away all of the glitter from the table with one swipe?") and what that tells them about protecting their bodies from real germs.

Example #2: (Middle of Unit 1)

{**Evaluates Student Mastery of Objective:** Identify which organs allow us to see, hear, smell, taste, and touch}

Advance Preparation: Create the assessment handout by dividing a piece of paper into two columns. On the left side of the paper, moving from top to bottom, draw (or insert) images of a nose, eye, ear, tongue, and hand. On the right side, draw (or insert) images of objects that one could smell, see, hear, taste, or touch.

Task Assessment: When provided with a two-column matching activity—described above—students will match each organ to the object which corresponds with each sense.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the activity should be conducted during this unit. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 1)

{**Contributes to the Objective:** Identify the basic needs of human beings}

Activity: As students examine the needs of human beings (Unit 1), animals (Unit 2), and plants (Unit 3), keep a chart of your students' ideas and examples for each group/unit. These charts can be used as evidence during later discussions. During Units 2 and 3, ask your students to identify patterns across the three domains providing appropriate support and scaffolding (e.g., all animals—including humans—eat food, some animals eat plants, some animals eat other animals, some animals eat both plants and other animals, etc.). Students will use the patterns culled from this "data" to describe what human beings, animals, and plants need to survive. (K-LS1-1)

Example #2: (Beginning of Unit 1)

{**Contributes to the Objective:** Describe habits that keep our bodies healthy}

T—Which of our basic needs (healthy food, water, shelter, air, clothing, rest, cleanliness, and exercise) are related to our health? Direct students to take a few moments to think, then pair students up to discuss their ideas with a partner.

After students have had sixty to ninety seconds to talk, ask several pairs to share their ideas with the group. As the partners debrief, encourage all students to think about the responses and whether or not they agree, including their rationales (e.g., eating healthy foods keeps our bodies healthy).

T—If many of our basic needs are connected to keeping our bodies healthy, what does that tell us? Students should draw the conclusion that heath is very important since it is closely connected to

almost every basic need. If student responses are off base, use targeted questions to guide them to this idea.

T—Today we are going to focus on how we can keep our bodies healthy. What do you do to stay healthy? As students share ideas, record the responses on the board or chart paper.

After a few minutes, draw students' attention to the board or chart paper, and model how to group similar ideas together (e.g., "You shared: Brushing my teeth, flossing, and washing my hands. How are we keeping our bodies healthy through these routines or habits? → These are examples of how we keep our bodies clean."). The goal is to identify examples for the following categories: eating healthy foods, exercising, getting rest, and keeping our bodies clean.

T—Let's take a closer look at each of these healthy habits, starting with exercising.

[Note: The activity below could be completed in the classroom or outdoors if your students need more space.]

Model how to locate your pulse on your wrist and/or neck. Ask students to place their finger on their pulse. Explain that this allows them to feel their blood circulating through their bodies.

T—I want you feel your pulse for thirty seconds. When your time is up, I will ask you to tell me what you noticed. When time is called, ask students questions that draw their attention to the pace of their pulse. Explain that they took their pulse in a resting state.

Explain to students that you will give them some time to "exercise" so they can compare their pulse after exercise to their pulse in its resting state. Ask the students to stand up and run in place (or around the playground) for one to two minutes.

T—Now I want you to sit down and feel your pulse for thirty seconds. After thirty seconds, ask the students to stop and tell you what they noticed compared to the first time they took their pulse. Students should identify that their pulse was faster after exercising.

T—Why do you think that happened? Through questioning, guide students with making the connection between the heart pumping faster and how exercise keeps the heart and body healthy.

Example #3: (Beginning of Unit 1)

{**Contributes to the Objective:** Describe how we can keep our bodies safe from germs}

Advance Preparation: At the start of this activity, students should be sitting on the carpet. If not, make sure there is at least one empty table/desk in the room, asking students who normally sit there to move. Make sure that you place several pencils, crayons, or other writing tools; a bag of glitter; and paper on this table/desk.

Hold up the bag of glitter.

T—We have been learning about how to keep our bodies healthy. Today we are going to learn about how germs can spread and how we can protect our bodies from germs.

We are going to pretend that this glitter represents germs. (Ask students to share some of the different ways germs can spread.) **Using this glitter, I am going to demonstrate how germs can spread by coughing.**

Walk up to the table/desk where no one is sitting. Pretending to cough, blow glitter on the table. Direct students to stand up and form a circle around the table.

T—What just happened here? (Possible student responses may include, "Your cough spread germs onto the table.") Through questioning, guide students to see that the "germs" not only spread onto the table, but also onto all objects sitting on the table.

Ask students to return to their seats (including the children who sit at the table with the glitter).

T—I want you to make a prediction about what is going to happen, if [names of students sitting at the table] work at their table. Encourage students to pause for several seconds to think, and then instruct them to tell a partner what they think will happen.

T—Using pencils/crayons and paper, write/draw your prediction. During this activity, you may prompt students, who are sitting at different tables, to ask to borrow writing instruments and paper from the table with the glitter.

After students have finished and have had an opportunity share their predictions, ask the students who are sitting at the table with the glitter to share where they see the glitter now. Through questioning, guide these students to discover that the "germs" are covering a larger area of the table, and also cover parts of their hands and paper. If students from different tables borrowed writing instruments or paper with "germs," the "germs" are now at their tables as well.

T—All of these germs spread through just one cough. How can we keep our bodies safe from germs? Through questioning, continue the discussion to meet the lesson objective.

Websites & Media

The Society for Neuroscience—BrainFacts.org:
http://www.brainfacts.org/sensing-thinking-behaving/senses-and-perception/

Enhance your knowledge about the brain and your senses with interesting facts, stories, and vibrant visuals from this website. Questions such as, "Why does stepping on a Lego hurt so bad?" just might kick-start your thinking about how you can engage your students to think about sensation.

Optical Illusions: http://www.sciencekids.co.nz/pictures/illusions.html

Illusions can amaze your students as they wonder how an illusion works and why their brains "trick" them into seeing something that their eyes don't actually see.

Guide Dogs: http://www.slideshare.net/guestb1e4b60/freedom-guide-dogs-for-kids

This student-friendly presentation can help you to introduce how guide dogs assist those with visual impairments.

Unite for Sight—Annie's Website for Kids: http://www.uniteforsight.org/kids/about.php

This organization supports efforts around the world to teach children about the eye and to provide vision screenings. Unite for Sight's mascot, Annie, can help you to plan kid-friendly lessons about eyeglasses, eye safety, and more.

PBS Kids—Arthur's Sign Design: http://pbskids.org/arthur/print/signdesign/index.html

This website can help you to introduce sign language to your students. Using the "Practice Signing" section, Arthur will help you and your students practice signing your names, ask questions, or even make statements using sign language.

PBS Kids—Sid the Science Kid's "I Sense" Game: http://pbskids.org/sid/isense.html

You might use this interactive game with your students to apply their knowledge of the senses. Select the common object that matches Sid's prompts about smell, touch, sight, and more.

Supplemental Trade Books

- Eating Well, by Liz Gogerly (Crabtree Publishing Company, 2009) ISBN 0778741176
- Eyes (Human Body), by Robert James (Rourke Publishing, 1995) ISBN 1571031049
- First Delights: A Book About the Five Senses, by Tasha Tudor (Price, Stern, Sloan, 1988) ISBN 0448093278
- Fuel the Body: Eating Well, by Amanda Doering Tourville (Picture Window Books, 2008) ISBN 1404848142
- Get Up and Go!, by Nancy Carlson (Penguin Group, 2008) ISBN 0142410640
- Go Wash Up: Keeping Clean, by Amanda Doering Tourville (Coughlan Publishing, 2008) ISBN 1404848088
- Happy Birthday Moon, by Frank Asch (Aladdin, 2000) ISBN 0689835442
- Hearing Things, by Allan Fowler (Children's Press, Inc., 1991) ISBN 0516449095
- It Looked Like Spilt Milk, by Charles Shaw (HarperTrophy, 1988) ISBN 0064431592
- Look! A Book About Sight, by Dana Meachen Rau (Picture Window Books, 2005) ISBN 1404810196
- Mice Squeak, We Speak, by Arnold L. Shapiro and illustrated by Tomie DePaola (Putnam Juvenile, 1997) ISBN 0399232028
- My Amazing Body: A First Look at Health and Fitness, by Pat Thomas (Barron's Educational Series, Inc., 2002) ISBN 0764121197
- My Five Senses, by Aliki (HarperTrophy, 1989) ISBN 006445083X
- My Senses Help Me, by Bobbie Kalman (Crabtree Publishing Company. 2010) ISBN 9780778794721
- No One Saw: Ordinary Things Through the Eyes of an Artist, by Bob Raczka (Millbrook Press, 2001) ISBN 0761323708
- Oh, the Things You Can Do that Are Good for You!: All About Staying Healthy, by Tish Rabe (Random House, Inc. 2001) ISBN 0375810986

- Polar Bear Polar Bear, by Bill Martin Jr. (Henry Holt and Co., 1992) ISBN 0805023461
- Seven Blind Mice, by Ed Young (Puffin Books, 2002) ISBN 0698118952
- Shhhh . . . A Book About Hearing, by Dana Meachen Rau (Picture Window Books, 2005) ISBN 1404810188
- Sleep Is for Everyone (Let's-Read-and-Find-out Science Book), by Paul Showers (HarperCollins Publishers, 1997) ISBN 0064451410
- The Five Senses (It's Science), by Sally Hewitt (BT Bound, 2003) ISBN 061337343X
- The Five Senses: Hearing, by Maria Ruis (Barron's Educational Series, Inc., 1985) ISBN 0812035631
- The Five Senses: Sight, by Maria Rius (Barron's Educational Series, Inc., 1985) ISBN 081203564X
- The Five Senses: Smell, by Maria Rius (Barron's Educational Series, Inc., 1985) ISBN 0812035658
- The Five Senses: Taste, by Maria Rius (Barron's Educational Series, Inc., 1985) ISBN 0812035666
- The Five Senses: Touch, by Maria Rius (Barron's Educational Series, Inc., 1985) ISBN 0812035674
- The Listening Walk, by Paul Showers and Aliki (HarperTrophy, February 1993) ISBN 0064433226
- Touching and Feeling, by Katie Dicker (Cherrytree Books, 2009) ISBN 1842345788
- What is Taste?, by Jennifer Boothroyd (Lightning Bolt Books, 2010) ISBN 0761350170
- You Can't Smell a Flower with Your Ear! All About Your 5 Senses, by Joanna Cole (Grosset & Dunlap, 1994) ISBN 0448404699
- You Can't Taste a Pickle with Your Ear: A Book About Your 5 Senses, by Harriet Ziefert and illustrated by Amanda Haley
- (Handprint Books, 2002) ISBN 1929766688
- Your Five Senses, by Melvin and Gilda Berger (Scholastic, 2003) ISBN 0439566886
- Helen Keller, by Pamela Walker (Scholastic, 2001) ISBN 9780516235882
- Sensing Light and Sound, by Jennifer Boothroyd (Lerner Publishing Group, 2014) ISBN 9781467745062

Core Knowledge Science Program—Domain Map

Science Content	
• Animals, including humans, need food, water, air, and space to live and grow • Animals get food from eating plants or other living things • Offspring are very much (but not exactly) like their parents • Most animal babies need to be fed and cared for by their parents; human babies are especially in need of care when young • Pets have special needs and must be cared for by their owners • A biography of Jane Goodall	
This unit contributes to meeting or exceeding the following Next Generation Science Standards:	
K-LS1-1*. Use observations to* ***describe patterns of what*** *plants and* ***animals (including humans) need to survive.***	***Rationale:*** In this second unit of Kindergarten there is a particular opportunity to look for patterns, by comparing the needs of human beings studied in Unit 1 with those of other animals explored in this unit. This unit explicitly engages students with the concept of what animals need to grow and survive (DCI LS1.C), but it also examines LS1.B parents' behaviors that help offspring to survive (see 1-LS1-2 below). K-LS1-1 will be further developed across Unit 3 *Plants & Farms*, and it may be reviewed/ applied during Unit 5 *Taking Care of the Earth* as well.
K-ESS2-2*. Construct an argument supported by evidence for how plants and* ***animals (including humans) can change the environment to meet their needs.***	This standard and its core ideas (DCIs ESS2.E and ESS3.C) will be addressed as students explore the idea that animals get food from eating plants or other living things, and thus change the environment when doing so (LS2.A and LS2.B). These ideas will also be expanded in Unit 3 *Plants & Farms* when students learn about farming and in Unit 5 *Taking Care of the Earth* when the concept of conservation is introduced.

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
K-ESS3-1*. Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.*	This standard, and its core idea (DCI ESS3.A) regarding natural resources, will be explicitly developed during Unit 5 *Taking Care of the Earth,* as well as in Grade 1 Unit 4 *Living Things & Their Environments*. This Kindergarten unit focuses on the needs of animals (LS1.C) first, and students will have the opportunity to apply and expand their knowledge of specific needs when making the connection to ESS3.A later in this grade and in Grade 1.
1-LS1-2*. Read texts and use media to determine patterns in* ***behavior of parents and offspring that help offspring survive.***	The core idea central to this standard, DCI LS1.B, is introduced in this unit, focusing on the concept that *"most animal babies need to be fed and cared for by their parents; human babies are especially in need of care when young."* This idea will be reviewed and applied again in Grade 1 through Unit 1 *Human Body Systems & Preventing Illness* (e.g., taking care of your body and getting vaccinations) and through Grade 1 Unit 4 *Living Things & Their Environments*.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. (K-ESS2-1 and K-ESS3-1)

MP.4 Model with mathematics. (K-ESS2-1 and K-ESS3-1)

K.CC Counting and Cardinality (K-ESS3-1)

K.CC.A Know number names and the count sequence. (K-ESS2-1)

K.MD.A.1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. (K-ESS2-1)

K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. (K-LS1-1)

K.MD.B.3 Classify objects into given categories; count the number of objects in each category and sort the categories by count. (K-ESS2-1)

POTENTIAL CCSS ELA Connections

R.K.1 With prompting and support, ask and answer questions about key details in a text. (K-ESS2-2)

W.K.1 Use a combination of drawing, dictating, and writing to compose opinion pieces in which they tell a reader the topic or the name of the book they are writing about and state an opinion or preference about the topic or book. (K-ESS2-2)

W.K.2 Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic. (K-ESS2-2)

W.K.7 Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-ESS2-1 & K-LS1-1)

SL.K.5 Add drawings or other visual displays to descriptions as desired to provide additional detail. (K-ESS3-1)

POTENTIAL Cross-Curricular Connections

ELA: Fiction—Stories such as "The Ugly Duckling"
Sayings & Phrases—"The early bird gets the worm," and "A dog is a man's best friend."
Poetry—Mother Goose Rhymes and Other Traditional Poems, such as "Mary Had a Little Lamb" and "Ladybug, Ladybug"

Visual Arts: Sculpture—Alexander Calder, *Lobster Trap and Fish Tail (This connection may only be meaningful for students if teachers explicitly use lobsters as an example during instruction.)*
Music: Songs—such as "Eensy, Weensy Spider," "Here Is the Beehive," "Oh Where, Oh Where Has My Little Dog Gone?," and "Five Little Ducks That I Once Knew"

Prior Knowledge

Core Knowledge Preschool Sequence
Scientific Reasoning and the Physical World
Goal: Demonstrate an initial understanding of the living world

- Animals are living things
- Animals live in many kinds of homes

CKLA Preschool

- Identify at least ten animals by name
- State that humans are animals
- Identify three body parts that belong to animals that are not human (e.g., beak, trunk, claw, etc.)
- Identify three body parts that humans and some animals have in common (e.g., eyes, ears, legs, hands, etc.)
- Describe how animals use specific body parts (e.g., an elephant uses its trunk to get water)
- State that animals' three basic needs are water, food, and shelter
- Describe at least two ways animals protect themselves from weather
- Describe at least two ways animals protect themselves from other animals
- Pair pictures of mother and baby animals that look similar to each other
- Sort pictures of birds, fish, and insects into piles based on the animal group to which they belong
- State defining characteristics of birds, fish, insects, and mammals
- Identify plants and animals that live in ocean, woodland, desert, and farm habitats

Core Knowledge Science (Previously taught Kindergarten units)
Unit 1 *The Human Body: Basic Needs & Five Senses*

- Identify the basic needs of human beings
- Describe how we can take care of our bodies

CKLA Kindergarten Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

Domain Anthology, *Plants*

- Explain that the plant makes its food in its leaves

Domain Anthology, *Farms*

- Identify needs of farm animals: food, water, and space to live and grow
- Describe how farm animal babies need to be fed and cared for by their parents or people

What Students Will Learn in Future Grades

Core Knowledge Sequence

Grade 1 *Living Things and Their Environments*

- Habitats; ocean and undersea life; and special classifications of animals

Grade 2 *Cycles in Nature*

- Life cycles

Grade 3

Introduction to Classification of Animals

- Scientists classify animals according to the characteristics they share.
- Different classes of vertebrates
- Basic characteristics of fish, amphibians, reptiles, birds, and mammals

Ecology

- Habitats, "balance of nature," food web, and ecosystems
- Man-made threats to the environment and protecting the environment

Grade 5

Classifying Living Things

- Kingdom, phylum, class, order, family, genus, species, and (variety)
- Homo sapiens
- Taxonomists
- Different classes of vertebrates

Cells: Structures and Processes

- Structure of cells (both plant and animal)
- Plant cells, unlike animal cells, have cell walls and chloroplasts
- Cells are shaped differently in order to perform different functions
- Organization of cells into tissues, organs, and systems

Life Cycles and Reproduction

- Life cycles
- All living things reproduce themselves
- Sexual reproduction in animals

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Kindergarten unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Basic Needs of Animals	Pets
*animal, human, needs, food, space, shelter, water, air, **basic**, **survive**, alive, health(y), protect, safe, rest, sleep, tired, grow, **nutrients***	***care**, pet, wild, tame, feed, **tend**, maintain, walk, dog, cat, rabbit, hamster, guinea pig, bird, fish, snake, reptile, **habits**, bathe, hygiene, disease, aware, sometimes, often*

Characteristics and Behaviors

trait**, characteristic, structure, feature, body, part, **system**, leg, arm, wing, tail, feather, beak, scales, trunk, claws, paws, feet, fur, fins, flippers, gills, hoof, horn, shell, fleece, inherit, **behavior**, sniff, burrow, swim, hibernate, leap, graze, peck, perch, fly, herbivore, carnivore, omnivore, mammal, **classify

Taking Care of Offspring

offspring, litter, birth, hatch, dependent, **responsible**, action, family, pack, herd, flock, parent, father, mother, child, baby, foal, sibling, brother, sister, cry, cheep, **raise**, collect, edible, nest, egg, feeding, cuddle, fawn, pouch

Habitats

*habitat, **environment**, **ecosystem**, community, region, desert, ocean, **woodland**, woods, forest, **meadow**, prairie, underground, island, cave, bat, condor, camel, lizard, sand, cactus, water, coast, tadpole, sea lion, otter, beaver, lobster, crab, eagle, seagull, dolphin, penguin, whale, duck, seal, forest, insect, deer, bear, panda, lion, elk, moose, cow, horse, goat, squirrel, raccoon, spider, adapt, **climate**, weather, **temperature**, huddle, dry, wet, danger, harm*

Also consider how you might apply the vocabulary learned and used during Unit 1 The Human Body: Basic Needs & Five Senses.

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "People are not animals."

Often, students use "animals" as a term to distinguish between people and animals. This understanding may be reinforced by common language use (e.g., signs that read "no animals on freeway" and statements referring to pets, such as "time to feed the animals").

Students (and teachers) may also use a restricted meaning for the word "animal" (Mintzes et al., 1991). For example, most people list only vertebrates as animals, although invertebrate species make up a large majority of all animals. Elementary- and middle-school students often use such criteria as number of legs, body covering, and habitat to decide whether things are animals.

Key points for instruction:

Elementary students may not understand that food is a scarce resource in ecosystems, thinking that organisms can change their food at will, according to the availability of particular sources (Leach et. al., 1992). This is an important idea for teachers to keep in mind when foreshadowing future units (e.g., Unit 5 Taking *Care of the Earth*).

The connection between the needs of humans and the needs of all animals is important to emphasize, particularly in light of the misconception noted at left. Students have also been shown to classify organisms based on the scope and sequence of their previous instruction; for example, some students classify insects as non-animals because they learned about insects during a separate unit.

Potential Objectives for This Kindergarten Unit

The organization of the following objectives reflects the order in which they are expected to be addressed. The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Classify living things and nonliving things
- Compare and contrast humans and other animals
- Identify at least three basic needs of animals (K-LS1-1)
- Describe how animals use specific body parts to meet their needs
- Describe at least two ways that animals protect themselves from other animals
- Distinguish between wild animals and pets
- Describe how owners keep their pets safe and healthy
- Describe how animals' basic needs are similar to/different from human beings' basic needs (K-LS1-1)

Middle

- Identify two ways that animals are born
- Pair pictures of a parent and baby animals that look similar to each other
- Identify similarities and differences in the traits of parents and their young
- Describe two ways that baby animals let their parents know that they need something
- Describe how animals care for their young offspring
- Describe similar (and different) ways animals and humans take care of their young offspring (1-LS1-2)

End

- Identify how scientists can learn about animal characteristics and behaviors
- State two defining characteristics of mammals
- Describe at least one difference between fish and mammals
- State two defining characteristics of birds
- Describe at least one difference between birds and insects
- Categorize pictures of birds, fish, insects, and mammals, sorting them into piles based on the group to which they belong
- Describe animals' characteristics or behaviors that allow them to survive in the wild
- Describe the meaning of the term "habitat"
- Identify animals that can live in ocean, woodland, desert, and savanna habitats (K-ESS3-1)
- Describe how animals can change their habitats in order to meet their needs (K-ESS2-2)
- Categorize pictures of animals into groups (herbivores, carnivores, or omnivores) based on examples of food that they eat

Potential Big Guiding Questions

Essential Questions:

- **How are your needs similar to the needs of all animals?**
- **How do pets' needs differ from those of other animals?**
- **Why do animals live where they do?**
- **How do animals change their environments to meet their needs?**

RE: Basic Needs of Animals

- How are you similar to an elephant?
- Do all animals sleep?
- How do animals protect themselves from other animals?

RE: Pets

- What is the difference between a pet and a wild animal?
- Why do some pets need a bath and others do not?

RE: Animal Characteristics and Behaviors

- What are the differences among a mammal, bird, fish, and an insect?
- How do animals use their environments to meet their needs?

RE: Habitats

- Are there mammals that live in the ocean?
- Do similar animals live in the desert *and* the forest?

RE: Taking Care of Offspring

- Why do babies cry?
- How do animal parents take care of their young?
- How are your parents similar to (and different from) the parents of a baby bird?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the assessment should take place.

Example #1: (End of Unit 2)

{**Evaluates Student Mastery of Objective:** Describe how animals can change their habitats in order to meet their needs}

Advance Preparation: Create the assessment handout by dividing a paper in half (top to bottom). At the top of the page illustrate or find images depicting a deer eating leaves from a bush; a lion lying in the shade under a tree; a squirrel digging a hole in the dirt to bury nuts; a rabbit hiding in tall blades of grass; and a beaver building a dam. Leave the bottom half of the paper blank.

Task Assessment: Provide students with the assessment handout, crayons, and a pencil. Point to each image and ask students what the animal is doing. Ask students to circle an example of an animal changing its environment to meet its need. (Clarify that ***not*** every picture depicts an animal making a change to its habitat.) In the space at the bottom of the page, ask student to draw a representation (the evidence they saw in the picture) of how the environment was changed by that animal. Rotate around the room, asking students to describe their illustration and transcribe their ideas on the bottom of the handout. Students, who are ready and able, can write words/phrases that describe their drawings. (K-ESS2-2)

Example #2: (End of Unit 2)

{**Evaluates Student Mastery of Objective:** Identify animals that can live in ocean, woodland, desert, and savanna habitats}

Advance Preparation:

- Habitat Image Cards—draw or find images of the ocean, woodland, desert, and savanna habitats.
- Sentence strips with questions that students could ask to learn about the animal's needs. (Answers to the questions would provide information needed to determine the the type of habitat an animal could live in.) Examples may include, "What food does the animal eat?" "Can the animal survive in very hot or very cold weather?" "How does the animal breathe?" "What does the animal use for shelter?" Next to each sentence, draw a visual clue—most Kindergarten students will not be able to read the text on the sentence strips independently.
- Blank sentence strips.
- Four to five Animal Image Cards—draw or find images of animals that live in either the ocean, woodland, desert, or savanna habitats. These animals may have been discussed during previous instruction, but these animals should not include a the lion, deer, whale, or camel.
- Create the assessment handout by dividing a paper into two columns. In the first column, draw or insert pictures of the animals reviewed through the assessment. These images should match the animal image cards. In the second column, draw or insert images of the four habitats. These should be copies of the same drawings or images depicted on the habitat image cards.
- **Note:** This assessment would be best administered to small groups of students, one group at a time. Consider meaningful tasks that remaining students could complete independently (and/or in small group if there is another adult in the classroom).
- **Note:** Prior to this assessment, students learned about the climate and natural resources of each of these habitats.

Task Assessment: Display images.

T- I am going to show you pictures of some animals, and you will need to figure out where each animal lives. To help determine the animal's habitat, you can ask me questions. But, it is important that you ask questions that will give you information about whether or not the animal could adapt to living in the ocean, woodland, desert, or savanna.

T- Here are examples of questions you may want to ask. Hold up each sentence strip and review the questions. Ask students if there are other questions they feel would be important to ask. Add these to the blank sentence strips.

Holding up the first image, guide students with asking questions (referring back to the questions on the sentence strips) about the animal's characteristics and needs.

T- Are you ready to use the information you learned about this animal to determine if it lives in the ocean, woodland, desert, or savanna? Provide each student with the assessment handout.

T- On your paper, draw a line connecting this animal to where it lives.

Repeat this procedure with the remaining animals.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the activity should be conducted during this unit. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 2)

{Contributes to the Objective: Identify at least three basic needs of animals}

Activity: As students examine the needs of human beings (Unit 1), animals (Unit 2), and plants (Unit 3), keep a chart of your students' ideas and examples for each group. This chart can be used as evidence during discussions of animals—including humans—during this unit. Ask your students to identify patterns across the first two domains providing appropriate support and scaffolding (e.g., all animals—including humans—eat food, some animals eat plants, some animals eat other animals, some animals eat both plants and other animals, etc.). Students will use the patterns culled from this "data" to describe what human beings, animals, and plants need to survive. [K-LS1-1]

Example #2: (End of Unit 2)

{Contributes to the Objective: Identify how scientists can learn about animal characteristics and behaviors}

Advance Preparation:

- You will need a copy of the Core Knowledge Text Resource, *Biography of Jane Goodall* pages 266–268.
- Each student (or pair of students) will need an observation journal. The journals can be composition books or teacher-created handouts stapled together.
- The second component of this activity is the opportunity for students to observe animal behavior. Therefore, you will need to determine what students will be observing (e.g., a class pet, animals at the zoo through a webcam or video clips, etc.) as well as when they will make these observations during the day.

- If students observe an animal in small groups or pairs, you may wish to allow them to complete this task during natural transitions during your day (e.g., as arrival or after they are prepared to dismiss for the day) and/or as part of one of your learning centers.
- If you prefer students make observations as a whole class, then it would probably be best to have students view several short clips of prerecorded video of the same animal during the next science lesson. Pause between clips for students to discuss what they saw with a partner and record their observations in their journals.

Activity: Explain to students that they will be learning about a famous scientist named Jane Goodall, who has studied chimpanzees for many years.

T- I am going to read you a story about Dr. Goodall. As you listen to the story, I want you to think about what she did in order to learn about chimpanzees and how scientists learn about the characteristics of animals and their behaviors.

Read aloud *The Biography of Jane Goodall*. Pause periodically to ask students to share ***what*** Dr. Goodall learned about chimpanzees and ***how*** she learned that information.

T- How did Jane Goodall learn about chimpanzees? (Student responses may include, "She looked at them," or "She watched them.")

T- When scientists carefully watch something, they call it an observation.

Ask students if they think observations can be made in very short instances or during longer periods of time (and what they remembered from the story that makes them think that).

T- In order to find patterns in chimpanzee behaviors, Dr. Goodall had to watch them very closely and for a long time. Over the next several days, we are going to act like scientists and observe animal behavior.

Introduce students to their observation journals. During each of the next one to two days, students will spend approximatley five minutes observing a class pet or animals through a webcam, such as on the following website: https://nationalzoo.si.edu/Animals/WebCams/. (If students watch a zoo webcam, it is important that they observe the same animal over the course of several days.) It may be best to build in time throughout the day (e.g., morning arrival, choice/center time, and during dismissal), so that small groups of students can take turns observing and recording what they see.

(During the following lesson, students will share their data, and you can model how students can look at the collected data to find patterns about the animal's behavior.)

Example #3: (End of Unit 2)

{**Contributes to the Objective:** Describe animals' characteristics or behaviors that allow them to survive in the wild}

Advance Preparation:

- Large images (that students can view from the carpet or their seats) of a lion in the savanna, a camel in the desert, a deer in the woodlands, and a whale in the ocean.

- One animal card per student. Each animal card displays an image of a lion, deer, camel, or whale and should be small enough that each child can hold the card up with one hand.

Activity: Display images of a lion in the savanna, a deer in the woodlands, a camel in the desert, and a whale in the ocean. Holding up the image of each animal, ask students if they can recall (from the prior day's lesson) the name of the animal and some of its characteristics and/or behaviors. As students share, records their ideas on the board or chart paper.

Pass out cards, each of which has a picture of a lion, deer, camel, or whale. Each student will have an image of one animal.

T- I am going to share a characteristic or a behavior. If it describes your animal, hold up your card.

As students engage in the activity, make statements or ask questions that call their attention to characteristics/behaviors that are unique to a specific animal or that are shared among several/all animals.

T- I want you to think about this question in your heads for a minute: what do these characteristics and behaviors (share a few examples) **allow these animals to do?** (Pause for thirty to sixty seconds.) **Now turn to your partner and tell him or her what these special characteristics and behaviors let each of these animals do.** (Allow students to talk for at least thirty seconds.) **Now I would like you to raise your hand and share what you and your partner discussed.**

The goal is for students to arrive at the idea that these characteristics and/or behaviors enable animals to survive in their environment. If students are off-topic, acknowledge their responses, but ask targeted questions that guide them to connect these characteristics to survival.

T- Each of these animals has unique characteristics or behaves in a certain way in order to survive in its environment…

Websites & Media

PBS Learning Video—What do animals eat? (approximately 1 minute)

http://www.pbslearningmedia.org/resource/tdc02.sci.life.colt.eat/what-do-animals-eat/

This short compilation includes footage of a variety of animals as they eat. You might ask your students to first name all of the animals they recognize in the video and then, after watching the clip again, to think about and share as many examples of animal food as they possibly can.

PBS Learning Video—Beavers (approximately 5 minutes)

http://www.pbslearningmedia.org/resource/tdc02.sci.life.colt.beaver/beavers/

The beaver is an example of an animal that changes its environment to meet its needs—"nature's own engineer." This video focuses on the beaver's ability to transform its environment to suit its needs.

Virtual Tour of the Smithsonian's National Zoo: https://nationalzoo.si.edu/Animals/WebCams/

Treat your students to a virtual field trip to the National Zoo. Smithsonian's National Zoo offers live webcams of their Asian elephant community, lion cubs, and giant pandas.

San Diego Zoo Exhibit—Polar Bears: http://animals.sandiegozoo.org/animals/polar-bear

The San Diego Zoo offers live footage, captivating photos, and fun facts of/about polar bears. For example, did you know that polar bears can swim at speeds of up to six miles an hour? Have your students learn more about polar bears, as well as other species, by taking a virtual tour of the San Diego Zoo.

Habitats & Animals: http://animals.sandiegozoo.org/habitats

Select a habitat and scroll through images of animals that live there. This may help your students to begin learning about the diversity of life on earth and can foreshadow their continued study of habitats in Grade 1.

Do all creatures sleep? http://animals.howstuffworks.com/animal-facts/all-creatures-sleep.htm

If you are curious to learn more about this *seemingly* simple question, then this article is for you.

Supplemental Trade Books

- Animal Homes, by Sally Hewitt ISBN 439228743
- Animal Parade, by Jakki Wood ISBN 9781845071660
- Cactus Hotel, by Brenda Z. Guiberson, Megan Lloyd ISBN 0805029605
- Deserts, by Neil Morris ISBN 0865058393
- In the Forest, by Maurice Pledger ISBN 1571453210
- Leaping Frogs, by Melvin Berger ISBN 156784023X
- Learning About Animals, by Evan-Moor Educational Publishers ISBN 9781557997715
- Learning about Animals, by Lo Ellen Moore ISBN 1557990972
- Life in the Desert, by Melvin Berger ISBN 9781567842173
- Life in the Sea, by Melvin Berger ISBN 9781567840131
- Life on the African Savannah, by Melvin Berger ISBN 9781567842142
- Our Animal Friends at Maple Hill Farm, by Alice Provensen, Martin Provensen ISBN 9780689844997
- There's a Rumble in the Jungle, by Giles Andreae, David Wojtowycz ISBN 9781589253674
- What Animal Am I? An Animal Guessing Game, by Iza Trapani ISBN 9780439318235
- Mice Squeak, We Speak, by Arnold L. Shapiro and illustrated by Tomie DePaola (Putnam Juvenile, 1997) ISBN 0399232028

- Polar Bear Polar Bear, What Do You Hear?, by Bill Martin Jr. (Henry Holt and Co., 1992) ISBN 0805023461
- Sleep Is for Everyone (Let's-Read-and-Find-out Science Book), by Paul Showers (HarperCollins Publishers, 1997) ISBN 0064451410
- Chicks & Chickens, by Gail Gibbons (Holiday House, 2003) ISBN 0823419398
- Pigs, by Gail Gibbons (Holiday House, 2000) ISBN 0823415546
- Sheep, by Rachael Bell (Heinemann, 2003) ISBN 1403440409

Recommended by the National Science Teachers Association:

- Next Time You See a Seashell, by Emily Morgan (NSTA Press) ISBN 9781936959150
- Next Time You See a Firefly, by Emily Morgan (NSTA Press) ISBN 9781936959181
- Next Time You See a Pill Bug, by Emily Morgan (NSTA Press) ISBN 9781936959174
- Next Time You See a Spiderweb by Emily Morgan (NSTA Press) ISBN 9781938946349
- What Does an Animal Eat? I Wonder Why, by Lawrence Lowery (NSTA Press) ISBN 9781936959464
- What Can an Animal Do? I Wonder Why, by Lawrence Lowery (NSTA Press) ISBN 9781936959457
- Looking for Animals: I Wonder Why, by Lawrence Lowery (NSTA Press) ISBN 9781941316276
- Animals Two by Two: I Wonder Why, by Lawrence Lowery (NSTA Press) ISBN 9781941316283

Core Knowledge Science Program - Domain Map

Science Content
• What plants need to grow: sufficient warmth, light, and water, air, and space (land) • Basic parts of common plants: seed, root, stem, branch, leaf, flower • Plants do not eat food, but make much of what they need themselves • Flowers and seeds: seeds as food for plants and animals (for example, rice, nuts, wheat, corn) • Two kinds of plants: deciduous and evergreen • Farming: How some food comes from farms as crops How farmers must take special care to protect their crops from weeds and pests How crops are harvested, kept fresh, packaged, and transported for people to buy and consume • A biography of George Washington Carver

This unit contributes to meeting or exceeding the following Next Generation Science Standards:	
K-LS1-1*. Use observations to describe* ***patterns of what plants*** *and animals (including humans)* ***need to survive****.*	***Rationale:*** This unit will explicitly engage students with the **concept of what plants need to grow and survive** (DCI LS1.C). This standard is further developed across the *Animals & Their Needs* and *The Human Body: Basic Needs & Five Senses* units of this grade. This core idea may be reviewed/applied during the *Taking Care of the Earth* unit as well.
K-ESS2-2*. Construct an argument supported by evidence for* ***how plants and animals (including humans) can change the environment*** *to meet their needs.*	As with K-LS1-1, the *Plants & Farms* unit will work with other units to meet or exceed this standard. In this unit, students will gain an early understanding that **plants do not eat food, but use light and gather water and minerals from their environment to make what they need to survive.** This concept of changing the environment (which also supports the progression of DCIs LS2.A and LS2.B) will be explored while studying how **farmers protect crops from weeds and pests**, **which change their environment in undesired ways.**

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
K-ESS3-1*. Use a model to represent the relationship between* ***the needs of different plants*** *and animals (including humans) and* ***the places they live****.*	***Rationale:*** The study of farms and farming contributes directly to the progression of DCI ESS3.A (Natural Resources), the core idea central to this Kindergarten standard. This unit also foreshadows learning in Grade 1 Unit 4 *Living Things & Their Environments,* which directly supports **K-ESS3-1** as it is written. **Important Note:** As written, this standard does not fully meet the early progression for ESS3.A, which is a core idea not addressed again until Grade 4 in the NGSS. This unit provides an excellent opportunity to meet this early progression. For example, studying farms and farming can help students to understand that humans do not necessarily live in environments that provide for all of their needs. Building a model of **how crops are harvested, kept fresh, packaged and transported for people to buy and consume** will address this concept while also engaging students in modeling human's impact on the Earth and the concept of system models.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. These skills, works of poetry, art, music, and more may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. (K-ESS2-1)

MP.4 Model with mathematics. (K-ESS2-1)

K.CC.A Know number names and the count sequence. (K-ESS2-1)

K.MD.A.1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. (K-ESS2-1)

K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. (K-LS1-1)

K.MD.B.3 Classify objects into given categories; count the number of objects in each category and sort the categories by count. (K-ESS2-1)

POTENTIAL CCSS ELA Connections

RI.K.1 With prompting and support, ask and answer questions about key details in a text. (K-ESS2-2)

W.K.1 Use a combination of drawing, dictating, and writing to compose opinion pieces in which they tell a reader the topic or the name of the book they are writing about and state an opinion or preference about the topic or book. (K-ESS2-2)

W.K.2 Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic. (K-ESS2-2)

W.K.7 Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-ESS2-1 & K-LS1-1)

POTENTIAL Cross-Curricular Connections

Potential Links:
ELA: Poetry—"Mary, Mary, Quite Contrary," "Roses are Red"
Fiction—American Legends and Tall Tales, Johnny Appleseed
Sayings and Phrases—"April showers bring May flowers" and "Great oaks from little acorns grow"
Music: Songs— "Oats, Peas, Beans, and Barley Grow"

Prior Knowledge

Core Knowledge Preschool Sequence
Scientific Reasoning and the Physical World

Goal: *Demonstrate an initial understanding of the living world*

- Plants are living things

CKLA Preschool

- State that plants are alive
- Name the four parts of a plant (i.e., roots, stem, leaves, flowers)
- State the function of the four parts of a plant (i.e., roots soak up water; stem holds the plant up; leaves collect sunlight and air; flowers make seeds)
- Describe how a sunflower grows (i.e., seed in ground; small root grows down; seedling comes up out of ground; flower grows from stem)
- Name plants' four basic needs: sunlight, water, air, nutrients (from soil)
- State three ways that plants are important to humans and animals (i.e., they provide oxygen, food, and shelter)
- Name five foods that come from plants (e.g., apple, blueberry, banana, carrot, lettuce, etc.)

Core Knowledge Science (Previously taught Kindergarten units)
Unit 1 *Human Body: Basic Needs & Five Senses*

- Distinguish between needs and wants
- Identify the basic needs of human beings

Unit 2 *Animals and Their Needs*

- Identify at least three basic needs of animals

CKLA Kindergarten Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

Domain Anthology, *Plants*

- Explain that different kinds of plants grow in different environments
- Explain that plants are living things
- Describe what plants need to live and grow: food, water, air, and light
- Identify the root, stem, branch, leaf, flower, fruit, and seed of a plant
- Explain that roots anchor the plant and take in water and nutrients
- Explain that stems support the plant and carry water and nutrients to the various parts of the plant
- Explain that the plant makes its food in its leaves
- Explain that seeds are the beginnings of new plants
- Explain the basic life cycle of plants
- Explain that some plants produce fruit to hold seeds
- Compare and contrast the fruits and seeds of different plants
- Identify the parts of specific plants that are eaten by people
- Identify the petals on a flower
- Describe how bees collect nectar and pollen
- Describe how bees make and use honey
- Describe the important role bees play in plant pollination
- Demonstrate familiarity with the tall tale "Johnny Appleseed"
- Compare and contrast deciduous and evergreen trees
- Explain that deciduous trees are a type of plant that loses its leaves in the fall and becomes dormant in the winter
- Explain that evergreen trees are a type of plant that stays green all year and does not become dormant in the winter
- Identify how deciduous trees are important to people and nature
- Identify things that plants provide to people: oxygen, food, and important products
- Describe the life and scientific achievements of George Washington Carver

Domain Anthology, *Farms*

- Explain what a farm is
- Describe a farmer's and a shepherd's jobs
- Identify animals found on farms and the sounds animals make
- Identify buildings found on farms
- Identify machines and tools of farming
- Demonstrate familiarity with the songs "Bingo" and "Old MacDonald Had a Farm"
- Identify needs of farm animals: food, water, and space to live and grow
- Describe how farm animal babies need to be fed and cared for by their parents or people
- Explain why farmers raise animals
- Identify foods that come from animals
- Explain why farmers grow crops
- Identify crops as plants grown on farms for use as food
- Describe how some food comes from farms as crops
- Sequence the seasonal rhythm of planting, growing, and harvesting
- Describe how farmers protect their crops from drought, and pests
- Sequence events of crops from farm to store (planted, harvested, transported, packaged)

What Students Will Learn in Future Grades

Core Knowledge Sequence

Grade 1
Living Things and Their Environments

- Habitats, Ocean and Undersea Life, and Special Classifications of Animals

Grade 2
Cycles in Nature

- Seasonal Cycles (seasons and life processes), Life Cycles (reproduction in plants)

Grade 3
Ecology

- Habitats, "balance of nature," food web, and ecosystems
- Man-made threats to the environment and protecting the environment

Grade 5
Classifying Living Things

- Kingdoms, Phylum, Class, Order, Family, Genus, Species, and (Variety)
- Homo sapiens
- Taxonomists
- Different classes of vertebrates

Grade 5 continued

Cells: Structures and Processes

- Structure of cells (both plant and animal)
- Plant cells, unlike animal cells, have cell walls and chloroplasts
- Cells are shaped differently in order to perform different functions
- Organization of cells into tissues, organs, and systems

Plant Structures and Processes

- Vascular and nonvascular plants
- Photosynthesis
- Asexual reproduction, vegetative reproduction, sexual reproduction
- Process of seed and fruit production
- Seed germination and plant growth

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Kindergarten unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Parts of a Plant

*plant, living, root, stem, seed, spore, leaf, flower, sprout, bulb, **bloom**, bud, cutting, blossom, shoot, needles, cone, trunk, branch, limb, fruit, pit, core, blade, petal, **pollen**, nectar, fiber, tissue, cells, slip, function, transport, anchor, absorb, germinate, **life cycle**, sapling, seedling, acorn, trait, characteristic, structure, part, piece, botany, **botanist***

Kinds of Plants

deciduous, evergreen**, tree, [types of trees], bush, shrub, herb, flowering, fern, conifer, weed, fruiting, vegetable, [types of fruits & vegetables], sunflower, rose, daisy, tulip, dandelion, **classification

Basic Needs of Plants

*important, water, air, carbon dioxide, oxygen, light, sunlight, shade, space, **soil,** ground, land, nutrients, **minerals**, nourish, energy, photosynthesis, survival, conditions, **environment**, habitat, temperature, warmth, cold, weather, dormant, climate, rain, **rainfall**, temperate, desert, forest, ocean, river*

Farms

*farmer, **resource**, natural, grow, crop, [examples of crops], fertilizer, irrigate, protect, tend, pests, pesticide, unwanted, undesired, garden, orchard, greenhouse, barn, fresh, spoil, **sow**, **harvest**, collect, **edible**, produce, graze, herd, flock, shepherd, livestock, [examples of livestock], **package**, seal, transport, ship, consume, purchase, market, store, grocery*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "Plants breathe by inhaling carbon dioxide and exhaling oxygen."

Plants do not breathe. Air enters the plant through the stomata (pores) in their leaves. Both carbon dioxide and oxygen are used for different processes in plants. Photosynthesis requires carbon dioxide, while respiration (the breakdown of sugars for use in the cells) requires oxygen. While plants do release oxygen, it is a byproduct of photosynthesis and is not released through breathing.

Misconception: "Plants get their energy from the soil through roots."

Chloroplasts in the plant absorb the sun's energy for use in photosynthesis. Water and minerals are taken in through the roots.

Misconception:"Leaves take in water."

Water is taken in through the roots.

Misconception: "Plants take in all substances they need to grow through their roots."

Plants take in air through their leaves. Chloroplasts in the plant absorb the sun's energy for use in photosynthesis. Water and minerals are taken in through the roots.

Key points for instruction:

Students may not consider trees to be plants. Researchers have found that when classifying animals, elementary students tend to define/use mutually exclusive groups rather than subsets of a larger group (e.g., stating that "humans are different than animals" when a person is both human and an animal.) Similar logic may be applied when studying plants. Listen carefully for student examples as they describe their thinking and use a variety of examples when helping students to define what is and isn't a plant.

Young students may not distinguish between food, as they know it, and misunderstand that the "food" made by plants is not exactly the same as the food that they eat.

Teachers should be sure not to overgeneralize the basic parts of all plants, for example when talking about seeds and flowers. Be sure to include in your examples plants such as ferns, which have neither seeds nor flowers.

When connecting this unit to previous learning (e.g., when reviewing Unit 1 *The Human Body*), keep into consideration that some students use movement and reactions to sensation as criteria for being alive, so students may not recognize plants as being living things (Driver et al, 1994). Plants do have senses and exhibit reactions to their environments. For example, **phototropism** is the phenomenon of plants growing or bending towards a source of light to meet their needs.

Potential Objectives for this Kindergarten Unit

The organization of the following objectives reflects the order in which they are expected to be addressed.The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Describe how plants are used in our everyday lives
- Identify the basic parts of a plant
- Describe how plants get and store energy
- Describe how plants grow
- Sequence the life cycle of a plant
- Identify characteristics of deciduous and evergreen plants
- Classify plants as deciduous or evergreen

Middle

- Identify what plants need in order to live and grow
- Compare and contrast plants' basic needs (to survive) to the needs of animals and human beings
- Infer how plants may change their habitat in order to meet their needs
- Describe how George Washington Carver used plants to meet people's needs

End

- Identify the needs of crops on a farm
- Describe how farmers use natural resources to take care of their crops
- Identify common livestock that can live on a farm
- Describe how plants help livestock meet their needs
- Describe the process of harvesting crops to people purchasing produce to consume
- Identify ways in which we can keep food fresh

Potential Big Guiding Questions

Essential Questions:

- **How are plants useful?**
- **How do farmers meet the needs of the crops they grow and the animals they raise?**

RE: Examining the parts of a plant

- How does this part of the plant [pointing to the roots, stem, branch, leaf, flower] look? (size, shape, color)
- What does this part of the plant [pointing to the stem, flower] smell like?
- How do you think this part of the plant [pointing to the stem, branch, leaf, flower] helps it grow?
- Why do you think the roots are spread out beneath the soil?
- How could soil help plants?

RE: Plants and Plant Life

- How are plants' needs different from the needs of human beings and animals? In what ways are they the same?
- In what ways are insects helpful to plants? In what ways are they harmful?
- How do plants affect their environment and other living things (human beings and animals)?

RE: Farms

- How do the needs of animals on a farm differ from wild animals? How do their needs differ from pets?
- How can farmers protect crops?
- How can we keep an apple fresh? (engineering opportunity)

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the assessment should take place.

Example #1: (Beginning of Unit 3)

{**Evaluates Student Mastery of Objective:** Identify the basic parts of a plant}

Advance Preparation:

- Create the assessment handout by drawing an image of a plant. Draw an arrow next to the plant's roots, stem, branches, leaves, and flower. **Note:** Students will be pasting a strip of paper on each arrow. Be sure to space the arrows so there is enough room to paste each strip.
- On separate strips of paper, write (or type) the terms, "roots," "stem," "branches," "leaves," and "flower." (Each child will need a set.)
- Gather glue sticks for each student.

Task Assessment: Provide each student the assessment handout. Explain that they will need to identify each part of the plant. Pass out the strip of paper with the term "roots" to each student.

T- (holding up a strip of paper with the word, "roots") **This word says, "roots," find the arrow that points to the roots of the plant.**

Pause for a moment in order to provide students with time to scan the picture and locate the roots. Walk around the room and check to be sure every child is pointing to an arrow on their paper.

T- Paste the word "roots" on the arrow that points to the plant's roots.

Repeat this process with the remaining terms.

Example #2: (End of Unit 3)

{**Evaluates Student Mastery of Objective:** Describe how farmers use natural resources to provide food for people} (K-ESS3-1)

Advance Preparation:

- Create a three-dimensional model depicting how crops are harvested, kept fresh, packaged and transported for people to buy and consume. **Note:** If you prefer to create a two-dimensional model, create images illustrating each step on separate pieces of paper.
- **Note:** This assessment would be best administered to students individually or to one small group of students at a time. Consider meaningful tasks that remaining students could complete independently (and/or in small group if there is another adult in the classroom).

Task Assessment: Ask students to describe what is happening in each step (in no particular order). **T- I want you to use this model and describe for me how food gets to your table. Think about which step happens first.**

As the children select the first step, prompt them to describe what is happening. You also may wish to have students manipulate the pieces of the model to reflect their sequence. If students forget where they left off, guide them with returning to the beginning and talking through each step.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the activity should be conducted during this unit. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 3)

{**Contributes to the Objective:** Identify the basic parts of a plant}

Advance Preparation: Variety of seedlings for every 1 to 3 students. The seedlings should be placed in clear cups (with minimal potting soil) so students can observe roots.

Activity: Place seedlings on student tables.

T- We have been learning about various living things and their needs, such as human beings and animals. Today we are going to learn about another type of living thing—a plant.

T- Plants, like human beings and animals, have different parts. How do our legs and hands help us? How does fur help some animals? Plants have parts that help them in different ways. You are going to work with your partner to observe these parts and their different functions (how they help a plant live).

T- I am going to ask you questions and you and your partner are going to look at the plant to find the answers.

See examples of guiding questions above.

Example #2: (Beginning of Unit 3)

{**Contributes to the Objective:** Classify plants as deciduous or evergreen}

Advance Preparation: Find images (or real samples) of a variety of deciduous leaves (e.g., maple leaf, red alder leaf, hazelnut leaf, etc.) and evergreen leaves (e.g. douglas fir needles, pine needles, spruce needles, madrone leaf, Oregon grape leaf, salal leaf, etc.).

Activity:

T- How are these leaves different? Probe by asking about the various characteristics, e.g., size, shape, texture, color. Note student responses on chart paper.

On a separate piece of chart paper, create a T-chart. Hold up a picture of (or actual) maple leaf. Affixing this leaf to one side of the T-chart, ask students to look at the other leaves.

T- Which leaves have similar characteristics to this maple leaf? As students identify specific leaves, ask them to describe the similar features. Note the characteristics at the bottom of the T-chart below these leaves.

Affix the remaining evergreen leaves to the other side of the T-chart.

T- How are the characteristics of these leaves (pointing to the evergreen leaves) **different from the leaves on this side** (deciduous) **of our chart? What patterns do you see?** Record student responses.

T- The leaves on this side of the chart with [___] **characteristics are examples of deciduous leaves.** Write deciduous on the top of that side of the T-chart. **And leaves that have** [____] **characteristics are examples of evergreen leaves.** Write evergreen on the top of this side of the T-chart.

T-Today we are going to learn about deciduous and evergreen plants. I want to you to pay special attention to other patterns that are unique to deciduous plants and patterns unique to evergreen plants. We will add this information to our T-chart…

Example #3: (Middle of Unit 3)

{**Contributes to the Objective:** Identify what plants need in order to live and grow} (K-LS1-1)

Activity: As students examine the means in which human beings (Unit 1), animals (Unit 2), and plants (Unit 3) interact with their environment, they will chart the collected data. Students will then identify patterns within the data (e.g., all animals eat food, some animals eat plants, some animals eat other animals, some animals eat both plants and other animals, etc.,). Students will use the patterns culled from the data to describe what human beings, animals, and plants need to survive.

Websites & Media

United States Botanic Garden https://www.usbg.gov/take-virtual-tour

Take students on a virtual tour of the United States Botanic Garden. This living plant museum highlights the diversity of plants and demonstrates how plants can enrich human life and support the Earth's ecosystems.

PBS Learning Video - Think Garden: Plant Structure (approximately 3 minutes)

http://www.pbslearningmedia.org/resource/5dea21b4-6c92-46ff-982c-8650f9429c01/think-garden-plant-structure/

This video examines plant structure by taking a closer look at the root and shoot systems.

PBS Learning Game - Sid the Science Kid: Vegetable Planting
http://pbskids.org/sid/fablab_vegetableplanting.html

This game simulates the process of growing seedlings.

The Story of Milk http://www.moomilk.com/virtual-tour

This virtual tour describes for students where milk comes from and how it gets to their table.

Egg Farm Virtual Field Trips http://www.aeb.org/educators/farm-to-table-virtual-field-trips

Students can explore multiple poultry farms and learn about how the chickens are cared for as well as how eggs move from the farm to their tables.

Supplemental Trade Books

Plants and Plant Growth

- *Big Red Tomatoes*, by Pamela Graham (National Geographic Society, 2001) ISBN 0792292219
- *Eating the Alphabet: Fruits and Vegetables from A to Z*, by Lois Ehlert (Voyager Books, 1993) ISBN 0152244360
- *Flower Garden,* by Eve Bunting and illustrated by Kathryn Hewitt (Voyager Books, 2000) ISBN 0152023720
- *From Bud to Blossom* (Apples), by Gail Saunders-Smith (Capstone Press, 2000) ISBN 1560659513
- *Growing Vegetable Soup*, by Lois Ehlert (Voyager Books, 1990) ISBN 0152325808
- *How a Seed Grows* (Let's-Read-and-Find-Out Science 1), by Helene J. Jordan (HarperTrophy, 1992) ISBN 0064451070

- *I Am a Leaf* (Hello Reader! Science, Level 1), by Jean Marzollo and Judith Moffatt (Cartwheel, 1999) ISBN 0590641204
- *I Am an Apple* (Hello Reader! Science, Level 1), by Jean Marzollo and Judith Moffatt (Scholastic, 1997) ISBN 0590372238
- *I'm a Seed* (Hello Reader! Science, Level 1), by Jean Marzollo and Judith Moffatt (Cartwheel, 1996) ISBN 0590265865
- *Jack's Garden*, by Henry Cole (HarperTrophy, 1997) ISBN 068815283X
- *Johnny Appleseed* (Rookie Biographies), by Christin Ditchfield (Children's Press, 2003) ISBN 0516278169
- *Johnny Appleseed*, by Reeve Lindbergh and illustrated by Kathy Jakobsen Hallquist (Little, Brown Young Readers, 1993) ISBN 0316526347
- *Maple Syrup* (Harvest to Home), by Lynne M. Stone (Rourke Publishing, 2001) ISBN 1589521285
- *Maple Syrup Season*, by Ann Purmell (Holiday House, 2008) ISBN 082341891X
- *Peanuts*, Pamela Graham (National Geographic Society, 2001) ISBN 0792289633
- *Plant Blossoms* (Look Once, Look Again Science Series), by David M. Schwartz (Creative Teaching Press, 1998) ISBN 1574713299
- *Planting a Rainbow*, by Lois Ehlert (Voyager Books, 1992) ISBN 0152626107
- *Potatoes*, by Beatrice Duggan (National Geographic, 2003) ISBN 0792242653
- *The Carrot Seed*, by Ruth Krauss and Crockett Johnson (HarperTrophy, 2004) ISBN 0064432106
- *The Honey Makers*, by Gail Gibbons (HarperTrophy, 2000) ISBN 0688175317
- *The Life and Times of a Peanut*, by Charles Micucci (Houghton Mifflin, 2000) ISBN 0618033149
- *The Life and Times of the Honeybee*, by Charles Micucci (Houghton Mifflin, 1997) ISBN 039586139X
- *The Reason for a Flower* (Ruth Heller's World of Nature), by Ruth Heller (Topeka Bindery, 1999) ISBN 0833590006
- *The Tiny Seed*, by Eric Carle (Aladdin, 2001) ISBN 0689842449
- *Why Do Leaves Change Color?*, by Betsy Maestro (HarperCollins, 1994) ISBN 0064451267
- *The Enormous Potato*, by Aubrey Davis (Kids Can Press, 1999) ISBN 9781550746693
- *George Washington Carver: Planting Ideas*, by Jennifer Kroll (Shell Education, 2010) ISBN 9781433315930
- *Seeds Sprout!*, by Mary Dodson Wade (Enslow Publishers, 2009) ISBN 9780766036147

Farms and Farming

- *A Day in the Life of a Farmer*, by Heather Adamson (Capstone Press, 2000) ISBN 0736846743
- *Barnyard Banter*, by Denise Fleming (Henry Holt and Company, 2008) ISBN 0805087788
- *Chicks & Chickens*, by Gail Gibbons (Holiday House, 2003) ISBN 0823419398
- *Fantastic Farm Machines,* by Chris Peterson and David R. Lundquist (Boyds Mill Press, 2006) ISBN 1590782712
- *Farming*, by Gail Gibbons (Holiday House, 1990) ISBN 0823407977
- *From Seed to Pumpkin*, by Wendy Pfeffer (Harper Trophy, 2004) ISBN 0064451909

- *Growing Vegetable Soup*, by Lois Ehlert (Voyager Books, 1990) ISBN 0152325808
- *Life on a Crop Farm* (Life on a Farm), by Judy Wolfman (Carolrhoda Books, 2001) ISBN 157505518X
- *Ox-Cart Man*, by Donald Hall and Barbara Cooney (Puffin, 1983) ISBN 0140504419
- *Pigs*, by Gail Gibbons (Holiday House, 2000) ISBN 0823415546
- *Potatoes*, by Beatrice Duggan (National Geographic, 2003) ISBN 0792242653
- *Sheep*, by Rachael Bell (Heinemann, 2003) ISBN 1403440409
- *The Little Red Hen Big Book*, by Paul Galdone (Clarion Books, 1985) ISBN 0899193498
- *The Milk Makers*, by Gail Gibbons (Aladdin, 1987) ISBN 0689711166
- *The Rusty*, Trusty Tractor, by Joy Cowley (Boyd's Mills Press, 2000) ISBN 1563978733
- *The Year at Maple Hill Farm*, by Alice and Martin Provensen (Aladdin, 2001) ISBN 0689845006
- *Chicks!*, by Sandra Horning (Random House, Inc., 2013) ISBN 9780307932211
- *A Day at Greenhill Farm*, by Sue Nicholson (DK Publishing, 1998) ISBN 9780789429575

Core Knowledge Science Program - Domain Map

Science Content
• The four seasons • Characteristic local weather patterns during the different seasons
• The sun: source of light and warmth • Daily weather changes: Temperature: thermometers are used to measure temperature Clouds Rainfall: how the condition of the ground varies with rainfall; rainbows Thunderstorms: lightning and thunder, hail, safety during thunderstorms Snow and snowflakes, blizzard

This unit contributes to meeting or exceeding the following Next Generation Science Standards:
Standards noted with an asterisk (*) are those that incorporate engineering and design

K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time. ***K-ESS3-2.*** Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.* ***K-PS3-1.*** Make observations to determine the effect of sunlight on Earth's surface. ***K-PS3-2.*** Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.*	***Rationale:*** This unit directly relates to all four of these standards, which are grouped within the NGSS topic of Weather and Climate for Kindergarten. The applicable core ideas embedded within this unit are: ESS2.D, ESS3.B, ETS2.B, and PS3.B. This unit also presents an excellent opportunity for students to apply their early learning about the sun, temperature, and thermometers to complete a design challenge relative to standard K-PS3-2. This Core Knowledge Science unit also kicks off the progression for learning about seasonal cycles and patterns, which will be extended and applied in Grade 1 during the Unit 2 *Astronomy*.

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
This unit connects to many future topics and standards, including: *1-ESS1-1*, *1-ESS1-2*, *2-ESS1-1*, *2-ESS2-1*, *2-ESS2-3*, and the *Grade 2 Topic: Structure & Properties of Matter*.	***Rationale:*** This unit is a particularly important foundation for students as the phenomena of seasons and weather reach across multiple disciplines in science. Through this unit students begin their earliest understandings of the sun (ESS1.A), they begin discussing cycles of events on Earth (ESS1.C)—seasonal patterns (ESS1.B)—as well as the importance of wind and water in Earth's systems (ESS2.A and ESS2.C). This unit also offers students concrete examples and experiences with temperature and the different states of matter (PS1.A) as they apply their previous learning about the basic needs of humans, other animals, and plants (LS1.C).

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. (K-ESS2-1)

MP.4 Model with mathematics. (K-ESS2-1),(K-ESS3-2)

K.CC Counting and Cardinality (K-ESS3-2)

K.CC.A Know number names and the count sequence. (K-ESS2-1)

K.MD.A.1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. (K-ESS2-1)

K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. (K- PS3-1),(K-PS3-2)

K.MD.B.3 Classify objects into given categories; count the number of objects in each category and sort the categories by count. (K-ESS2-1)

POTENTIAL CCSS ELA Connections

RI.K.1 With prompting and support, ask and answer questions about key details in a text. (K-ESS3- 2)

W.K.7 Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-PS3-1),*(K-PS3-2),*(K-ESS2-1)

SL.K.3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood. (K-ESS3-2)

POTENTIAL Cross-Curricular Connections

ELA: Poetry—"It's Raining, It's Pouring," "April Rain Song," "Rain, Rain, Go Away," "I Do Not Mind You, Winter Wind," "The More It Snows," and "Rain"

Sayings & Phrases—"April showers bring May flowers" and "[It's] raining cats and dogs"

Visual Arts: Elements of Art (Color)—Pieter Bruegel the Elder, *Hunters in the Snow*

Music: Songs— "Eensy, Weensy Spider"

Mathematics: Measurement of temperature and time—relative temperatures (hotter/colder), sequencing events, and orientation in time (today, yesterday, tomorrow; morning, afternoon; this morning versus yesterday morning, etc.)

Prior Knowledge

Core Knowledge Preschool Sequence
Scientific Reasoning and the Physical World
Goal: Demonstrate an initial understanding of the living world
Observe, describe and record:

- some basic properties of water, its presence and its effects in the physical world
- some basic properties of air, its presence and its effects in the physical world
- some basic properties of light, its presence and its effects in the physical world
- some characteristics of weather
- some characteristics of the seasons

CKLA Preschool

- Defining, reviewing, and expanding on words such as *autumn, spring, summer,* and *winter* relative to specific habitats (e.g., woodlands and deserts)

Core Knowledge Science (Previously taught Kindergarten units)
Unit 3 Plants & Farms

- Identify what plants need in order to live and grow
- Compare and contrast plants' basic needs (to survive) to the needs of animals and human beings
- Identify the needs of crops on a farm
- Describe the process of harvesting crops to people purchasing produce to consume

CKLA Kindergarten Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

Domain Anthology, *Seasons and Weather*

- Demonstrate understanding of the following units of time and their relationship to one another: day, week, month, year
- Name the four seasons in cyclical order, as experienced in the United States, and correctly name a few characteristics of each season
- Characterize winter as generally the coldest season, summer as generally the warmest season, and spring and autumn as transitional seasons
- Draw pictures that show an understanding of each season
- Characterize the North and South Poles as always cold in temperature, the middle section of the earth as usually warm, and most of the United States as having four seasons
- Describe daily weather conditions of their own locality in terms of temperature (hot, warm, cool, cold), cloud cover (sunny, cloudy), and precipitation (rain, snow, or sleet)
- Name at least one month in a specific season while referring to a calendar
- Name at least one holiday in a specific season
- Describe any unique seasonal differences that are characteristic of their own locality (change of color and dropping of leaves in autumn; snow or ice in winter; increased rain and/or flooding in spring, etc.)
- Identify ways in which weather affects daily routines, such as dress, activities, etc.
- Identify a thermometer as an instrument used to measure temperature and describe how it works: when it is hotter outside, the liquid in the thermometer rises; when it is cooler, the liquid descends
- Explain the lesson the grasshopper learns at the end of the fable "The Grasshopper and the Ants"
- Identify the following characteristics of thunderstorms: heavy rain, thunder, lightning, and strong winds
- Describe safe and unsafe behaviors during thunderstorms
- Explain why weather prediction is important in their daily lives

What Students Will Learn in Future Grades

Core Knowledge Sequence
Grade 2

II. Cycles in Nature

A. Seasonal Cycles

- Four Seasons and Earth's orbit around the sun
- Seasons and life processes

C. Introduction to the Water Cycle

- Most of the earth's surface is covered by water.
- The water cycle:
  - Evaporation and condensation
  - Water vapor in the air, humidity
  - Clouds: cirrus, cumulus, stratus
  - Precipitation, groundwater

Grade 4

V. Meteorology (including review from Grade 2)

- The Water Cycle: evaporation, condensation, precipitation
- Types of clouds: cirrus, stratus, cumulus
- The atmosphere:
  - Troposphere, stratosphere, mesosphere, thermosphere, exosphere
  - How the sun and the earth heat the atmosphere
- Air movement: wind direction and speed, prevailing winds, air pressure, low and high pressure, air masses
- Cold and warm fronts: thunderheads, lightning and electric charge, thunder, tornadoes, hurricanes
- Forecasting the weather: barometers (relation between changes in atmospheric pressure and weather), weather maps, weather satellites
- Weather and climate: "weather" refers to daily changes in temperature, rainfall, sunshine, etc., while "climate" refers to weather trends that are longer than the cycle of the seasons

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Kindergarten unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Seasons	Predicting Weather
*season, **autumn**, fall, winter, spring, summer, year, month, [months of the year], calendar, **cycle**, earth, daylight, weather, average, trend, different, change, **condition**, warm(er), cool(er), wet, dry, outside, inside, [activities common during the different seasons]*	***meteorologist**, meteorology, **forecast**, news, radio, station, **predict,** community, area, map, outlook, notice, record, describe, effect, cause, problem, danger, careful, cautious, safety, precaution, rule, raincoat, umbrella, cancel, help, tool, technology, structure, satellite, weather vane, design, warning, siren, prepare, respond, **reduce,** impact, event, indoor, outdoor, shelter*

Local Weather Patterns	Other Weather Patterns
*water, rain, rainfall, raindrop, snow, snowflake, ice, crystal, **precipitation**, soak, shower, wind, direction, blowing, atmosphere, air, sun, sunlight, heat, local, **pattern**, daily, temperature, thermometer, humid, **measure**, take, record, chart, observe, observation, data, morning, afternoon, freezing, melt(ing), thaw, characteristic, normal, common, (un)likely, rare, sometimes, often, climate, **region**, zone*	*sunny, cloud(y), calm, **overcast,** thunder, lightning, strike, flash, boom, loud, rumble, clap, storm, **severe**, extreme, **blizzard**, harsh, **flood**, flash, pour, hail, sleet, puddle, **drizzle**, sprinkle, flurry, slush, splash, tornado, twister, hurricane, typhoon, rainbow, color, [colors of the rainbow] fog, mist, scatter, frigid, shovel, sweat, chill, shiver, clothing*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "The seasons are caused by the earth's changing distance from the sun."

Students of all ages (including college and adult learners) have difficulty understanding and explaining the causes of the seasons. The root misconception behind this has been identified as a belief that the earth orbits the sun in an elongated elliptical path (Galili & Lavrik, 1998; Sadler, 1998). Other students, citing the tilt of the Earth on its axis, believe that the changing distance between a hemisphere and the sun is the cause of seasons (e.g., "summer occurs because our hemisphere is closer to the sun"). Teachers should be sure to understand that the distance to the sun changes relatively little, and that these minor changes cannot explain seasonal variations.

Misconception: "Lightning never strikes the same place twice."

Lightning tends to strike the highest points in a given area, as a result, such locations are likely to be struck repeatedly (Nelson, Aron & Francek, 1992).

Misconception: "Thunder occurs when two clouds collide."

Thunder and lightning are the visible and auditory effects of a massive charge transfer between clouds. (Russell et al 1993 as cited in Dove, 1998).

Misconception: "Snow and ice make it cold."

Snow and ice are a result of cold temperatures, not the cause.

Misconception: "Air and oxygen are the same thing." Air is a mixture of gases, including nitrogen, oxygen, argon, and carbon dioxide. **Misconception:"The seasons cause the weather to change."** Certain weather patterns and temperatures are associated with a particular season. A season is a classification of a period of time, not a force that causes weather.	**Key points for instruction:** The existence of water vapor in the atmosphere can be difficult for students to understand even into the middle school grades (Lee. et. al, 1993; Johnson, 1998). The focus of this Kindergarten unit should be on relative amounts of rainfall and snow during certain seasons, the condition of the ground when it rains, and *not* on the causes of precipitation. Grades 2 and 4 will provide specialized instruction to address potential misconceptions such as, "When water evaporates it ceases to exist" and "Evaporated water is still liquid, but it has changed locations."

Potential Objectives for this Kindergarten Unit

The organization of the following objectives reflects the order in which they are expected to be addressed.The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Describe how weather affects people in their day-to-day lives
- Describe weather patterns and temperature at different times of the year
- Compare and contrast weather in our community to a different region of the country
- Identify the four seasons
- Describe weather patterns associated with fall and winter
- Describe weather patterns associated with spring and summer
- Identify a tool that can be used to measure temperature
- Use thermometers to measure water and air temperature **(ongoing)**
- Observe and record local weather conditions **(ongoing)**

Middle

- Predict when objects will have hotter and cooler temperatures
- Describe how the sun affects the temperature
- Describe how sunlight affects materials on Earth (K-PS3-1)
- Describe characteristics of clouds
- Describe what clouds tell us about the weather

End

- Define the term 'forecast'
- Describe why weather forecasts are important when the weather is expected to be severe
- Describe how to stay safe during severe weather
- Describe how weather conditions change over time (e.g., over the course of several days/weeks) (K-ESS2-1)

Potential Big Guiding Questions

Essential Questions:

- **How do the seasons and weather affect living things?**
- **Why are weather forecasts important?**

RE: Seasons:

- How are the summer and winter different?
- How are the spring and autumn (fall) similar?
- What types of activities can you do in the summer, but not in the winter?

RE: Weather:

- When do we get the most snow? (or rain?)
- Has this week/month been mostly rainy, cloudy, or sunny?
- What causes the outside temperature to change?
- What kinds of severe weather are common in our area?

RE: Forecasting the weather:

- How can weather forecasts protect people from harm?
- What tools help people to forecast the weather?
- What can you do to be safe during different kinds of storms?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the assessment should take place.

Example #1: (Middle of Unit 4)

{**Evaluates Student Mastery of Objective: "**Predict when objects will have hotter and cooler temperatures," and "Use thermometers to measure water and air temperature"}

Advance Preparation:

- Three plastic/paper cups labeled "A," "B", and "C."
- Digital thermometers
- Access to warm/lukewarm water
- Ice cubes

Task Assessment: Place three cups (each filled with water) in front of a small group of students. Cup "A" is filled with warm water, cup "B" is filled with water at room temperature, and cup "C" is filled with cold water (water and ice cubes). Allow the students to take the temperature by feeling the water in each cup. Ask students to predict which cup (A, B, or C) will have the warmest temperature when measured with the

thermometer. Ask students to predict which cup will have the coldest temperature. As students make their predictions ask them to explain their thinking.

Hand each student a digital thermometer. Ask students to place their thermometers in the cup of water they think will have the coldest temperature. (Students should place their thermometers in cup "C"; however, if several students do not, that's ok.) Ask students to read (or show you) the temperature on the thermometer. Record the temperature on chart paper. (If some students picked a different cup, ask them to feel the water and their cup and then the water in cup "C." Ask which feels colder. Ask what that will tell them about the temperature--the water that feels colder has a colder temperature.) Ask students to place their thermometer in the cup with the warmest water. (Students can feel the water in all three cups again if they can't remember.) Ask students to read/show you the temperature on the thermometer. Record the temperature on chart paper. Ask students which cup of water hasn't been measured yet--cup "B." Ask students to feel the water in cup "A" and then cup "B." Share the water temperature they measured for cup "A," then ask students if they believe that the water in cup "B" will have a warmer temperature than cup "A", and why. Students should predict that "A" will have will have a warmer temperature because the water in that cup feels warmer than the water in cup "B." Ask students to place their thermometers in cup "B" and share the temperature. Record the temperature on the chart paper. Direct student's attention to the chart paper and discuss how the feeling of the water (warm, room temperature, cold) compared to the actual water temperature. Water that felt warm had a warmer temperature than water that felt cold.

Example #2: (Middle of Unit 4)

{**Evaluates Student Mastery of Objective: "**Describe how sunlight affects materials on Earth (e.g., sand, dirt, rocks, water, grass)"} (K-PS3-1)

Advance Preparation:

- This assessment requires the following objects:
  - two rocks (approximate same size and shape)
  - two cups filled with same amount of dirt or potting soil
  - two cups filled same amount of water
  - two cups filled with the same amount of grass clippings or leaves.
- Place one of each object in an area of your classroom that is shaded and place the remaining objects on a windowsill or area of your classroom that receives direct sunlight for most of the day. It may be helpful to place each object that is sitting in the sun on top of a small colored plate (e.g., green) and use plates of a different color (e.g., purple) for each object sitting in the shade. Let the objects sit out for a day (or several if sunlight is limited) prior to administering this task assessment.

Task Assessment: Place the alike objects side-by-side in front of a small group of students. Confirm with students that each of these materials are found on Earth. The materials on green plates have been sitting on the window sill for the past __ days while the objects that are placed on the purple plates have been placed [location of the classroom], which does not receive direct sunlight.

T- You will be comparing these materials through careful observations. You will use your sense of touch to determine how the sun can affect materials on Earth.

Ask the students to pair up and provide each pair with alike objects (e.g., the two rocks). Ask them to first feel the object that has been sitting in the shade (on the purple plate) and describe what it feels like. Next, ask students to feel the object that has been sitting in the sun.

T- Does it feel different?

If needed, elicit responses by asking guiding questions, such as, "How does it feel different compared to the ___ that was sitting in the shade?" Students should respond that the object sitting in the sun feels warmer or hotter and the object that sat in shade feels cooler or colder. Record students' thoughts on chart paper.

Refer students to the data collected on the chart paper. Read the observations students made when observing the objects through sight alone and then the observations they made when they touch the objects.

T- What does that tell us about the sun? How does sunlight affect objects on Earth, like rocks, water, grass, and dirt? How do you know?

Students responses should allude to the idea that the sun warms objects on the earth. To support their answers they should refer back to how the objects sitting in the sun felt warmer/hotter compared to objects sitting in the shade.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the activity should be conducted during this unit. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 4)

{**Contributes to the Objectives:** "Describe weather patterns and temperature at different times of the year"}

Activity: To activate students' prior knowledge about the seasons (and connecting this to Unit 1 *The Human Body: Basic Needs & Five Senses*) encourage your class to think about what they see, hear, smell, taste, and/or touch during different times of the year {asking about one sense at a time}. Write all ideas on chart paper, sorting by the time of year or season as defined by the students. Consider also prompting the students to think about the types of weather that they would expect to see, hear, etc. during different times of the year. Discuss with students that, during this unit, they will learn more about differences between times of the year called seasons, such as how much rain or snow falls and/or how hot or cold it is outside. Post and return to this chart as students progress across the unit to review and add to your list of predicted observations.

Example #2: (Beginning of Unit 4)

{**Contributes to the Objective:** "Use thermometers to measure water and air temperature"}

Activity: As part of a daily routine (e.g., morning calendar activities), discuss local weather conditions. This should include asking students if the weather is visibly sunny, windy, cloudy, rainy, snowy as well as collecting the daily temperature.

If possible, affix an analog thermometer outside a classroom window that can be read from inside. Explain that this type of thermometer measures the air temperature and model daily how you read the outside temperature. If and when students are able, ask them to read the daily temperature. At the end of every week discuss the recorded weather patterns.

Websites & Media

Timelapse Videos of the Seasons:
https://vimeo.com/search?duration=short&q=timelapse+seasons

Timelapse videos of an area can highlight the kinds of changes that occur over extended periods of time. For example, you might show this 40 second video of a woodland area that begins in the winter and progresses through all four seasons.

Interactive Seasons Activities:
http://www.sheppardsoftware.com/scienceforkids/seasons/seasons.htm

Select an interactive game to create images of the seasons using your students' examples of what they might see or hear during each one. The images can be "painted" using colors and representations of the animals, plants, and activities that are identified by your students. The resulting image can also be printed to display a class-created picture of each season.

Weather Games for Kids: http://www.weatherwizkids.com/weather-games.htm

You may be able to use some of these digital games with your students, such as the *Weather Word Search* to find and discuss vocabulary used in this domain.

Weather Underground: http://www.wunderground.com

The Weather Underground network offers a wide selection of digital media that you could consider sharing with students. This includes live webcams of weather around the U.S. and the world (as well as time lapse videos of past days), photos of various weather occurrences, and even informative videos for teachers to learn more.

Weather and Climate Resources from the OSU College of Education and Human Ecology: **http://beyondpenguins.ehe.osu.edu/issue/weather-and-climate-from-home-to-the-poles/**

The "Beyond Penguins and Polar Bears" project at OSU maintains useful information for teachers to build their background knowledge and to plan effective instruction that includes polar regions/examples so that they highlight the diversity of life and environments on Earth. Professional development resources, articles, and high-quality examples of lessons and activities are linked throughout this website and are offered under an Attribution-ShareAlike 3.0 Unported Creative Commons License.

SciJinks: It's All About Weather: **http://scijinks.jpl.nasa.gov/menu/topics/**

SciJinks is a joint project of NOAA and NASA that provides resources and digital media for topics including weather, satellite meteorology, and Earth science. The website is designed for middle and highschool students and their educators, however the Topics section can help you to build your background knowledge (e.g., "What is the difference between climate and weather?" and "What is a heat wave?"). The Multimedia section of this site also offers excellent digital photos of weather phenomena such as clouds and other extreme weather, including tornadoes. An image or two from this set could be displayed to students and spark their questions and discussions about these amazing happenings.

Supplemental Trade Books

- *Animals in Winter* (Let's-Read-and-Find-Out Science 1), by Henrietta Bancroft and Richard G. Van Gelder (HarperTrophy,1996) ISBN 0064451658
- *Bring Me Some Apples and I'll Make You a Pie: A Story about Edna Lewis*, by Robin Gourley (Houghton Mifflin Harcourt Publishing Company, 2009) ISBN 0618158362
- *Can You See the Wind?* (Rookie Read-About Science), by Allan Fowler (Children's Press, 1999) ISBN 0516264796
- *The Cloud Book*, by Tomie de Paola (Holiday House, 1975) ISBN 0823405311
- *Energy from the Sun (*Rookie Read-About Science), by Allan Fowler (Children's Press, 1998) ISBN 0516262556
- *Fall* (Thinking About the Seasons), by Clare Collinson (Sea-to-Sea Publications, 2011) ISBN 1597712590
- *Frederick*, by Leo Lionni (Dragonfly Books, 1973) ISBN 0394826140
- *Frog and Toad All Year*, by Arnold Lobel (HarperFestival, 1990) ISBN 1559942282
- *Four Seasons Make a Year*, by Anne Rockwell and pictures by Megan Halsey (Walker & Company, 2004) ISBN 0802788831
- *It's Cold Where I Live*, by Leroy Taylor (National Geographic School Publishing, 2003) ISBN 0792242807

- *The Lake*, by Lily Richardson (National Geographic Society, 2003) ISBN 0792243498
- *The Reasons for Seasons*, by Gail Gibbons (Holiday House, 1996) ISBN 0590907352
- *The Seasons of Arnold's Apple Tree*, by Gail Gibbons (Voyager Books, 1988) ISBN 0152712453
- *Snow Is Falling* (Let's-Read-and-Find-Out-Science, Stage 1), by Franklyn Branley and Holly Keller (HarperTrophy, 2000) ISBN 0064451860
- *Snowflake Bentley*, by Jacqueline Briggs Martin (Houghton Mifflin, 1998) ISBN 0395861624
- *Tools Measure Weather,* by Lesley Pether (National Geographic School Publishing, 2003) ISBN 0792243420
- *Tornado Alert* (Let's-Read-and-Find-Out Science 2), by Franklyn M. Branley and Giulio Maestro (HarperTrophy, 1999) ISBN 0064450945
- *Watch the Sky,* by Jacob Fink (National Geographic Society, 2001) ISBN 0792289234
- *Weather Forecasting,* by Gail Gibbons (Aladdin Library, 1993) ISBN 0689716834
- *Weather in the City,* by George Wong (National Geographic Society, 2001) ISBN 0792289463
- *Weather Words and What They Mean*, by Gail Gibbons (Holiday House, 1992) ISBN 082340952X
- *What Will the Weather Be?,* by Linda DeWitt and illustrated by Carolyn Croll (HarperTrophy, 1993) ISBN 0064451135
- *What's the Weather Today?*, by Allan Fowler (Children's Press, 1991) ISBN 0516449184
- *When a Storm Comes Up* (Rookie Read-About Science), by Allan Fowler (Children's Press, 1995) ISBN 0516460358
- *When Spring Comes,* by Solomon Gordon (National Geographic Society, 2006) ISBN 0792242742
- *Why Do Leaves Change Color?* (Let's-Read-and-Find-Out Science, Stage 2), by Betsy Maestro and Loretta Krupinski (HarperTrophy, 1994) ISBN 0064451267
- *Winter* (Thinking About the Seasons), by Clare Collinson (Sea-to-Sea Publishing, 2011) ISBN 1597712620
- *Winter Is Here*, by Sid Webb (National Geographic Society, 2003) ISBN 0792242920
- *The Boy Who Didn't Believe in Spring,* by Lucille Clifton (Penguin Young Readers Group, 1992)ISBN 9780140547399
- *A Tree for All Seasons,* by Robin Bernard (National Geographic, 2001) ISBN 9780792266747
- *Whatever the Weather*, by Karen Wallace (DK Publishing, 1999) ISBN 9780789447500

Core Knowledge Science Program—Domain Map

Core Knowledge Science Content	
• Some natural resources are limited, so people must be careful not to use too much of them (for example, oil deep in the earth used to make gasoline, wood from trees used to burn, build homes, and/or to make paper, and water for drinking, cooking, washing, etc.) • Conservation: Practical measures for conserving energy and resources (for example, walking or using public transportation instead of driving a car, planting saplings to replace trees that are cut down, not leaving water running when not being used, limiting how often lawns and decorative plants are watered, turning off unnecessary lights, etc.) • Some materials can be recycled (for example, aluminum, glass, paper) • Pollution (for example, littering, smog, and water pollution) can be harmful, but if people are careful they can help to reduce pollution.	
This unit contributes to meeting or exceeding the following Next Generation Science Standards: *Standards noted with an asterisk (*) are those that incorporate engineering and design*	
K-ESS2-2*. Construct an argument supported by evidence for how plants and* ***animals (including humans) can change the environment to meet their needs.*** ***K-ESS3-3****.* ***Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.******	***Rationale:*** This unit extends learning from two previous units, *Animals & Their Needs* and *Plants & Farms,* to connect student knowledge to the developing core idea of ESS3.C (Human Impacts on Earth's Systems). Specifically, the concept of organisms changing their environment (DCI ESS2.E) is applied and extended through connection to the concept of the conservation of natural resources (ESS3.A). These are three core ideas central to the NGSS Kindergarten topic of Interdependent Relationships in Ecosystems.
K-ESS3-1*. Use a model to represent the relationship between* ***the needs of*** *different plants and* ***animals (including humans)*** *and the places they live.*	***Rationale:*** The core idea of natural resources (ESS3.A) is also central to this particular standard, K-ESS3-1, which notes in its DCI Foundation Box: "Humans use natural resources for everything that they do." This unit connects student knowledge about human and animal needs (Units 1 and 2), and about farming (Unit 3), with new student learning about natural resources.

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
2-PS1-1. *Plan and conduct an investigation to* ***describe and classify different kinds of materials by their observable properties.*** ***2-PS1-2****. Analyze data obtained from testing different materials to* ***determine which materials have the properties that are best suited for an intended purpose.******	***Rationale:*** As students learn that some materials can be recycled, such as aluminum, glass, and paper, they are beginning the early progression of PS1.A by discussing different kinds of matter and classifying examples "by [their] observable properties (e.g., visual, aural, textural), by [their] uses, and by whether [they] occur naturally or [are] manufactured." (Framework, page 108) This idea will be extended by the introduction to magnets in Kindergarten Unit 6, *Pushes, Pulls, & an Introduction to Magnets,* during which students will classify materials according to whether they are or are not attracted to a magnet. In future grades, this progression will continue in Grade 1 Unit 5: *Matter & Its Properties*; in Grade 1 Unit 6: *Introduction to Electricity* (re: conductive versus nonconductive materials); and in Grade 2 Unit 4: *Magnetism* (re: naturally occurring lodestones versus manufactured magnets). This idea will then be applied in Grade 2 Unit 5: *Simple Machines* during an engineering design challenge.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music may help as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. (K-ESS3-1)

MP.4 Model with mathematics. (K-ESS3-1)

K.CC Counting and Cardinality (K-ESS3-1)

POTENTIAL CCSS ELA Connections

R.K.1 With prompting and support, ask and answer questions about key details in a text. (K-ESS2-2)

W.K.1 Use a combination of drawing, dictating, and writing to compose opinion pieces in which they tell a reader the topic or the name of the book they are writing about and state an opinion or preference about the topic or book. (K-ESS2-2)

W.K.2 Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic. *(K-ESS2-2),(K-ESS3-3)*

SL.K.5 Add drawings or other visual displays to descriptions as desired to provide additional detail. *(K-ESS3-1)*

POTENTIAL Cross-Curricular Connections

Potential Links:

ELA: Sayings & Phrases—"Waste not, want not."

History & Geography: American Presidents, Past and Present—Theodore Roosevelt (a pioneer for conservation as a naturalist and environmentalist)

Mathematics: Patterns & Classification—Establish concepts of likeness and difference by sorting and classifying objects according to various attributes; define a set by the common property of its elements; in a collection of objects that includes a given set and an item that does not belong, indicate which item does not belong.

Prior Knowledge

Core Knowledge Preschool Sequence
Scientific Reasoning and the Physical World

Goal: *Demonstrate an initial understanding of the elements of the material world.*

Level II

- Observe, describe, and record some basic properties of water, air, and light, their presence, and their effects in the physical world
- Identify and describe objects that can be recycled
- Identify and describe some ways that resources and energy can be conserved (e.g., recycling, turning off the lights, turning off the water, etc.)

Core Knowledge Science (Previously taught Kindergarten units)
Unit 1: ***The Human Body: Basic Needs & Five Senses***
Identify the basic needs of human beings.

Unit 2: ***Animals & Their Needs***
Describe how animals can change their habitats in order to meet their needs.

Unit 3: *Plants & Farms*

- Identify what plants need in order to live and grow.
- Compare and contrast plants' basic needs (to survive) with the needs of animals and human beings

CKLA Kindergarten Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

Domain Anthology: *Taking Care of the Earth*

- Explain why people have a special responsibility to take care of the earth.
- Explain that earth is composed of natural resources (land, water, and air) and that humans, plants, and animals depend on earth's natural resources to live.
- Explain different types of pollution, including litter, air pollution, and water pollution, and how most types of pollution are caused by people.
- Explain what happens to garbage, from its creation to being dumped in the landfill; to recyclable materials, from home to a recycling factory; to discarded food, from the table, to the compost pile, and to the garden; and the water cycle.
- Identify the recycling symbol and the phrase "reduce, reuse, and recycle," and understand that recycled materials are made from items that have already been used and otherwise would be garbage.
- Identify common recyclable materials, including glass, plastic, aluminum, cardboard, and paper; and that composting is a type of recycling.
- Identify possible solutions for the problems of garbage, litter, pollution, and conserving natural resources.

What Students Will Learn in Future Grades

Core Knowledge Sequence

Grade 1: *Living Things & Their Environments*

C. Environmental Change and Habitat Destruction

- Environments are constantly changing, and this can sometimes pose dangers to specific habitats, for example:
  - Effects of population and development
  - Rain forest clearing, pollution, and litter

Grade 3: *Ecology* (including review from Grade 1)

- Habitats, the interdependence of organisms with their environment
- The concept of a "balance of nature" (constantly changing, not a static condition)
- The food chain or food web: producers, consumers, and decomposers *(although the tendency is to recognize the limits of these models as well; see also Grade 1.)*
- Ecosystems: how they can be affected by changes in environment (for example, rainfall, food supply, etc.), and by human impacts on the earth
- Human impacts on the environment:
  - Air pollution: emissions, smog
  - Water pollution: industrial waste, runoff from farming
- Measures we can take to protect the environment (for example, conservation, recycling)

Core Vocabulary

The following list contains the Core Vocabulary words suggested for purposeful integration across this Kindergarten unit. Boldfaced terms can be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.

Natural Resources

*environment, **natural resource**, manufactured, riches, use, activity, depend, need, want, find, locate, important, everyday, comfort, planet, earth, consume, limited, abundant, waste, grow, replenish, replace, **(non)renewable**, material, substance, product, production, consumption, fossil, **fuel**, coal, gas, oil, petroleum, sunlight, minerals, soil, trees, plants, crops, land, livestock, food, water, ocean, river, stream, lake, ice, glacier, air, atmosphere, ozone*

[Also consider how to apply previously learned vocabulary from Unit 3 Plants & Farms]

Human Impacts on the Environment

*change, impact, consequence, global, world, **cause**, **effect**, long-term, short-term, **system**, **cycle**, interact, conserve, sustain, reduce, lessen, save, help, clean, preserve, protect, aware(ness), careful, practical, effective, responsible, reminder, positive, negative, environment, habitat, community, population*

Pollution and Garbage

***pollution**, pollutant, harm(ful), hazard(ous), dangerous, litter, dispose, discard, waste, **packaging**, landfill, dump, garbage, trash, mess, pile, bin, litterbug, smog, car, truck, vehicle, factory, company, smoke, burn, decay, **toxic**, contamination, health, clean, fresh, **treatment**, destroy, exhaust, chemical, industrial, urban, rural*

Recycling	Other Forms of Conservation
*reuse, recycle, **recyclable**, renew, symbol, aluminum, can, newspaper, paper, bottle, glass, plastic, soda, jug, bag, cardboard, compost, collect, **transport**, recycling center, shredder, heat, oven, **furnace**, remove, smelt, melt, blend, mix, pour, cool, harden, roll, mill, flatten, reshape, shipment, procedure, **process**, step-by-step, [examples of items made from recycled material]*	*faucet, sink, light switch, electricity, forest, woods, **logging**, wood, paper, [items made of wood and paper], erosion, weathering, plant, park, rain forest, tropical, temperate, **diversity**, species, **alternative**, solar, wind, hydroelectric, electric, nuclear, green, bikes, carpool, transportation, bus, [other types of mass transit]*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "Different kinds of organisms (species) do not compete for the same natural resources."

Students may conclude that different organisms/species use different resource stores (i.e., sources of resources) to meet their needs for food, water, space, and/or light. This idea may be reinforced by oversimplified representations of food chains/webs without special instruction to uncover and address this misconception. Increasingly complex relationships in the environment will be systematically explored through the CK Science program and across grades K–5.

Misconception: "Conservation means not using natural resources."

This is an overgeneralization. For example, humans need fresh water to survive, so we must use this natural resource in order to live. There are at least two different ways to approach conservation: *conservation* in the sense of reducing the use of certain natural resources (i.e., "use this, not that," such as using reusable water bottles instead of plastic ones that may be thrown away); and *efficiency* in the sense of doing what we need/want with fewer resources (i.e., solving the problem of "how can we do more with less?").

Misconception: "Organisms of the *same* species do not compete with each other for natural resources." Similar to the above misconception, students may conclude that organisms of the *same species (or in similar groups or classes)* use different resource stores to meet their needs (i.e., they rely on different sources of water, food, and/or light). For example, some students state that plants do not compete with other plants for light, water, and space. This may be reinforced by simplified representations of food chains/webs without special instruction to uncover and address this misconception. Increasingly complex relationships in the environment will be systematically explored across grades K–5.	**Key points for instruction:** "Students of all ages . . . may have the tendency to imagine that all environmentally friendly actions help to solve all environmental problems (for example, the use of unleaded petrol reduces the risk of global warming)," (*Atlas of Science Literacy,* Vol. 2, pg. 20, AAAS Project 2061). As instruction progresses within and across the grades, teachers should attempt to clearly and accurately foster descriptions of cause and effect relationships.

Potential Objectives for This Kindergarten Unit

The organization of the following objectives reflects the order in which they are expected to be addressed. The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Explain what a "natural resource" is and give at least three examples
- Identify everyday objects that are made from natural resources
- Describe how humans use the earth's natural resources (K-ESS3-1)
- Identify common resources that are limited and nonrenewable
- Classify resources as renewable or nonrenewable
- Describe how humans have changed the environment around them in order to meet their needs (K-ESS3-2)
- Identify examples of garbage produced by humans
- Describe why landfills pose a problem for humans, animals, and plants
- Identify different forms of pollution
- Describe why pollution poses a problem for humans, animals, and plants

Middle

- Describe why humans have a special responsibility to take care of the earth
- Describe how humans can reduce the pollution in their environment
- Identify items that can be used over and over again
- Identify materials that can be recycled (2-PS1-1)

- Classify objects as recyclable or as garbage
- Compare and contrast the process of composting with the process of recycling

End

- Identify how we can conserve energy and resources
- Describe the significance of Earth Day
- Develop solutions that can protect the earth's natural resources (K-ESS3-3)

Potential Big Guiding Questions

Essential Questions:

- **What is a natural resource?**
- **How do humans depend on earth's natural resources?**
- **How do humans change the planet?**

RE: Natural Resources and Human Impacts on the Environment:

- What kinds of natural resources are used in our classroom?
- How do humans depend on other animals as well as on plants? (application of previous units)
- How do humans change their environment to meet their needs? (application of previous units)

RE: Pollution, Garbage, and Recycling

- How much waste do we produce as a class in a day (or week)?
- What items can we use over and over again without making waste?
- Where do our newspapers, cans, and bottles go when we recycle them?

RE: Other Conservation Efforts

- What other kinds of natural resources do we often use?
- What can we do to limit our impact on the environment?
- Why do people use compost piles?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the assessment should take place.

Example #1: (Beginning of Unit 5)

{**Evaluates Student Mastery of Objective:** Describe why pollution poses a problem for humans, animals, and plants.}

Advance Preparation: Create the assessment handouts by dividing pieces of paper in half (top to bottom). At the top of the page, draw or attach three images depicting a plastic bag on the ground,

exhaust coming from a car's tailpipe, and an image of wastewater spilling into a river. Leave the bottom half of the paper blank for students to complete the task assessment.

Task Assessment: Ask students to describe what they see in each image. Through guided questioning, help students understand that each image is a representation of pollution. Explain to students that they will select one image, and in the space below (at the bottom of their paper), they will draw what that specific form of pollution does to the people, animals, and/or plants nearby. Rotate around the room, asking students to describe their illustrations, and transcribe their ideas on the bottom of the handouts. (Students, who are ready and able, can write words/phrases that describe their drawings.) Ask students to elaborate on why the pollution poses a problem for humans, animals, and/or plants in the immediate area.

Example #2: (Middle of Unit 5)

{**Evaluates Student Mastery of Objective:** Identify materials that can be recycled.} (2-PS1-1)

Advance Preparation:

- This activity requires a piece of chart paper or board, magazines, scissors, glue/tape, and large pieces of paper or poster board, one for each pair of students.
- Draw a T-chart on each piece of paper/poster board. On the left side of the chart, draw a symbol that represents "recycling" or affix a green dot; on the right side, draw a symbol that represents "trash" or affix a red dot. You may also wish to tear out magazine pages ahead of time with images of food and other everyday items for students to cut out. Also have two to three images of recyclable and non-recyclable materials of your own to elicit students' ideas during the introduction of this assessment opportunity.

Task Assessment: After the materials have been distributed to each table, explain to students that they will pair up with a partner to flip through a magazine (or magazine pages), looking for materials that can be recycled, as well as items that need to be thrown away after use.

T- What types of materials can be recycled? Engage students in a discussion to review the recyclable items previously taught: aluminum (cans), glass (bottles), plastic (bottles), and paper (newspapers, magazines, etc.). As students review each item, tape/paste a corresponding image on a piece of chart paper, and label each example (e.g., affix an image of a plastic soda bottle and label it as "plastic").

After the review, ask students to work in pairs to sift through the magazine pages and to identify recyclable and non-recyclable items. Pairs should work to cut out each image and to glue or tape it onto their T-charts in the correct sections. As students work on the activity, rotate from table to table, asking the pairs of students to describe the items they have identified as recyclable and those that need to be thrown in the trash—and why.

After students have had the opportunity to identify several items that are recyclable, as well as those that are not, ask pairs to "present" their findings to the whole group. *(Try to call on at least one pair that found a plastic, glass, or aluminum product not in the form of a can or bottle. Or, if necessary, be sure that you have such an example ready to be discussed if no one finds such an example. During previous instruction, students focused on plastic/glass bottles and aluminum cans as recyclable products. Using different products—such as milk jugs, pickle or baby food jars, and cereal boxes—will help students to*

recognize that the material from which a product is made is what makes the product recyclable and not how the product is used.) As students identify products that can be recycled, ask them (and classmates in the audience) to explain their thinking. Through questioning, guide students to focus on and describe the materials from which each product is made. Refer back to the review chart made during the introduction to this assessment as needed.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the activity should be conducted during this unit. Aligned NGSS are noted in parentheses.

Example #1: (Ongoing across Unit 5)

{**Contributes to the Objective:** Describe how people can conserve energy and resources.}

Activity: Have students discuss possible jobs around the classroom that could contribute to taking care of the earth. Make a list of these jobs, and then add them to your daily classroom jobs/routines. Examples may include making sure that paper is being recycled, that the water is turned off in the bathrooms or in classroom sinks, and/or making sure classroom lights are turned off when they are not needed. At the end of the week, have students report back to the class about how they have progressed with their jobs. This is a concrete way to begin having children think about and communicate actions to reduce the human impacts on the earth.

Example #2: (Middle of Unit 5)

{**Contributes to the Objectives:** Identify examples of garbage produced by humans; and Describe why landfills pose a problem for humans, animals, and plants.}

Activity: Track how much garbage is produced and the amount of recyclable items collected by your class each day.

Set up both recycling and trash bins in an area that is easily accessible in your classroom. At the end of each day, weigh the trash bin and the recycling bin using a weight or spring scale. On chart paper or the board, record how much trash (in grams or pounds) the classroom produced that day as well as how much trash students were able to save from landfills by recycling. At the end of the month, determine the total amount of trash collected and how much was recycled. Ask students to think about how their efforts to recycle impacted their environment.

Websites & Media

Pictures & Histories of U.S. National Parks:

http://kids.nationalgeographic.com/explore/history/history-of-the-national-parks/

This website provides information and images related to the national resources preserved through our national parks.

Children of the Earth United: http://childrenoftheearth.org/

Use this website to find educational materials that focus on the earth's natural resources, as well as on conservation methods such as recycling.

Conservation and Recycling Activities, Challenges, and Pledges:

- Billion Acts of Green—http://www.earthday.org/take-action/
- DoSomething.org—https://www.dosomething.org/search/apachesolr_search/recycling

Initiatives such as these offer periodic challenges and pledges that you might select with your students to sign up for and complete. Challenges have ranged from "Clean Like a Champion," during which teams sign up for a high-paced, athletic cleanup of a local park, to signing a pledge to reduce plastic waste by switching from disposable bottles to reusable alternatives instead.

Supplemental Trade Books

- *And Still the Turtle Watched,* by Sheila MacGill-Callahan (Puffin, 1996) ISBN 0140558365
- *Caring for Earth,* by Solomon Gordon (National Geographic Society, 2003) ISBN 0792243153
- *Garbage and Recycling* (Young Discoverers: Environmental Facts and Experiments), by Rosie Harlow and Sally Morgan (Kingfisher, 2002) ISBN 075345503X
- *I Am Water* (Hello Reader! Level 1 Science), by Jean Marzollo and Judith Moffatt (Cartwheel, 1996) ISBN 0590265873
- *It's Earth Day!* (Little Critter), by Mercer Mayer (HarperFestival, 2008) ISBN 0060539593
- *Just a Dream,* by Chris Van Allsburg (Houghton Mifflin, 1990) ISBN 0395533082
- *The Lorax*, by Dr. Seuss (Random House Books for Young Readers, 1971) ISBN 0394823370
- *Rachel: The Story of Rachel Carson,* by Amy Ehrlich and Wendell Minor (Voyager Books, 2008) ISBN 0152063242
- *Recycle!: A Handbook for Kids,* by Gail Gibbons (Little, Brown Young Readers, 1996) ISBN 0316309435
- *A River Ran Wild,* by Lynne Cherry (Voyager Books, 2002) ISBN 0152163727
- *The Three R's: Reduce, Reuse, Recycle* (What Do You Know About? Books), by Nuria Roca and Rosa M. Curto (Barron's Educational Series, 2007) ISBN 0764135813
- *The Wartville Wizard,* by Don Madden (Aladdin, 1993) ISBN 0689716672

- *Where Does the Garbage Go?*, by Paul Showers and illustrated by Randy Chewning (Harper Trophy, 1994) ISBN 0064451143
- *Why Should I Save Water?* (Why Should I?), by Jen Green (Barron's Educational Series, 2005) ISBN 0764131575
- *The Wump World*, by Bill Peet (Sandpiper, 1981) ISBN 0395311292
- *Composting: Nature's Recycler,* by Robin Koontz (Picture Window Books, 2006) ISBN 9781404822009
- *The Earth and I,* by Frank Asch (Houghton Mifflin Harcourt, 2008) ISBN 9780152063955
- *Keeping Water Clean,* by Helen Frost (Capstone Press, 2000) ISBN 9780736848770

Core Knowledge Science Program—Domain Map

Science Content
• Pushes and pulls can have different strengths and directions • When objects touch, they push on one another even if the objects do not move • Pushing or pulling on an object can start motion or stop it • When objects collide they can change the speed or direction of previous motion • A bigger push or pull makes things speed up or slow down more quickly • Identify familiar everyday uses of magnets (for example, in toys, in cabinet locks, in "refrigerator magnets," etc.) • Classify materials according to whether they are or are not attracted by a magnet

This unit contributes to meeting or exceeding the following Next Generation Science Standards:
Standards noted with an asterisk (*) are those that incorporate engineering and design

K-PS2-1*. Plan and conduct an investigation to compare* ***the effects of different strengths or different directions of pushes and pulls*** *on the motion of an object.* ***K-PS2-2****. Analyze data to determine if a design solution works as intended to* ***change the speed or direction of an object with a push or a pull.**** ***K-2-ETS1-2****. Develop a simple sketch, drawing, or physical model to illustrate how* ***the shape of an object helps it function as needed*** *to solve a given problem.*	***Rationale:*** This Kindergarten unit explicitly introduces the core idea of PS2.A: Forces & Motion, as students explore how "objects pull or push each other when they collide or are connected." Students also investigate the effects of different strengths and directions of pushes and pulls relative to the speed/direction of an object's motion (DCI PS3.C). For example, they can explore how changing the motion of toy cars and/or small balls can solve a problem.This unit also contributes directly to the early progression of PS2.B, Types of Interactions and Contact Forces, and provides early, concrete experiences with magnets, which will be explored in more scientific detail in Grades 2 and 4. The suggested culminating activity for this unit also offers students an opportunity to meet or exceed the engineering standard, ***K-2-ETS1-2***, when students develop and discuss a simple representation of how to solve a problem based on the shape of an object.

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards	
2-PS1-1. *Plan and conduct an investigation to* ***describe and classify different kinds of materials by their observable properties.*** ***2-PS1-2****. Analyze data obtained from testing different materials to determine* ***which materials have the properties that are best suited for an intended purpose.******	***Rationale:*** Students continue the early progression of PS1.A, started in Unit 5: *Taking Care of the Earth,* as they classify materials according to whether they are or are not attracted by a magnet. In future grades, this progression will continue in G1 U5: Matter & Its Properties; Grade 1 Unit 6: *Introduction to Electricity* (re: conductive versus nonconductive materials); Grade 2 Unit 4: *Magnetism* (re: naturally occurring lodestones versus manufactured magnets); and will then be applied in Grade 2 Unit 5: *Simple Machines* during an engineering design challenge.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. (K-PS2-1)

K.MD.A.1 Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. (K-PS2-1)

K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. (K-PS2-1)

Core Knowledge Sequence Guidelines

Mathematics: Patterns & Classification—Establish concepts of likeness and difference by classifying and sorting objects according to various attributes; define a set by a common property of its elements, and; in a given set, indicate which item does not belong.

POTENTIAL CCSS ELA Connections

RI.K.1 With prompting and support, ask and answer questions about key details in a text. (K-PS2-2)

W.K.7 Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them). (K-PS2-1)

SL.K.3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood. (K-PS2-2)

Prior Knowledge

Core Knowledge Preschool Sequence
Scientific Reasoning and the Physical World

Goal: Demonstrate an initial understanding of the elements of the material world.

- **Level II:** Observe, describe, and record the effects of magnets on various objects and other magnets.

Core Knowledge Science (previously taught Kindergarten units)
Unit 5: *Taking Care of the Earth*

- Classify objects as recyclable or as garbage *(i.e., this objective supports the growing understanding of the core idea PS1.A, as students continue to classify materials according to observable properties)*.

What Students Will Learn in Future Grades

Core Knowledge Sequence
Grade 2 Simple Machines

- Types of simple machines (e.g., wheel-and-axle, gears: wheels with teeth and notches, how gears work, and familiar uses, such as in bicycles)
- Friction, and ways to reduce friction (lubricants, rollers, etc.)

Grade 2 Magnetism

- Magnetism demonstrates that there are forces we cannot see that act upon objects.
- Most magnets *contain* iron.
- Lodestones: naturally occurring magnets
- Magnetic poles: north-seeking and south-seeking poles
- Magnetic field (strongest at the poles)
- Law of magnetic attraction: unlike poles attract, like poles repel
- The earth behaves as if it were a huge magnet: north and south magnetic poles (near, but not the same as, geographic North Pole and South Pole)
- Orienteering: use of a magnetized needle in a compass, which will always point to the north

Grade 4 Electricity

- Conductors versus insulators
- Electromagnets: how they work and common uses

Core Vocabulary

*The following list contains the Core Vocabulary words suggested for purposeful integration across this Kindergarten unit. **Boldfaced** terms can be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Pushes and Pulls

*push, pull, touch, press, force, **interaction**, connected, tied to, rope, string, wire, **balance**, lever, weight, **cause**, **effect**, strength, size, strong, weak, more, less, direction, way, left, right, up, down, sideways, angle, **motion**, movement, slide, roll, move, fall, slip, at rest, motionless, still, unmoved*

Changes in Motion

collide**, crash, hit, propel, bounce, strike, change, alter, divert, different, happen, **accelerate**, quick, slow, speed up, slow down, stop, start, friction, contraption, tool, **device**, **model**, drawing, picture, representation, **engineer

Introduction to Magnets

*magnet, magnetism, magnetic, **phenomenon**, invisible, **property**, ability, field, **attract**, **repel**, hold, stuck, pole, north, south, **material**, metal, filings, iron, nickel, cobalt*

Classifying Objects with Magnets

*classification, **classify**, sort, **matter**, **characteristic**, attribute, size, shape, color, set, group, same, alike, **common**, different, unlike, familiar, everyday, objects, type, paper clip, staple, coin, [other everyday objects attracted to magnets]*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "Forces only occur when motion is changed," or **"Only moving objects have forces acting on them."**
Students of all ages can fail to recognize that objects at rest experience forces. Activities and discussions using a leveled balance or lever can help to demonstrate that forces exist when motion does not.

Misconception: "Objects in motion within a curved tube/path will continue to curve when the object exits the tube/path."
Students of all ages may believe that a track or path will influence an object's motion even after the track ends (Mayer, 2007; McClosky, Caramaza, & Green,1980). When an object exits the curved path, the force exerted by the path is removed, so the object will actually continue in a *straight line.* To explore this concept with early elementary students, Page Keeley offers a formative assessment probe, the "Marble Roll," in her book *Uncovering Student Ideas in Primary Science* (page 71, 2013).

Misconception: "A large magnet is stronger than a small magnet."
Young students often think a larger magnet will have a larger effect, using a "more of A, so more of B" logic (Keely, 2013). Teachers should be aware of the examples used during instruction, using small, strong magnets as well as larger, weak magnets to draw attention to the differences in size and strength of the forces.

Misconception:"Magnetism is a type of gravity."
Students of all ages may think that gravity and magnetism are related and "interchangeable" terms (AAAS, Volume 2, page 26, 2007). In later grades, for example in CK Science, Grade 2 Unit 4: *Magnetism*, teachers should be especially aware of this misconception when exploring the ideas of orienteering using compasses and the early study of earth's magnetic field.

Misconception: "Magnets don't work where there is no air."
Similar to misunderstandings about gravity, some students believe that magnetism is observable on earth, but not in space. This may be related to misunderstandings of gravity and magnetism as "interchangeable." (Arons, 1997; Driver et al, 1994)

Key Points for Instruction:
Children need to develop the language tools to describe motion appropriately prior to developing an understanding of the principals of motion (Driver, Squires, Rushworth, and Wood-Robinson, 1994). It is highly recommended that teachers scaffold and promote vocabulary development during this unit, using strategies such as Word Walls (Keely, 2013).

Elementary students are usually familiar with the behavior of magnets, but they may not explain that behavior in terms of forces (i.e., they may not recognize that a magnet moving or sticking to an object is the effect of a push or pull). (AAAS, Volume 2, page 26, 2007)

Potential Objectives for This Kindergarten Unit

The organization of the following objectives reflects the order in which they are expected to be addressed.The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Predict how pushes and pulls affect objects.
- Describe what happens when objects touch.
- Identify whether the force between two objects is a push or a pull.
- Describe the direction of a push or pull.
- Apply your knowledge of forces to balance a lever.

Middle

- Compare the strength of force applied to reach different distances.
- Describe the term 'motion.'
- Identify what causes a change in motion.
- Predict what will happen when two objects collide and push on each other.

End

- Describe different ways magnets are used in everyday life.
- Describe the term 'attract.'
- Classify materials according to whether they are or are not attracted by a magnet.
- Describe the term 'repel.'
- Apply your knowledge of forces and magnets to solve a problem.

Potential Big Guiding Questions

Essential Questions:

- **Can you predict what will happen when objects touch or collide?**
- **Where can we find magnets in our classroom?**
- **What kinds of objects are attracted to a magnet?**

RE: Pushes and pulls

- What is keeping this object at rest?
- How are pushing and pulling similar/different?
- How can you balance this lever?
- What happens when a stronger/weaker force is applied to an object?
- What happens when a force is applied in a different direction?
- How might you push/pull this object to our target?

RE: Magnets

- Can you predict what will be attracted to a magnet?
- What is the difference between the terms 'attract' and 'repel?'
- Can you solve a problem using your knowledge of forces and magnets?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the assessment should take place.

Culminating Performance Assessment: Applying Pushes & Pulls (End of Unit 6; also see Potential Activity, Example #1)

Advance Preparation:

- You will need to provide students with the following materials:
  - A small ball
  - A barrier (e.g., set of blocks or books)
  - A large flat target (e.g., piece of paper or paper plate)
  - A starting position (e.g., paper circle or star)
  - An array of child-friendly materials that students can use to help direct the ball to hit the target (e.g., a toy car ramp, large blocks, lincoln logs, bins/containers, etc.)
  - Paper on which students can draw model representations of their "contraptions" and illustrate how the contraptions will help the ball to hit the target
- Tape the starting position and target on the floor or large table. Place a small "barrier" in between the two (see sample diagram above at right).

Task Assessment: Challenge your students to be engineers and inventors in this culminating performance task. Explain that they will draw a model illustrating how their contraptions can be used to direct the ball to hit the target. This task assessment will be completed across two days.

Day 1:

Have students sit around the table or area where you have placed the objects (i.e., starting position, barrier, and target). Describe to students that you have a simple problem for them to solve and that they will be engineers as they help you to find a variety of solutions.

T—I want to push this ball so that it rolls and hits this target. Do you think I will be able to do that? After providing students with thirty to sixty seconds of think-time, ask them to share their thoughts. Students should conclude that one would not be able to do this because of the barrier between the ball and the target. Model what happens when one pushes the ball toward the target.

T—What happened? Students should describe the event of the ball bouncing off the barrier.

T—Do you think if I change the amount of force I apply, I can make the ball hit the target? In response to students who say, "Yes," ask, **How much force do you think I should apply?** (Encourage students to use descriptors such as lighter, weaker, less, strong, heavy, or hard). Turning to students who say "No,"ask, **Why don't you think I can hit the target by applying a weaker or stronger force?** Prepare to demonstrate what happens when the ball is rolled toward the barrier with greater/weaker force (based on student feedback). If you are applying a greater force, you may wish to have all students move to the side of the table/floor by the target, to avoid anyone being hit by the ball when it bounces off the barrier. Roll the ball, and discuss why a greater/weaker force will not be an effective way to reach the target behind the barrier.

T—If we can't get through the barrier, how can we reach the target? Through questioning, help students arrive at the idea that they can reach the target by finding a way around or over the barrier.

Display an assortment of materials from your classroom that students can work with (e.g., a toy car ramp, large blocks, bins/containers, etc.).

T—You are going to choose from these materials to build a "contraption" that will help our ball to reach the target. What are two ways that the ball could reach the target? If students suggest that the ball could move over the barrier, say, **Since we can only roll the ball, we will need to build or use something that can roll the ball over the barrier.** You may want to model some non-examples and demonstrate some ideas that will not work, such as building stairs with blocks, so that students understand that to move the ball over the barrier, they will need a smooth surface. If students suggest moving the ball around the barrier, ask, **Can the ball be rolled on a curved surface? Think about what you could build to help get the ball to the target if you rolled it to the side.** Be sure to ask students to use words learned in this unit regarding direction and strength of forces, as well as those regarding changes in motion.

Ask students to return to their individual seats, and pass out paper to them. Explain that they will each draw a picture model that illustrates how to use material(s) to solve the problem (i.e., to help the ball reach the target). Remind students that they can only roll the ball, and leave the starting point, barrier, target, and materials visible as they work. Rotate around the room, and ask students to describe their models, making note of keywords or phrases used by each student. Ask how much force they would apply to the ball, in which direction, and why. Encourage students to think about the relationship between their contraption's shape and their solution (e.g., a ramp is slanted to help carry the ball over the barrier). If possible at the end of the day, photocopy their picture modes so you have a copy of their first drafts.

Day 2:

Explain to students that you would like them to share their models from Day 1 with one or two partners. Encourage students to tell their partners how they think their contraptions will help the ball hit the target. Remind students to use descriptions of the amount of force they think is needed and in which direction. As students share, walk around the room, making note of their ideas. Identify at least two to three models that you believe will solve the problem when tested and, while students continue to discuss, gather the materials that these students will need to build their contraption.

One at a time, ask these two or three students to share their picture models with the class. Assist (or encourage several other students to assist) each student with building/positioning his or her contraption

as the model is described. Once built, have students stand around the starting point, barrier, and target. (**Safety Note:** As students test their models, it may be best to move other students back a safe distance so they are not accidently struck by the ball.) As each child tests his or her model, ask him or her to describe the amount of force he or she is applying, the direction of that force, and why. For example: **"Why wouldn't you want to apply a very strong force when rolling the ball up the ramp?"** or **"Why wouldn't you apply a weak force when rolling your ball toward the wall you made out of building logs?"**

After the two to three demonstrations, ask students to return to their seats and to compare their own picture models with what they have just seen.

T—A part of an engineer's job is finding ways to improve her or his original model. Look at the model you drew yesterday. Think about what your classmates just showed us, and how you can change your model to solve our problem in a better way. It can be a big change or a small change. For example, do you think using different materials would be better? Or, do you think you can make your drawing better with more details?

Give students a minute to think about what they should do. After signaling that they can begin drawing, rotate around the room, asking students to describe how and why they are adjusting their models. If some students wish to create very different models compared with their original drafts, it may be helpful to provide them with another piece of paper.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the activity should be conducted during this unit. Aligned NGSS are noted in parentheses.

Example #1: (Middle of Unit 6)

{Objective: Compare the strength of force applied to reach different distances.}

Advance Preparation:

- This activity requires direct teacher supervision of a small group. It is most effective when used as a station or part of a series of small group activities.
- Provide two targets (e.g., small hoops, plastic cups, or paper plates) that are labeled 'A' and 'B' that you will use to mimic a mini golf game.
- Provide a small ball (e.g., a plastic or foam ball). One to two extra balls may help facilitate the activity as well.
- Provide one object that can be used to push the ball toward a target (e.g., a toy golf club or any child-safe object that can be used to propel the ball toward the targets). **Safety Note:** It is

recommended that only one toy golf club or other object is used and that it is monitored closely by the teacher as groups rotate to complete this activity.

- In a relatively open area of your classroom, set the targets in two locations at different distances (in approximately the same direction). Depending upon your classroom space, you may wish to complete this activity in an alternate location, such as outdoors or in a gymnasium.
- Identify a good "starting position" from which you believe students will be able to successfully hit a ball onto/into each target. Be sure that the targets are at different distances so that your students can discuss differences in the amount of force needed to successfully hit their target.
- Before conducting this activity, consider any extenuating circumstances that may require adjustments in order for students to successfully and safely complete the activity.

Activity: Through this activity, students will investigate and discuss the concept of "bigger" and "smaller" forces through concrete experiences.

Explain to students that they will work as part of a small group to propel a ball to hit two targets. [**Safety Note:** It is recommended that the teacher sets ground rules for how the toy golf club or other object is to be used safely and that the teacher closely monitors the student attempting to hit the ball towards the targets.] Identify the first target ('A' or 'B'), and ask a volunteer from the group to aim the ball and hit it. If the student hits the target, ask him or her to describe the force he or she applied. If he or she misses the target, ask the group to describe what could be done next time to hit the target from the starting position (e.g., apply more/less or stronger/weaker force). (If applicable, you can also discuss the direction of the force, however, help students to address the amount of force and the direction each separately.) In addition, looking at the ball's new position, you may ask the group to think about the amount of force that would need to be applied since the ball is now closer to or further from the target. When aiming for the second target, ask group members to predict whether more or less force should be applied to hit it and to explain their prediction. After a different child from the group attempts to hit this target, ask the students if their predictions were correct. You can add a layer of challenge by asking students to compare the forces they used to push the object to "hit the mark" when aiming at target 'A' versus target 'B.'

Time permitting, consider extending this activity by setting the targets in opposite directions but at the same distance. Engage students in a conversation about applying a push force in different directions.

Example #2: (End of Unit 6)

{Objective: Classify materials according to whether they are or are not attracted by a magnet.}

Advance Preparation:

- Prepare your room so that students will have easy access to various objects that are and are not attracted to a magnet. For example be sure that classroom supplies, such as paper, pencils, toys, paper clips, coins, etc., are accessible for students to complete a small-group "scavenger hunt" around your room. Their goal will be to collect six items, in groups of two to three, including three items that are attracted to magnets and three that are not.

- Ensure that you have enough child-safe magnets, one for each student, so that all students can participate and demonstrate their reasoning through nonverbal responses, as you also probe for verbal answers to your questions.

Activity: Ask students to share what they have learned about magnets so far (e.g., ways that magnets are used in everyday life and/or a working definition of the term "attract" that was developed in an earlier lesson). Then, invite your students to participate in a "magnetic scavenger hunt" for items around your classroom. Their goal, in groups of two to three students, is to collect at least three objects that are attracted to a magnet as well as three objects that are not. [**Safety Note:** It is recommended that the teacher sets ground rules for behavior during the scavenger hunt. For example, that all students should walk and be courteous of others and that groups should stay together while searching for items around the room.] Before starting the scavenger hunt, provide time for all groups to brainstorm ideas of what they might collect to meet your challenge, for example, using the Think-Pair-Share protocol. Give student groups thirty to sixty seconds to discuss possible objects that they could collect, and then provide all students with a child-safe magnet. Also ask your students to think about the following question as they complete the hunt: "How will I know whether an object is attracted to a magnet or not?" Setting a time limit, such as three to five minutes, invite each group to collect a variety of classroom objects that match your challenge.

Periodically provide students with a time check, letting them know, for example, that they have two minutes left to complete the challenge, etc. When the time limit is up, ask students to sit with their groups at tables or on the carpet. Provide at least two to three more minutes for students to organize their items and to come to a consensus about why each item fits your challenge/criteria.

Then, ask each group to pair with another set of students to share what they found and to discuss why it fits your challenge. (Hint: to spur productive listening, consider asking your students to share what the partner group found before sharing what they found themselves.) Rotate through the groups as they share, probing for more information about what they were thinking about each object and why (e.g., "How do you know that this item is/isn't attracted to a magnet?"). When groups are finished sharing, ask for volunteers to share another group's examples first and then to share their own.

Websites & Media

PBS Kids—Sid the Science Kid's Balancing Game: http://pbskids.org/sid/balancingact.html

Consider using this interactive game to introduce or support your discussion of balances, levers, and the forces that objects exert/experience even when they are at rest.

How Stuff Works:

The web pages below can help you to enhance your background knowledge of magnets and magnetism. They may also be useful for teaching about magnets during future domains, such as astronomy, geology, and matter.

- **Magnets** http://science.howstuffworks.com/magnet.htm
- **Compasses** *(Foreshadowing Grade 2)* http://adventure.howstuffworks.com/outdoor-activities/hiking/compass.htm
- **Stuff to Blow Your Kid's Mind: Magnets** *(Foreshadowing Grades 1, 2, and 4)* http://shows.howstuffworks.com/stuff-to-blow-your-mind/51304-stuff-to-blow-your-kids-mind-magnets-video.htm

Supplemental Trade Books

- *What Magnets Can Do,* by Allan Fowler (Children's Book Publisher, 1995) ISBN 051646034X
- *What Makes a Magnet,* by Franklyn Branley and True Kelley (HarperCollins, 1996) ISBN 0064451488

Recommended by the National Science Teachers Association:

- *Magnetic and Nonmagnetic* (My World of Science), by Angela Royston (Heinemann Educational Books, 2003) ISBN 140343168X
- **Teacher Reference:** *Stop Faking It! Force & Motion*, by William C. Robertson (NSTA Press, 2002) ISBN 9780873552097

Core Knowledge Science Program—Domain Map

Science Content	
• A biography of Wilbur and Orville Wright (engineers who solved the problem of powered flight) • Engineers use the design process to solve problems: ○ Defining the problem ○ Possible Solutions ○ Plans & Models *Foreshadowed for future learning:* ○ *Engineering investigations and testing* ○ *Comparing multiple solutions* ○ *Revisions and optimizing the design solution*	
This unit contributes to meeting or exceeding the following Next Generation Science Standards: *Standards noted with an asterisk (*) are those that incorporate engineering and design*	
K-2-ETS1-1. *Ask questions, make observations, and gather information about a situation people want to change to define a simple* ***problem that can be solved through the development of a new or improved object or tool.****	***Rationale:*** This unit will introduce the core idea central to this standard, ETS1.A (Defining Engineering Problems), through the study of two brothers and their creation of the Wright Flyer, the first airplane to sustain powered flight.
This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
K-2-ETS1-2. *Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.**	***Rationale:*** The core idea, ETS1.B (Designing Possible Solutions), was introduced during earlier units in Kindergarten (e.g., Unit 6 *Pushes & Pulls*) and will be applied again during design challenges in later grades, such as in Grade 1 Unit 6 *Introduction to Electricity* and Grade 2 Unit 5 *Simple Machines*.
K-2-ETS1-3. *Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**	ETS1.C (Optimizing the Design Solution) will be introduced and explicitly modeled during Grade 1 units so that students can begin to independently apply this idea during Grade 2 learning.Teachers may foreshadow this idea if/when they summarize different solutions to a single design problem.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections *(all apply to NGSS K-2-ETS1-1)*

MP.2 Reason abstractly and quantitatively.

MP.4 Model with mathematics.

MP.5 Use appropriate tools strategically.

K.MD.A Describe and compare measurable attributes.

K.MD.B Classify objects and count the number of objects in each category.

POTENTIAL CCSS ELA Connections *(all apply to NGSS K-2-ETS1-1)*

RI.K.1 With prompting and support, ask and answer questions about key details in a text.

W.K.6 With guidance and support from adults, explore a variety of digital tools to produce and publish writing, including in collaboration with peers.

W.K.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

Prior Knowledge

Core Knowledge Preschool Sequence
Scientific Reasoning and the Physical World

Goals: *Select and use tools; and Demonstrate use of the scientific reasoning cycle*.

Level II

- Select and use an appropriate tool to complete a task (e.g., to join paper, dig a hole, water a plant, etc.).
- Demonstrate use of the scientific reasoning cycle.

Core Knowledge Science (Previously taught Kindergarten units)
Unit 3 *Plants & Farms*

- Describe how George Washington Carver used plants to meet people's needs.

Unit 4 *Seasons & Weather*

- Describe why weather forecasts are important when the weather is expected to be severe.
- Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.

Unit 6 *Pushes, Pulls, and an Introduction to Magnets*

- Identify whether the force between two objects is a push or a pull.
- Describe the direction of a push or pull (using terms such as “left,” “right,” “up,” and “down”).
- Describe different ways magnets are used in everyday life (for example, in toys, in cabinet locks, in “refrigerator magnets,” etc.).

What Students Will Learn in Future Grades

Core Knowledge Sequence

Grade 2 Simple Machines

- Types of simple machines (e.g., wheel-and-axle, gears: wheels with teeth and notches, how gears work, and familiar uses such as bicycles)
- Friction, and ways to reduce friction (lubricants, rollers, etc.)

Biographies of Other Engineers

- Grade 1—Thomas Edison (invented an electric light bulb)
- Grade 2—Anton van Leeuwenhoek (invented a microscope) and Elijah McCoy (invented an automatic lubricator)
- Grade 3—Alexander Graham Bell (invented a telephone)
- Grade 4—Michael Faraday (chemist and physicist whose work led to the development of the electric motor and electric generator)
- Grade 6—Lewis Howard Latimer ((worked with Alexander Graham Bell on drawings of Bell’s invention, the telephone; and improved Thomas Edison’s light bulb)
- Grade 8—Charles Steinmetz (scientist who made key advances in electric power)

Engineering Design

- Students will also learn more about and apply additional steps of the engineering design process in future grades, such as:
    - Engineering investigations/testing
    - Comparing multiple solutions
    - Revisions to and optimizing the design solution

Core Vocabulary

The following list contains the Core Vocabulary words suggested for purposeful integration across this Kindergarten unit. ***Boldfaced*** *terms can be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

The Wright Brothers

bicycle, bike, shop, store, rent, sell, glide, wind, tunnel, kite, **glider**, idea, power, **engine**, motion, fly, **flight**, **design**, study, create, develop, build, machine, tool, invention, **mechanical**, manufacture, improve, fix, important, newspaper, example

Engineering and Design

engineer, **problem**, question, ask, define, science, apply, knowledge, **research**, study, **investigate**, experiment, solve, solution, tinker, try, design, improve, optimize, **model**, draw, sketch, **communicate**, demonstrate, criteria, goal, target, success

Airplanes

plane, **airplane**, jet, **lift**, **force**, push, pull, travel, structure, **function**, front, back, sides, wing, tail, **rudder**, **propeller**, blade, flap, cockpit, pilot, buckle, window, **control**, steer, wheel, landing, skid, drag, stop

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "Air is weightless."	Key points for instruction:
Understanding that air is a material that surrounds us and takes up space is a target for upper elementary students (AAAS, Vol.2, 2007). However, even high school students have been shown to have difficulty recognizing that air has weight and mass (Sere, 1985; Krnel, Watson, & Glazar, 1998). Students of all ages may describe that air only exerts force or pressure when it is moving and only in a downward direction (Driver et. al., 1994; Henricks, 2002).	Lift, the force that allows an aircraft to fly, is more complex than most people realize. Many diagrams—even in encyclopedias, textbooks, and websites—are overgeneralized and misleading because they focus on only one of the many factors that produce the force of lift (NASA, 2015). Teachers should be sure to plan their instructional language carefully, with a clear understanding of the grade-level objectives for their students. For example, this Kindergarten unit intentionally focuses on the basic parts of an airplane and the history of the Wright brothers, and does not attempt to answer the question, "What makes an airplane fly?"

Potential Objectives for this Kindergarten Unit

The organization of the following objectives reflects the order in which they are expected to be addressed.The proposed timing within the unit ("beginning" or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Identify the problem that the Wright brothers wanted to solve
- Identify the basic parts of an airplane
- Describe the purpose of an airplane's tail and rudder
- Describe the purpose of an airplane's propeller
- Compare and contrast the actions of gliding and flying
- Draw a model of a new airplane using what you know about parts of an airplane (foreshadowing (K-2-ETS1-2)
- Describe why engineers use models and drawings

End

- Describe how scientists ask questions and solve problems (K-2-ETS1-1)
- Identify problems that can be solved by engineers (K-2-ETS1-1)
- Describe a new problem that could be solved by engineers (K-2-ETS1-1)
- Identify possible solutions to a selected problem
- Develop a model that illustrates a solution to a selected problem (K-2-ETS1-2)
- Using a model, describe a solution to a selected problem

Potential Big Guiding Questions

Essential Questions:

- **How do the inventions of the Wright brothers affect our lives today?**
- **How do engineers solve problems?**
- **How do engineers know when they have solved a problem?**

Other possible questions:

- What is the difference between gliding and flying?
- Why did the Wright Flyer need a propellor?
- What is the purpose of the rudder on an airplane?
- Why do engineers use drawings and models?
- What other problems could be solved through engineering?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS are noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the assessment should take place.

Example #1: (Beginning of Unit 7)

{Evaluates Student Mastery of Objective: *Draw a model of a new airplane using what you know about parts of an airplane.***}**

Invite your students to design and draw a new airplane using what they have learned about the parts of all planes. To provide up-front support, consider asking students to name the parts of an airplane that help it to fly (e.g., wings, engine, propeller, rudder, steering wheel/stick, etc.). Ask your students to draw a model of a new airplane, using their knowledge *and* imagination. Circulate throughout the room in order to annotate their drawn models with keywords or phrases as they identify the critical parts. To challenge students, consider asking them to recall what specific parts the Wright brothers improved/created to enable flight (i.e., engine, propeller, and rudder). For added support/scaffolding, consider reading or rereading key sections of the biography of the Wright Brothers found in *What Your Kindergartener Needs to Know* (page 379) or using one of the supplemental trade books found on page 9 of this unit map. Ask students to describe how their new planes will be "powered" and which characteristics of their planes will help to control the plane during flight, continuing to annotate their drawings as they respond. Student-drawn pictures of their designs will provide an experience to which students can connect as they discuss the importance of models and designs during the engineering process *(foreshadowing K-2-ETS1-2)*.

Culminating Performance Assessment: Engineering Design Challenge (End of Unit 7)

{Evaluates Student Mastery of Objectives:

- Describe a new problem that could be solved by engineers. (K-2-ETS1-1)
- Identify possible solutions to a selected problem.
- Develop a model that illustrates a solution to a selected problem. (K-2-ETS1-2)
- Using a model, describe a solution to a selected problem.}

Task Assessment: Challenge your students to be engineers in this culminating performance task. This task assessment will be completed over the course of four days. On Day 1, students are presented with a series of problems (e.g., "How can we make sure our classroom plants receive enough water and sunlight while indoors?" "How can we reduce the amount of trash we create?", etc.) that directly relate to content presented in previous units. Students select the problem they wish to solve, and on Day 2, identify possible solutions. On Day 3, students develop models that illustrate how the problem can be solved, and on Day 4, students describe their models to the class.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate approximately when the activity should be conducted during this unit. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 7)

{**Contributes to the Objective:** *Identify the problem that the Wright brothers wanted to solve.*}

As an introduction to the accomplishments of the Wright Brothers, discuss what your students already know about airplanes and flight. Invite them to think about how people traveled before airplanes were invented. Explain that it could take weeks by train or ship to travel the distances that people today can travel in just a few hours. Encourage your students to imagine what a long trip across the ocean or across the entire United States might have been like.

Example #2: (End of Unit 7)

{**Contributes to the Objective:** *Describe how scientists ask questions and solve problems.***}**

Advance Preparation: This activity makes use of Core Knowledge Instructional Master #34, which is available as part of the Kindergarten Teacher Handbook; prepare one copy for each student. The instructional master is used in conjunction with a world map/globe and an extended discussion of the questions/problems that Jane Goodall, George W. Carver, and the Wright brothers answered and/or attempted to solve. Using six large sentence strips or your board/projector, write the following information in two columns for whole-group use later in the lesson:

1) Jane Goodall
2) George Washington Carver
3) Wilbur and Orville Wright

a) "Can we build a tool that helps us to fly?"
b) "How do chimps behave in the wild?"
c) "How many uses are there for peanuts?"

Using a world map or globe, help students make connections among all the individuals studied across the year and where she or he worked (i.e., Jane Goodall in Kenya, George Washington Carver in the southeast United States, and the Wright brothers in Kitty Hawk, North Carolina). With guidance and support, ask your students to recall what each of these individuals did to contribute to science or engineering, noting student ideas on the board or chart paper. As you review each scientist/inventor, note where she or he worked, using sticky notes or pushpins on the map or globe. Ask your students to think about what makes each place important; for example, Carver lived in the southeastern United States, studying agricultural problems in that region; Goodall studied chimpanzees found in Kenya; and the Wright brothers used the windy dunes of Kitty Hawk to test their airplane.

Then, using Instructional Master #34, ask your students to use what they know about these individuals to independently match their images with representations of their contributions. *(You may find it useful to reread short passages from each of the biographies used in Units 2, 3, and 7 in order to transition to and support this task, recalling details such as: the Wright brothers owned a bike shop; and Jane Goodall had a beloved stuffed animal chimp as a child.)* Rotate around the room, probing students' thinking about who each image represents and how they know this. As students finish, ask them to pair with a partner to discuss, "Which of these individuals was an engineer?"

As you rotate around the classroom, or as a final question for the whole group, consider challenging your students with the following question: "Why do scientists ask questions or create tools to solve problems?" As students answer, probe for additional examples of questions and problems that can be addressed through science and engineering.

Websites & Media

Smithsonian National Air & Space Museum—The Wright Flyer:
http://airandspace.si.edu/collections/artifact.cfm?object=nasm_A19610048000

The National Air & Space Museum offers pictures and in-depth descriptions of the world's first airplane. Visit this online exhibit, and learn more about the steering mechanism that Wilbur and Orville designed and about how they established the basic tenets of modern aeronautical engineering.

Library of Congress—Photographs of the Wright Brothers:
https://www.loc.gov/photos/?q=wright+brothers

Browse through more than three hundred negatives of Wilbur and Orville Wright, and of their collaborators, in these archival collections of images.

How Stuff Works:

- **Airplanes—**http://science.howstuffworks.com/transport/flight/modern/airplanes.htm
- **Classic Airplanes—** http://science.howstuffworks.com/transport/flight/classic/classic-airplanes.htm

Build your background knowledge of modern and classic airplanes as you read websites such as those above. These pages also offer a concise description of how airplanes developed across the twentieth century.

PBS Kids—Sid the Science Kid's "Let's Fly": http://pbskids.org/sid/letsfly.html

Consider using this game as your students review the basic parts of an airplane, including wings, tail/rudder, and propellers.

Supplemental Trade Books

- *50 American Heroes Every Kid Should Meet*, by Dennis Denenberg and Lorraine Roscoe (The Millbrook Press, 2002) ISBN 0761316450 [Contains profiles of Wilbur and Orville Wright, as well as of George Washington Carver]
- *First Flight: The Story of Tom Tate and the Wright Brothers*, by George Shea and Don Bolognese (Scott Foresman, 2003) ISBN 0064442152 [Fictional account of a boy who helped the Wright brothers build their first glider.]
- *The Wright Brothers* (Famous People in Transportation), by Lola Schaefer (Pebble Books, 2000) ISBN 0736805494
- *Airborne: A Photobiography of Wilbur and Orville Wright*, by Mary Collins (National Geographic, 2003) ISBN 0792269578
- *The Wright Brothers: How They Invented the Airplane*, by Russell Freedman (Holiday House, 1994) ISBN 082341082X

Core Knowledge Science Program—Domain Map

Science Content
Body Systems • *Review and extension from Kindergarten:* Offspring are very much (but not exactly) like their parents. • Skeletal system: skeleton, bones, skull • Muscular system: muscles • Digestive system: mouth, stomach • Circulatory system: heart and blood • Nervous system: brain, nerves *[Each body system will be studied in greater detail across Grades 2–6]* **Preventing Illness** • *Review and extension from Kindergarten:* Most animal babies need to be fed and cared for by their parents; human babies are especially in need of care when young. • Taking care of your body: exercise, cleanliness, healthy foods, rest • A biography of Louis Pasteur • Vaccinations • A biography of Edward Jenner

This unit contributes to meeting or exceeding the following Next Generation Science Standards:	
1-LS3-1**. Make observations to construct an evidence-based account that **young plants and animals are like, but not exactly like, their parents.	***Rationale:*** This unit will extend previous learning from Kindergarten relative to core ideas LS3.A and LS3.B, which were started in Unit 2 *Animals & Their Needs* and Unit 3 *Plants & Farms* in that earlier grade. Grade 1 students will build knowledge of body systems that all humans share, while reviewing that many other traits can vary from person to person. These core ideas will be extended further during Unit 4 *Living Things & Their Environments,* also in Grade 1.
1-LS1-2**. Read texts and use media to determine **patterns in behavior of parents and offspring that help offspring survive.	As above, this unit will build from the foundations laid in Kindergarten units to address **1-LS1-2.** The core idea central to this standard, LS1.B, will be explored in this unit with examples and patterns of how human parents care for their children. This also provides students with an opportunity to explore the engineering concept, ETS2.B, as they learn about vaccinations, the

	biography of Edward Jenner, and how parents use knowledge of germs/disease to keep their children safe. LS1.B (Growth and Development of Organisms) will be further extended to include patterns of behavior among other animals during Unit 4 *Living Things & Their Environments.*
This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards: *Standards noted with an asterisk (*) are those that incorporate engineering and design*	
1-LS1-1*. Use materials to design a solution to a human problem by mimicking how plants and/or* ***animals use their external parts to help them survive, grow, and meet their needs****.**	***Rationale:*** The core ideas central to **1-LS1-1,** LS1.A and LS1.D, were explicitly introduced in Kindergarten during Unit 1 *The Human Body: Basic Needs & Five Senses*. These ideas can be integrated and reviewed during this unit—for example, during the study of the nervous system—in order to prepare students to meet or exceed this standard. These ideas will be explicitly integrated into the Unit 4 *Living Things & Their Environments* when students explore the idea that living things live in places to which they are particularly suited.
1-PS4-4*. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.**	Continuing the study of LS1.A and LS1.D also directly supports a growing understanding of DCI PS4.C (Information Technologies & Instrumentation), which begins its progression with the idea that, "People use their senses to learn about the world around them. Their eyes detect light, their ears detect sound, and they can feel vibrations by touch" (*Framework*, page 137). The standard **1-PS4-4** can be foreshadowed as you provide an overview of how your units will connect across the year, applying what they learn about the human body later during their study of light, sound, and the biography of Thomas Edison.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. (1-LS3-1)

MP.5 Use appropriate tools strategically. (1-LS3-1)

1.MD.A.1 Order three objects by length; compare the lengths of two objects indirectly by using a third object. (1-LS3-1)

POTENTIAL CCSS ELA Connections

RI.1.1 Ask and answer questions about key details in a text. (1-LS3-1 & 1-LS1-2)

RI.1.2 Identify the main topic and retell key details of a text. (1-LS1-2)

RI.1.10 With prompting and support, read informational texts appropriately complex for grade. (1-LS1-2)

W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-LS3-1)

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-LS3-1)

POTENTIAL Cross-Curricular Connections

Potential Links:

ELA: Sayings & Phrases—"An apple a day keeps the doctor away"

[review from Kindergarten] "Better safe than sorry"

Music: Songs—"Dry Bones"

Prior Knowledge

Core Knowledge Kindergarten Sequence

- Five senses and the associated body parts:
  - Sight: eyes
  - Hearing: ears
  - Smell: nose
  - Taste: tongue
  - Touch: skin
- Basic needs and taking care of your body:
  - Healthy foods and water
  - Air
  - Shelter and clothing
  - Rest
  - Cleanliness
  - Exercise

CKLA Kindergarten

Domain Anthology, *The Five Senses*

- Identify and describe the five senses: sight, hearing, smell, taste, and touch
- Identify the body parts associated with the five senses
- Provide simple explanations about how the eyes, ears, nose, tongue, and skin work
- Describe how the five senses help people learn about the world
- Describe some ways people take care of their bodies
- Describe some ways the five senses help protect people from harm
- Describe the experiences and challenges of someone who is blind or deaf
- Explain the contributions of Ray Charles
- Explain the contributions of Helen Keller

Core Knowledge Science (Previously taught units in the CK Science program)

Grade K Unit 1 *The Human Body: Basic Needs & Five Senses*

- Distinguish between needs and wants
- Identify the basic needs of human beings
- Identify habits that keep our bodies healthy (K-LS1-1)
- Describe how we can keep our bodies safe from germs
- Describe how we can take care of our bodies
- Identify which organs allow us to see, hear, smell, taste, and touch
- Describe how the sense of sight helps us learn
- Describe how the pupils in our eyes change in bright light compared to little light
- Describe how the sense of hearing helps us learn
- Describe how the sense of hearing helps keep us safe from harm (1-LS1-1)
- Identify devices that support people with limited vision and/or hearing

- Describe how the sense of smell helps us learn
- Classify scents as sweet or sour
- Describe how the sense of taste helps us learn
- Identify another sense that can also help us taste
- Classify foods as tasting sweet, salty, bitter, or sour
- Describe how the sense of touch helps us learn
- Describe how the sense of touch keeps us safe from harm (1-LS1-1)

CKLA Grade 1 Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

Domain Anthology, *The Human Body*

- Explain that the human body is a network of systems
- Identify the skeletal, muscular, digestive, circulatory, and nervous systems
- Recall basic facts about the skeletal, muscular, digestive, circulatory, and nervous systems
- Define the heart as a muscle that never stops working
- Explain the importance of exercise and a balanced diet for bodily health
- Identify the brain as the body's control center
- Explain that germs can cause disease in the body
- Explain the importance of vaccination in preventing disease
- Identify Edward Jenner as the man who developed the first vaccine
- Identify Louis Pasteur as the man who discovered pasteurization
- Explain the importance of exercise, cleanliness, a balanced diet, and rest for bodily health
- Explain the importance of regular checkups
- Explain the importance of vaccination in preventing disease
- Explain that the food pyramid is one way to depict a balanced diet
- Identify the component food groups in a balanced diet

What Students Will Learn in Future Grades

Core Knowledge Sequence

Grade 2 *The Human Body*

- Cells, Digestive and Excretory Systems, and a Healthy Diet

Grade 3 *The Human Body*

- The Muscular, Skeletal, and Nervous Systems
- How the Eyes and Ears Work

Grade 4 *The Human Body*

- The Circulatory and Respiratory Systems

Grade 5 *The Human Body*

- Changes in Human Adolescence

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Grade 1 unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Body Systems

*network, **system**, **function**, process, survive, structure, trait, **specialized**, cell, tissue, organ, body, human, person, everyone, most, shape, skeleton, skull, bone, spine, **vertebrae**, support, rib, hip, finger, hand, knuckle, toe, foot, calcium, fracture, break, cast, X-ray, joint, muscle, tendon, bicep, tricep, **contract**, relax, **voluntary**, lift, strong, work, move, stretch, sprain, digest, saliva, teeth, gland, enzyme, catalyst, acid, break down, swallow, esophagus, stomach, intestine, **absorb**, energy, chemical, heart, chamber, artery, vein, blood, vessel, pulse, beat, pump, **circulate**, cardiac, aorta, plasma, platelet, cut, clot, scab, respond, sense, brain, nerves, **signal**, message, spinal cord, **receptor***

Germs and Disease

*harmful, virus, bacteria, germ, disease, bug, sick, **symptom**, cough, sneeze, flu, cold, stuffy, sniffle, runny, tissue, ache, fever, **temperature**, thermometer, **infection**, infect, unhealthy, weak, rash, swollen, smallpox, cowpox, chickenpox, spread, pasteurization*

Preventing illness

*helpful, healthy, habits, exercise, **balanced diet**, nutrient, nutritious, vitamin, junk food, clean, wash, bathe, shower, bathroom, scrub, soap, sanitizer, sleep, rest, sometimes, often, reduce, **prevent**, safe, medicine, pill, shot, **vaccine**, **immunity**, doctor, medical, hospital, office, appointment, checkup, exam, examine, test, stethoscope, better, heal, recover*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "The body systems operate separately from each other."
This idea can be inadvertently emphasized by instruction that does not carefully probe for student ideas about the relationships between systems in the body. For example, the linear timeline of a unit may focus on how a system is supported by those previously studied, but teachers should be sure to explore student thinking about the reciprocal and interconnected nature of the body as a whole.

Misconception: "Energy is a substance in food." or "Food turns into energy in your body."
Chemical reactions during the process of digestion and cellular respiration release stored chemical energy in food. Teachers should be mindful of how they describe the process of digestion because overgeneralizations, like the misconceptions above, are common in everyday speech. The definition of energy is complex (e.g., read the *Framework's* core ideas PS3.A–D) and the scientific definitions of chemical energy and stored energy are reserved for study in middle and high school grades. The goal for this early grade is to introduce key terms and ideas about the digestive system and its parts relative to LS1.A (Structure and Function). It is recommended that Grade 1 teachers refer to food as a source of energy and that energy is released when food is digested.

Misconception: "The brain controls only our voluntary/conscious movements and actions."
The human brain has been linked to many involuntary functions in the body (e.g., regulation of temperature, production of hormones, etc.). Upper elementary students have been shown to identify the nervous system as being critical to sending messages to the brain, controlling activity, and stabilizing the body (Gellert, 1962), but Grade 5 students may not understand that the brain also has a critical role in our involuntary actions, such as regulating the pumping of the heart (Johnson & Wellman, 1982).

Key points for instruction:
Primary grade students may begin instruction with little knowledge of their internal organs and think that the contents of the body are only what they have seen going in or coming out of it—e.g., food and blood (Gellert, 1962).

When asked to locate the approximate position on a model or drawing of a human body, students of all ages have trouble identifying the location of organs such as the stomach, intestines, and/or liver (Blum, 1977). Teachers should be mindful of how they refer to and model the location of internal organs during discussions and investigations.

Misconception: "Blood leaves your vessels and enters other parts of your body."
Lower elementary students often know about circulation and of the blood's relationship to breathing, but students (even into even upper elementary) may not recognize the complex pattern/path of the circulatory system and/or that the blood returns to the heart (Carey, 1985).

Misconception: "Soap kills germs."
Hand soaps are "surfactants" that lower the surface tension between two or more substances. This is useful because, when applied to your hands and combined with water, soap makes it easier for the germs to detach from your skin and wash away down the sink. Hand *sanitizers*, on the other hand, work to break down proteins using alcohols that can kill bacteria. For more interesting misconceptions about cleanliness and germs, consider watching this fun Mental Floss video with Elliott Morgan: 10 Misconceptions about Germs and Hygiene.

Key points for instruction, continued:
It is important for teachers to remember that the nervous system—the brain in particular—plays an important role in all human senses. For example, the eye captures light from your surroundings, but it is the brain that processes this information. The importance of the brain relative to sight can be highlighted using optical illusions.

During research studies, fourth-graders have been shown to understand that the brain helps the body, but they do not always realize that body parts help the brain (Johnson & Wellman, 1982).

Potential Objectives for this Grade 1 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed. The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Distinguish between living and nonliving things
- Describe physical characteristics of living organisms (i.e., human beings, animals, and plants)
- Describe similarities and differences between young plants and animals and their parents **[1-LS3-1]**
- Describe how parents help their offspring survive **[1-LS1-2]**
- Compare and contrast the needs of human beings, animals, and plants

Middle

- Describe habits that keep our bodies safe from germs
- Define the term "vaccine"
- Describe how scientists help people stay healthy

- Define the term "system"
- Identify what muscles enable our bodies to do
- Describe how involuntary muscles help our body
- Identify the three main parts of the circulatory system
- Describe how our blood helps our bodies stay healthy
- Categorize activities that can keep our heart healthy

End

- Identify the types of foods that make up a healthy plate
- Describe the system that turns the food we eat into energy
- Explain why it's important for us to eat nutritious foods
- Describe how our skeleton, bones, and skull help our body
- Identify unique characteristics of bones
- Explain why our brain is called the control center of our body
- Describe how our senses help us take in information from the environment

Potential Big Guiding Questions

Essential Questions:

- **How do your body parts work together to meet your needs?**
- **What do parents do to keep children safe?**
- **What makes up a balanced diet?**

RE: Body Systems

- How are you similar to/different from your parents?
- Which body parts are associated with the [skeletal, muscular, digestive, circulatory, nervous] system?
- How does your muscular system help you to breathe?
- Why do people wear a cast to help heal a broken bone?

RE: Germs, Disease, and Preventing Illness

- How long should I wash my hands before eating?
- What is the difference between hand soap and hand sanitizer?

RE: Healthy Diets

- How much "junk food" do you eat each week?
- Why are nutritious foods important during digestion?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example #1: (Beginning of Unit 1)

{**Evaluates Student Mastery of Objective:** Describe similarities and differences between young plants and animals and their parents **[1-LS3-1]**}

Advance Preparation:

Images (or comparable replacements) of the following: small evergreen tree, fully grown evergreen tree, sunflower seedling, full grown sunflower, adult man or woman, infant, adult monkey, baby monkey, adult elephant, baby elephant

Task Assessment: Shuffle the images and then lay them out in front of a small group of students. Ask the students to group the images based on similarities. As the students group the images, ask them to explain their rationale (e.g., "This group is human beings, this group is animals, and this group is plants," "This group has eyes and this group has no eyes," etc.). Provide students with a few moments to closely look at the features of each living thing. Ask them to pair the images based on those which have very similar features. Once students have paired all the images (i.e., the small evergreen tree with the fully grown evergreen tree, the sunflower seedling with the full grown sunflower, the man or woman with the infant, the adult monkey with the baby monkey, and the adult elephant with the baby elephant), ask them to describe how each pair has similar features (for example, "How did you know these plants/animals should be grouped together?").

T - These (pointing to each adult) **are the parents and these** (pointing to each young child/plant) **are their offspring. This monkey is the parent, and this monkey is her child. This seedling is the offspring of the sunflower.**

Ask the students to describe how the child (or young plant) looks different from the adult—how they know this animal or plant is the younger of the two. Encourage students to look for patterns between all of the young animals/plants. Ask similar questions about the adults, for example, "What patterns do you see that all of the parents seem to share?"

T - Based on the patterns we observed, what can we say about the features of young plants or animals and their parents?

Example #2: (End of Unit 1)

{**Evaluates Student Mastery of Objective: "**Describe how our senses help us take in information from the environment"}

Advance Preparation:

- Create the assessment handout by drawing a T-chart. On the left-hand side of the chart's header, write "objects" and write "senses" on the right-hand side of the header. Below these headers,

create 2 rows for student responses and/or drawings. (You may wish to include sentence starters and/or visual cues in each row under "senses" [e.g., I see…, I hear…, I smell …, I feel…].)

- Gather clip boards for each pair of students to support their writing/drawing as they move around the room.
- Identify 5–8 objects (approximately 1 object per 4 students) that children can examine with their senses. Label each object.
- Determine how partners will rotate from object to object (e.g., assign the objects, ask partners to walk up to an object and then rotate to the right for the second round, etc.). Ensure there is adequate space for two pairs of students to be focusing on the same object simultaneously.

Task Assessment: Explain to students that they will be examining objects using their senses. Draw their attention to objects in the classroom that you have labeled. Pass out the assessment handout (and clip board) and a writing utensil to each pair of students. Explain that each student will be working with a partner to examine two objects. Model how they will write the name of the objects and describe what they learn about the objects through their senses. **Safety Note:** Clarify that they will not be using the sense of taste during this task. Provide students with 3–5 minutes to examine and make note of what they learned about the objects using their senses.

After students have studied two objects, engage them in a discussion about what they learned through their senses.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction where it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (End of Unit 1)

{**Contributes to the Objectives:** "Describe how our skeleton, bones, and skull help our bodies"}

Advance Preparation:

- Image or three-dimensional model of a skeleton (and playdough)
- Image of skeleton layered over organs (e.g., an image of the rib cage protecting your heart, lungs, etc.)
- Image of a bone
- Image of a skull

Activity:

Explain to students that you will be asking them to feel their wrists and hands and share what they notice. Model how to use your thumb and index finger to feel your wrist. Ask students to do the same.

T - What do you notice about the feel of your wrist?

Student responses may include “bumpy,” “hard,” “stiff,” “rigid,” or “solid.” If students need more support with describing how their wrists feel, provide them with choices (e.g., does it feel soft and squishy or hard and solid?), and/or props such as soft (e.g., plush ball) and hard (e.g., wooden block) objects to compare. Using your index finger, model how to move that finger across the surface of your wrist and top and bottom of your hand. Ask students to do the same.
T - What do you notice about your hand? Tell the person sitting next to you how it feels. Provide students with approximately 30–60 seconds to talk. Call on several partners to share and ask other students if they agree/disagree.
T - What we are feeling are our bones. (Display image of a bone.) **When we feel something hard under the surface of our skin, we are feeling a bone.**
Do you think we have bones in other parts of our body (other than our hands and wrists)? Do you think we have many bones in our body? Why do you think we have many/few? Through questioning, guide students to explain their reasoning.
Display an image or model of a skeleton. Explain to students that over 200 bones make up the skeleton.
T - Take a close look at this skeleton and the many, many bones. How do you think these bones help us? Provide students with 30 seconds to think about the question. Next, ask students to pair up and share their ideas with a partner. After (approximately) one minute, call on several groups of students to share their ideas. Note student ideas on chart paper.
Display images of a skull and a skeleton (layered over organs) and lead students in a discussion focused on how they think the skull and skeleton are helping the body. (If you have a 3-D model of a skeleton, place some playdough inside so students can concretely see how the bones provide protection to organs.)

Example #2: (End of Unit 1)

{**Contributes to the Objectives:** “Describe how our senses help us take in information from the environment”}

Advance Preparation:

- Apple
- An apple slice for each student (Be sure to follow your school’s policy regarding food distribution and allergies.)

Activity:

Hold up an apple. Ask students to describe the apple to their partners. (Provide students approximately 2 minutes to talk.) Call on groups of students to share and capture their ideas on chart paper. Ask students to share how they learned that information (e.g., I saw it).
Pass out an apple slice to each student. Ask them to think about other ways they can learn information about the apple. Describe what students are doing as a means of encouraging others to do the same (e.g., Rashida is smelling her apple slice, Tommy is tasting his apple).
T - What else did you learn about the apple? Add ideas to chart paper. **How did you learn that information?** Students may add that they tasted, touched, and/or smelled the apple.
Review the characteristics identified by the class.

T - We were able to identify many characteristics of an apple. We gathered that information by looking at it, smelling it, touching it, and even tasting it. Guide students in connecting this experience with their previous knowledge of the senses from Kindergarten (Unit 1).
T - Think about what we learned about the nervous system. How do you think these sense receptors helped us learn about these apples? Guide students through a discussion that helps them arrive at a broad understanding that these receptors send messages to the brain.

Websites & Media

Visible Body—Free eBooks: http://go.visiblebody.com/vb-free-ebooks

Visible Body offers a collection of interactive animation apps that are available for purchase, including My Incredible Body which is geared toward elementary students. This website also offers free eBooks and activities packed with images and amazing details about the human body.

Choose My Plate: http://www.choosemyplate.gov/kids

This website includes games, activities, videos, and songs that can build children's understanding of the food groups and how to choose a nutritious diet.

Supplemental Trade Books

- All About Scabs, by Genichiro Yagyu (Random House Adult Trade Publishing Group, 1998) ISBN 0916291820
- Eat Healthy, Feel Great, by William Sears, M.D., Martha Sears, R.N., and Christie Watts Kelly (Little, Brown and Company, 2002) ISBN 0316787086
- Eating Well (Looking After Me), by Liz Gogerly and Mike Gordon (Crabtree Publishing Company, 2009) ISBN 0778741176
- Exploring Health (A Sense of Science), by Claire Llewellyn (Sea-to-Sea Publications, 2009) ISBN 0749670444
- First Encyclopedia of the Human Body (Usborne Internet-Linked), by Fiona Chandler (Usborne Books, 2004) ISBN 079450695X
- Germs Make Me Sick!, by Melvin Berger (Scott Foresman, 1995) ISBN 0064451542
- Healthy Eating (Science Everywhere!), by Helen Orme (New Forest Press, 2010) ISBN 1848982895
- Healthy Eating, by Claire Llewellyn (QEB Publishing, 2006) ISBN 1845384725
- How Bodies Work (I Know That!), by Claire Llewellyn (Sea-to-Sea Publishing, 2007) ISBN 1597710237

- How to Stay Healthy (I Know That!), by Claire Llewellyn (Sea-to-Sea Publishing, 2007) ISBN 1597710245
- It's Catching: Colds, by Angela Royston (Heinemann, 2001) ISBN 1588102270
- Louis Pasteur, by Kremena Spengler (Capstone Press, 2003) ISBN 0736834419
- Me and My Amazing Body, by Joan Sweeney (Random House Children's Books, 1999) ISBN 0375806237
- My First Visit to the Doctor, by Eve Marleau and Michael Garton (QEB Publishing, 2009) ISBN 1595669876
- My Healthy Body, by Bobbie Kalman (Crabtree Publishing Company, 2010) ISBN 9780778794714
- Oh, the Things You Can Do That Are Good For You! by Tish Rabe and illustrated by Aristides Ruiz (Random House, Inc., 2001) ISBN 0375810986
- Showdown at the Food Pyramid, by Rex Barron (Penguin Young Readers Group, 2004) ISBN 0399237151
- The Busy Body Book, by Lizzy Rockwell (Random House Children's Books, 2008) ISBN 0553113747
- The Nervous System (Human Body Systems), by Helen Frost (Capstone Press, 2000) ISBN 0736806512
- The Digestive System (Human Body Systems), by Helen Frost (Capstone Press, 2000) ISBN 0736806490
- The Edible Pyramid, by Loreen Leedy (Holiday House, Inc., 2007) ISBN 0823420744
- The Human Body, by Gallimard Jeunesse and Sylvaine Peyrols (Scholastic Reference, 2007) ISBN 0439910889
- The Muscular System (Human Body Systems), by Helen Frost (Capstone Press, 2000) ISBN 0736806504
- The Circulatory System (Human Body Systems), by Helen Frost (Capstone Press, 2000) ISBN 0736887768
- The Skeletal System (Human Body Systems), by Helen Frost (Capstone Press, 2000). ISBN 0736806539
- Tiny Life on Your Body, by Christine Taylor-Butler (Children's Press, 2006) ISBN 0516254804
- Under Your Skin: Your Amazing Body, by Mick Manning (Albert Whitman & Company, 2007) ISBN 0807583138
- What Happens to a Hamburger? (Let's-Read-and-Find-Out Science, Stage 2), by Paul Showers and illustrated by Edward Miller (Harper Trophy, 2001) ISBN 0064451836
- Your Insides, by Joanna Cole (Price Stern Sloan, 1992) ISBN 0399221239

Core Knowledge Science Program—Domain Map

Science Content
• Sun: source of energy, light, heat • The eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune *[Note: In 2006, Pluto was classified as a dwarf planet]* • Stars: Constellations, Big Dipper The sun is a star • Earth and its place in the solar system: The shape of the earth, the horizon The earth moves (revolves) around the sun; the sun does not move The earth spins (rotates) on its axis; one rotation takes one day (24 hours) Sunrise and sunset When it is day where you are, it is night for people on the opposite side of the Earth • The Moon Phases of the moon: full, half, quarter, crescent, new

This unit contributes to meeting or exceeding the following Next Generation Science Standards:	
1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.	***Rationale:*** This unit will explicitly engage students with the disciplinary core idea ESS1.A, which is central to this Grade 1 standard. Observable patterns of movement across the sky will be explored when studying constellations, the changing phases of the moon, and seasonal differences in the day-night cycle.
1-ESS1-2*. Make observations at different times of year to* ***relate the amount of daylight to the time of year.***	This unit will build on the Kindergarten introduction to the seasons and apply that learning to DCI ESS1.B. In doing so, this will meet the K–2 grade band endpoint for this core idea which states, "Seasonal patterns of sunrise and sunset can be observed, described, and predicted." This core idea will be extended in later grades during Grade 3 Unit 5 *Astronomy* and Grade 5 Unit 6 A *Biography of Galileo* in order to support students as they prepare for the Grade 5 Topic *Space Systems: Stars and the Solar System*.

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:

1-PS4-2**. Make observations to construct an evidence-based account that states **objects in darkness can be seen only when illuminated. ***1-PS4-3**. Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.*	***Rationale:*** DCI PS4.B (Electromagnetic Radiation), which is central to both **1-PS4-2** and **1-PS4-3**, is introduced in this unit as it engages students with the component idea that, "Very hot objects give off light (e.g., a fire, the sun)." (*Framework,* page 134) This core idea will be further developed during Unit 7 *Introduction to Light & Sound* as well as during Grade 3 Unit 3 *Light*. This Grade 1 unit also creates a solid foundation for the later development of PS3.B (Energy Transfer) and LS2.B (Energy Transfer in Ecosystems) with the idea that the sun's energy is a source of heat and light for the Earth which travels over a significant distance. PS3.B will first be assessed by the NGSS during the Grade 4 Topic *Energy* and LS2.B is assessed during the Grade 5 *Matter & Energy in Organisms & Ecosystems*. This early grade unit offers concrete experiences, coupled with previous learning about Plants and Animals, to foreshadow and connect to this future learning.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. *(1-ESS1-2)*

MP.4 Model with mathematics. *(1-ESS1-2)*

MP.5 Use appropriate tools strategically. *(1-ESS1-2)*

1.OA.A.1 Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using objects, drawings, and equations to represent the problem. *(1-ESS1-2)*

1.MD.C.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another. *(1-ESS1-2)*

POTENTIAL CCSS ELA Connections

W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). *(1-ESS1-1 and 1-ESS1-2)*

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. *(1-ESS1-1 and 1-ESS1-2)*

POTENTIAL Cross-Curricular Connections

Potential Links:

Geography: Spatial Sense—Working with maps, globes, and other geographic tools

Mathematics: Recognize fractions as part of a whole: ½, ⅓, ¼ *(with regards to the visible portions of the moon across its phases)*

ELA: Poetry—"My Shadow" by Robert Louis Stevenson

When introducing the planets in our solar system, also consider foreshadowing the future study of Ancient Greek mythology and civilization, which will occur in Grade 2 English Language Arts (e.g., CKLA Domain Anthology, *Greek Myths*) and in Grade 2 History, Geography, Civics, and the Arts (e.g., the HGCA Unit *Ancient Greek Civilization & Sculpture*)

Prior Knowledge

Core Knowledge Kindergarten Sequence
Season & Weather

- The sun: source of light and warmth
- The four seasons and characteristic weather patterns during the different seasons
- Temperature: thermometers are used to measure temperature

CKLA Kindergarten
Domain Anthology, *Seasons & Weather*

- Demonstrate understanding of the following units of time and their relationship to one another: day, week, month, year
- Name the four seasons in cyclical order, as experienced in the United States, and correctly name a few characteristics of each season
- Characterize winter as generally the coldest season, summer as generally the warmest season, and spring and autumn as transitional seasons
- Name at least one month in a specific season while referring to a calendar

Core Knowledge Science (Previously taught units in the CK Science program)
Kindergarten Unit 4 *Seasons & Weather*

- Describe how the sun affects the temperature
- Describe how sunlight affects materials on Earth (K-PS3-1)

CKLA Grade 1 Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

Domain Anthology, *Astronomy*

- Recognize the sun in the sky
- Explain that the sun, moon, and stars are located in outer space
- Explain that the sun is a source of energy, light, and heat
- Classify the sun as a star
- Identify Earth as a planet and our home
- Identify the earth's rotation, or spin, as the cause of day and night
- Explain that other parts of the world experience nighttime while we have daytime
- Explain sunrise and sunset
- Explain that Earth orbits the sun
- Describe stars as large, although they appear small in the night sky
- Describe stars as hot, distant, and made of gas
- Explain that astronomers study the moon and stars using telescopes
- Describe how people sometimes tell stories about the moon and stars
- Explain what a constellation is
- Identify the Big Dipper and the North Star
- Identify the four phases of the moon—new, crescent, half, full
- Explain that the moon orbits the earth
- Explain that astronauts travel to outer space
- Describe the landing on the moon by American astronauts
- Explain the importance of the first trip to the moon
- Explain that our solar system includes the sun and the planets that orbit around it
- Indicate that there are eight planets in our solar system (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune)
- Classify Pluto as a dwarf planet

What Students Will Learn in Future Grades

Core Knowledge Sequence
Grade 2 *Cycles in Nature*

A. Seasonal Cycles

- Earth's orbit around the sun and the four seasons
- Seasons and life processes

B. The Water Cycle *[A cycle powered by the sun]*

- Evaporation and condensation

Grade 3 *Astronomy*

- The "Big Bang" as one theory
- The universe: an expanse almost beyond imagining
- Galaxies: Milky Way and Andromeda
- Our solar system:
  Sun: source of energy (heat and light)
  The eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune *[and the dwarf planet Pluto]*
- Planetary motion—orbit and rotation:
  How day and night on earth are caused by the earth's rotation
  Sunrise in the east and sunset in the west
  How the seasons are caused by the earth's orbit around the sun and the tilt of the earth's axis
- Gravity, gravitational pull:
  Gravitational pull of the moon (and to a lesser degree, the sun) causes ocean tides on earth
  Gravitational pull of "black holes" prevents even light from escaping
- Asteroids, meteors ("shooting stars"), comets, Halley's Comet
- How an eclipse happens
- Stars and constellations, Orienteering (finding your way) by using North Star, Big Dipper
- Exploration of space:
  Observation through telescopes
  Rockets and satellites: from unmanned to manned flights
  Apollo 11, first landing on the moon: "One small step for a man, one giant leap for mankind."
  Space shuttle
- Biography of Copernicus (had new sun-centered idea about the solar system)
- Biography of Mae Jemison (astronaut and medical pioneer)

Grade 4 *Meteorology*

- The water cycle (review from Grade 2): evaporation, condensation, precipitation
- The atmosphere—how the sun and the earth heat the atmosphere

Grade 5 *Science Biographies*

- Biography of Galileo

Grade 5 *World History—The Reformation*

- Copernicus and Galileo: Conflicts between science and the church
- Ptolemaic (earth-centered) vs. sun-centered models of the universe

Core Vocabulary

The following list contains the core vocabulary words suggested for purposeful integration across this Grade 1 unit. ***Boldfaced*** *terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Our Solar System	Earth's Place in the Solar System
system, *planet, moon,* ***orbit****, revolve, path, ellipse, elliptical, gravity,* ***celestial****, body, star, twinkle, shine, sun, solar, energy, light, heat, rays, shadow, [names of the eight planets], dwarf, pluto, rings, gas, giant, storm, rocky, frozen, inner, outer, space, expanse, void, universe, astronomy, astronomer, telescope, observatory,* ***constellation****, Big Dipper, star map, myth, asteroid, comet, meteor, debris, shooting/falling star, meteorite, launch, rocket, shuttle,* ***satellite****, Hubble, probe, lander, rover, space station, spacecraft, mission, technology*	*Earth, shape,* ***sphere****, globe,* ***horizon****, east, west, day, night, sunrise, sunset, dusk, dawn,* ***axis****, rotate, spin, side, opposite, dark, light, hour, month, year,* ***revolve****, motion, path, Moon, lunar, phase, visible, reflect, sunlight, moonlight, crater, full moon, half/quarter moon, crescent moon, new moon, calendar, observe,* ***investigate****, record, describe, explain, predict*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "The sun revolves around the Earth causing day and night."
Many students find it counter-intuitive that it is the Earth that moves (rotates/spins) to cause day and night, and not the sun. The sun's apparent movement across the sky during the day can lead students to this common misconception. This concept can be a good opportunity for teachers and students to discuss the scope and timeframe of an investigation. That is, day-to-day observations of the sun from relatively the same location may not be enough to convince someone of the true relationship between the sun and the Earth. Instead, knowledge of time/daylight differences across the globe, discussions of the horizon and the shape of the Earth, and patterns of seasonal change in the day-night cycle can help to build correct understanding over time.

Misconception: "The moon shines like the sun."
The light seen from the moon is actually sunlight that is reflected off of the moon's surface. Consider probing your students' thinking about this misconception when discussing the phases of the moon and the origins of "moonlight." Grade 1 Unit 7 *An Introduction to Light & Sound* will help to reinforce and extend learning about the nature of light and the sun.

Misconception: "The phases of the moon are caused by the shadow of the earth."
The waxing and waning of the moon are due to the positions of the Earth, moon, and sun relative to one another, but they are not caused by Earth's shadow. Instead, **lunar eclipses** are caused by the shadow (umbra) of the Earth. Particularly useful to uncover this misconception are photos of a Gibbous moon, which can be discussed relative to the spherical shape of the Earth and the shape of its shadow/umbra (i.e., the shadow of the Earth is not concave).

Misconception: "The seasons are caused by the earth's changing distance from the sun."
Students of all ages (including college and adult learners) have difficulty understanding and explaining the causes of the seasons. The root misconception behind this has been identified as a belief that the earth orbits the sun in an elongated elliptical path (Galili & Lavrik, 1998; Sadler, 1998). Other students, citing the tilt of the Earth on its axis, believe that the changing distance between a hemisphere and the sun is the cause of seasons (e.g., "summer occurs because our hemisphere is closer to the sun"). Teachers should be sure to understand that the distance to the sun changes relatively little, and that these minor changes cannot explain seasonal variations.

Key points for instruction:
It is recommended that students first master the idea that the Earth is spherical and that it rotates on its axis before they can be expected to explain the day-night cycle, the seasons, and the phases of the moon (Vosniadou, 1991). Also critical to these explanations is for students to have an understanding of the relative size, motion, and distance/orientation of the sun, moon, and Earth (Sadler, 1987). At this early grade level, students are not expected to explain the seasons or the cause of the phases of the moon Instead, they will be focusing on the development of key terms and language that will support later discussions in upper elementary and middle school. Grade 1 students should investigate the shape of the Earth, its horizon, and the day-night cycle to develop early explanations of these specific phenomena.

Potential Objectives for this Grade 1 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed. The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Describe characteristics of the sun
- Describe how the sun affects living things on the Earth
- Describe characteristics of the Earth
- Using a model, demonstrate how the Earth spins
- Explain what causes day and night
- Examine patterns in order to identify the season (i.e., winter, spring, summer, fall) with the longest/shortest amount of daylight (1-ESS1-2)
- Describe the Earth's orbit

Middle

- Describe characteristics of the moon
- Identify the four phases of the moon (1-ESS1-1)
- Describe characteristics of stars
- Explain what a constellation is
- Identify when the sun, moon, and stars are visible in the sky (1-ESS1-1)
- Predict where the sun, moon, and stars will appear in the sky at different times of day (1-ESS1-1)

End

- Describe characteristics of the planet Mars
- Compare characteristics of the planets Mercury and Venus to Earth
- Contrast characteristics of the planets Jupiter and Saturn to Earth
- Describe characteristics of the planets Uranus and Neptune
- Identify similar features among all eight planets

Potential Big Guiding Questions

Essential Questions:

- **How does the shape of the Earth affect your everyday life?**
- **Can you predict how the objects in our sky move?**
- **How do the Earth, sun, and moon appear in space?**

RE: the Sun and Earth

- Why does the sun burn you?
- How does the sun bring life to our planet?

- Does the sun rise at the same time every day?
- Do we ever see the sun at nighttime?
- How can it be daytime in one part of the world and nighttime in another?
- What is a timezone?
- Why is it not a good idea to call a friend in Australia at noon?
- What causes the cycle of night and day?
- How long do you think it takes the Earth to complete one revolution?
- If you are ___ years old, how many times has the Earth revolved around the sun (in your lifetime)?
- How can the Earth be moving if we can't feel it?
- How are the sun and Earth alike? How are they different?

Re: The Moon and Stars

- Why can't you see the stars during the daytime?
- Can you see the moon during the day?
- Can a single star be a constellation?
- How can stars be large if they look so small in the sky?
- What makes the Moon appear to glow?
- How is the moon like the Earth? How is it different?

Re: The Eight Planets

- Could humans survive on Mars?
- What's it like inside the planet Jupiter?
- Why is Pluto not considered a planet anymore?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example #1: (Beginning of Unit 2)

{**Evaluates Student Mastery of Objectives:** "Using a model, demonstrate how the Earth spins" and "Explain what causes day and night"}

Note: This assessment can be used to after Potential Activity Example #1, described below, and/or with the Grade 1 Model Lesson that is based upon the Foundation's Meaningful Instruction professional development training.

Advance Preparation:

- Styrofoam ball for each student (or each pair of students)
- Toothpick for each student or pair (Note: Toothpicks need to be long enough to go through the styrofoam ball and model the axis of the Earth)
- Markers for each student or pair
- A desk lamp

Assessment Task: Pairs of students will work together on this performance assessment to demonstrate and discuss a small model of Earth's rotation. For each pair, direct students to mark a small "x" on the ball.

T - We are going to imagine that this "x" represents where we are on the Earth.

T - We are going to pretend that the toothpick represents the Earth's axis. Model for students how to put the toothpick through the ball and how to hold their model Earth at a slight angle (approximately 23.5 degrees away from a vertical plane) to mimic the Earth's tilt. Direct students to hold both ends of the toothpick and ask them to demonstrate how their Earth representation rotates on its axis. Encourage them to pay attention to the path of their location marked by the "x."

T - Talk to your partner about what you notice about the "x" as the Earth turns, as it rotates. Why do you think it moves in that path?

Place a small lamp in the middle of the table and give each student the opportunity to rotate their model in front of the lamp. (Consider turning off your classroom lights to better simulate day and night using these small models.)

Encourage students to talk about when it is daytime or nighttime based upon the "x" location in relation to the light from the lamp.

T - How does our small model relate to the Earth and sun? If it is daytime here at our school, where the "x" is on our model, what time of day is it on the other side of the Earth? What causes day and night?

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 2)

{**Contributes to the Objective:** "Explain what causes day and night"}

Note: This activity can be used in conjunction with the Grade 1 Model Lesson that is based upon the Foundation's Meaningful Instruction professional development training.

Advance Preparation:

- A large globe (preferably attached to a stand, which replicates the Earth spinning on its axis)

- A bright lamp
- Sticker or Post-It note that can be affixed to your location on the globe

Activity: Begin with a discussion about how the Earth spins on its axis. Place a sticker on the globe so students can see where they live. (This will also assist students with following the path of movement as the globe rotates.) Slowly spin the globe and ask students to describe how the earth moves.

T - What time of day is it now, daytime or nighttime? Do you think it's possible (at this very moment) in another part of the world for it to be nighttime? (Provide students with time to think and then share ideas with a partner.) **We are going to learn today what causes day and night, and find out if it's possible for part of the world to be experiencing daytime while the other part of the world is experiencing nighttime.**

Turn all of the lights off with the exception of a lamp placed in the corner of the room

T - What object in our solar system produces light like that lamp? In what ways is this lamp like the sun? Because of (name common characteristics identified by students)**, we are going to use this lamp as a model of the sun.**

Spin the globe so the sticker is facing the lamp. Point to that side of the globe

T - What do you notice about this side of the globe? (Student responses may include, "It's bright," "Light is shining on it."). **What time of day do you think it would be for people living on this side of the Earth? Why?** (Students should conclude that it is daytime since light from the sun can be seen during the day.)

Point to the other side of the globe.

T - What about over here? What time of day do you think it is for people living here? (Students should infer that it is nighttime because the sun light is not reaching that part of the Earth.

Ask students to focus on their location (the sticker). Slowly rotate the globe and then pause. Each time ask students to indicate whether it is daytime or nighttime, and how they know. As students demonstrate understanding, ask them questions that challenge their thinking:

T - Look where (_country/continent on opposite side of world_) is on our globe relative to our model. **Would it be a good idea to call a friend who lives in that country/continent right now? Why or why not?**

T - How could we find out what time of day it is in that country/continent at this very moment? (Encourage students to think of tools or technologies that might help them to find out what time it is on the opposite side of the Earth.)

T - What about (_country/continent in the same hemisphere_)**? Could we call a friend that lives here right now? Why or why not?**

Example #2: (Middle of Unit 2)

{**Contributes to the Objective:** "Identify when the sun, moon, and stars are visible in the sky" and "Predict where the sun, moon, and stars will appear in the sky at different times of day"} **(1-ESS1-1)**

Advance Preparation:

- Draw a diagram of your school building (landscape view) and surrounding property (e.g., playground, field, etc.)
- Gather clipboards as well as yellow and gray crayons for each student (or pair of students)

- Obtain a compass (if possible provide one for each student or pair of students)
- Create a T-chart to be used as the Homework Activity Handout. On the left side, write "moon" and write "stars" on the right side. In the directions, ask students to draw an image of the "moon" and "stars" and write a description. If students have access to a compass at home, ask that they note the location of the moon (i.e, northern, southern, eastern, or western sky)

Activity: Explain to students that they will be tracking the sun's location over several days. (**Safety Note:** Before engaging in this activity, explain to students that they **should not** look directly at the sun.) Provide each student (or pair of students) with a diagram of your school, a clipboard, and a yellow crayon. In the morning, walk out to the school yard and locate the sun. Ask students to mark the location on their diagram (e.g., draw the sun with the yellow crayon and write 'M' or "A.M." to label it, or draw the sun and write the time below, etc.,). Using the compass identify, ask students to identify the location of the sun and label the diagram (i.e., 'E' for east or 'NE' for northeast). Repeat this process at approximately noontime and again at the end of the school day.

You may wish to extend this activity to include observations of the moon during the daytime if/when it is visible. (To help identify when/where the moon may be visible to you during the day, consider using this webpage: http://www.timeanddate.com/astronomy/moon/light.html.) During the activity it is important remind students of safety (e.g., not to look directly at the sun) and you may wish to have students put their hand up to block the sun so they do not accidently look at it while scanning the sky for the moon. When they locate the moon, each student can draw an image on their landscape diagram with a gray crayon and use the compass to identify its orientation in the sky. If the conditions are not optimal, you may wish to have the students only complete their observations at night as part of a homework assignment.

Homework Activity: Ask students to observe the moon and stars at night.
This task involves each student drawing a picture of the moon (e.g., the phase), using a compass (if available) to identify its orientation in the sky, and writing a phrase or several sentences to describe what they have seen. Students should also draw several images of stars they view in the sky and write a brief description.

After students collect data about what appears in the sky during the day and at night as well as the general locations of these celestial bodies in the sky over time, engage students in a discussion about their findings.
T - What could we observe in the sky during the day?
T - Why do you think we couldn't see the stars during the day?
T - (If you didn't see the moon) Have you ever seen the moon during the daytime?
T - How did the sun's location change during the day?
T - Where do you think we will find the sun in the sky tomorrow morning? Where do you expect it to be at the end of the school day tomorrow?
T - Do you think we will be able to see the sun/moon/stars again tomorrow? When (morning or night)? Repeat this activity over the course of several days in order for students to observe patterns in the sun's and moon's location.

Websites & Media

NASA' Space Place: http://spaceplace.nasa.gov/

During this unit, consider reviewing NASA's Space Place sections on the Sun and the Solar System. These pages have excellent information to help answer questions that you might hear from your students such as, "Why does the sun burn you?" and "What's it like inside Jupiter?"

NASA Kid's Club: http://www.nasa.gov/audience/forkids/kidsclub/flash/index.html

This website is full of kid-friendly information and games, including information about the current crew aboard the International Space Station and about future plans for possible manned missions to Mars.

PBS Kids—Ready Jet Go! Clips with Astronaut Amy: http://pbskids.org/readyjetgo/video.html

Clips from the astronomy-focused animated series, Ready Jet Go!, could be useful to review information learned during this domain-based unit. Particularly, "Astronomer Amy" Mainzer offers excellent clips of real space exploration missions and concepts. Using clips from the fictional series itself, students can also learn and discuss ideas such as how the International Space Station stays in orbit without falling back to Earth and without flying out into space.

Starry Night—Free Classroom Resources:
http://www.starrynighteducation.com/resources_free.html

Starry Night offers interactive simulations of astronomy and earth science concepts as part of an array of apps that are available for purchase. The website also offers free resources such as free interactive sky charts and the audio pronunciation guide to help you build confidence in naming celestial bodies.

Weather Underground International Webcams:
https://www.wunderground.com/webcams/index.html?range=intl

The Weather Underground network, which may have been introduced to your students by Kindergarten teachers during *Seasons & Weather* (Kindergarten Unit 4), offers live webcams of conditions around the U.S. and the world. Using two or more live webcams (e.g., in the U.S., Japan, Australia, etc.), consider having students make observations about and discuss the time of day in different parts of world.

Supplemental Trade Books

- A Guide to the Planets, by Sue Whiting (National Geographic Society, 2004) ISBN 0792248171
- Blast Off! A Space Counting Book, by Norma Cole and illustrated by Marshall H. Peck (Charlesbridge, 1994) ISBN 088106498X
- Earth Cycles, by Michael Elsohn Ross and illustrated by Gustav Moore (Millbrook Press, 2003) ISBN 0761319778
- Find the Constellations, by H. A. Rey (Houghton Mifflin Books for Children, 2008) ISBN 054713178X
- Going Around the Sun: Some Planetary Fun, by Marianne Berkes (Dawn Publications, 2008) ISBN 158469100X
- How Much is a Million? 20th Anniversary Edition, by David M. Schwartz and illustrated by Steven Kellogg (HarperCollins, 2004) ISBN 0688099335
- If You Decide to Go to the Moon, by Faith McNulty and illustrated by Steven Kellogg (Scholastic Press, 2005) ISBN 0590483595
- Me and My Place in Space, by Joan Sweeney and illustrated by Annette Cable (Crown Publishers, 1998) ISBN 0517709686
- Midnight on the Moon (Magic Tree House, No. 8), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 1996) ISBN 0679863745
- My Book of Space, by Ian Graham (Kingfisher, 2001) ISBN 0753453991
- Once Upon a Starry Night: A Book of Constellations, by Jacqueline Mitton and illustrated by Christina Balit (National Geographic Children's Books, 2009) ISBN 1426303912
- Our Solar System, by Seymour Simon (Collins, 2007) ISBN 0061140082
- Planets: A Solar System Stickerbook, by Ellen Hasbrouck and illustrated by Scott McDougall (Little Simon, 2001) ISBN 068984414X
- Reaching for the Moon, by Buzz Aldrin and illustrated by Wendell Minor (Collins, 2008) ISBN 0060554479
- Solar System: The Best Start in Science (Science Everywhere!), by Helen Orme (New Forest Press, 2010) ISBN 1848982925
- Space: A Nonfiction Companion to Midnight on the Moon, by Will Osborne and Mary Pope Osborne (Random House Books for Young Readers, 2002) ISBN 037581356X
- Stargazers, by Gail Gibbons (Holiday House, 1999) ISBN 0823415074
- Sun Up, Sun Down, by Gail Gibbons (Voyager Books, 1987) ISBN 015282782X
- The Big Dipper, by Franklyn M. Branley and illustrated by Molly Coxe (HarperCollins, 1991) ISBN 0064451003
- The Magic School Bus: Lost in the Solar System, by Joanna Cole and illustrated by Bruce Degen (Scholastic Inc., 1990) ISBN 0590414291
- The Moon Seems to Change, by Franklyn M. Branley and illustrated by Barbara and Ed Emberley (HarperCollins, 1987) ISBN 0064450651
- The Night Sky, by Felix James (National Geographic Society, 2001) ISBN 0792289552
- The Sun is My Favorite Star, by Frank Asch (Voyager Books, 2000) ISBN 0152063978
- The Sun, by Anita Garmon (National Geographic Society, 2002) ISBN 0792285093

- There's No Place Like Space! All About Our Solar System, by Tish Rabe and illustrated by Aristedes Ruiz (Random House Inc., 1999) ISBN 0679891153
- What Makes Day and Night, by Franklyn M. Branley and illustrated by Arthur Dorros (HarperCollins, 1986) ISBN 0064450503
- What the Moon is Like (Let's-Read-and-Find-Out-Science, Stage 2), by Franklyn M. Branley and illustrated by True Kelley (HarperCollins, 2000) ISBN 0064451852

Core Knowledge Science Program—Domain Map

Science Content
Geographical features of the Earth's surface • The shape of the earth, the horizon • Oceans and continents • North Pole and South Pole, equator **Inside the Earth** • What's inside the Earth: Layers: crust, mantle, core High temperatures • Volcanoes and geysers • Rocks and minerals: Characteristics of different kinds of rocks: metamorphic, igneous, sedimentary Introduction to the formation of different kinds of rocks Important minerals in the Earth (such as quartz, gold, sulfur, coal, diamond, iron ore) Introduction to the composition of soil

This unit contributes to meeting or exceeding the following Next Generation Science Standards:	
***1-ESS1-2**. Make observations at different times of year to relate the amount of daylight to the time of year.*	***Rationale:*** This unit will explicitly build upon learning that was started in the previous Unit 2 *Astronomy*, which directly addresses the concept of patterns in the day-night cycle as suggested by **1-ESS1-2**. This Unit 3 will continue the progression of students' understanding of ESS1.B (Earth and the Solar System) by extending learning about the shape of the Earth and its features, such as the North and South Poles and the Equator.
2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.	As students build their knowledge of geography and geology content, such as the oceans, continents, volcanoes, and geysers, they will be explicitly preparing to meet this Grade 2 standard as they develop and use maps of the Earth. At the center of this particular standard is the early grade band endpoint for DCI ESS2.B (Plate Tectonics & Large-scale Systems), which will be extended in Grade 4 Unit 4 *Geology* to help prepare students for the NGSS Grade 4 Topic *Earth's Systems*.

*2-ESS2-3. Obtain information to **identify where water is found on Earth** and that it can be solid or liquid.*	***Rationale:*** This unit—coupled with the later Grade 1 units *Living Things & Their Environments* (Unit 4 re: water habitats) and *Matter* (Unit 5 re: different states of matter, using water as an example)—will directly support the core idea ESS2.C (Roles of Water in Earth's Surface Processes). Students also have the opportunity to learn about water's importance and prevalence on Earth's surface during Grade 2 Unit 1 *Cycles in Nature* when students will review where they can find water and explore the concept that most of Earth's surface is covered in water. This core idea will be investigated during that unit while expanding their knowledge to include early study of the water cycle.
This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.	***Rationale:*** This unit offers the opportunity to introduce and/or foreshadow the core idea central to this standard, ESS1.C (History of the Earth), as students begin to investigate the process of how rocks are formed. New learning about rocks, volcanoes, and even geysers can be compared and contrasted against the timescale/cycles of phenomena studied during previous units (e.g., the day-night cycle as well as the seasons). This approach directly relates to the early learning progression for ESS1.C which states, "Some events on Earth occur in cycles, like day and night, and others have a beginning and an end, like a volcanic eruption" (*Framework*, page 178). **2-ESS1-1** will also be explicitly addressed during Grade 2 Unit 1 *Cycles in Nature*.

5-ESS2-1**. Develop a model using an example to **describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. ***4-ESS3-1**. Obtain and combine information to **describe that energy and fuels are derived from natural resources** and their uses affect the environment.*	***Rationale:*** An early introduction to the process of rock formation offers the opportunity to foreshadow DCI ESS2.A (Earth Materials & Systems) which is an excellent example of how Earth's systems interact (e.g., the geosphere, hydrosphere, and atmosphere). This unit also offers an excellent opportunity to connect the study of important minerals and foreshadow additional learning about ESS3.A (Natural Resources), which was introduced in Kindergarten within units such as Unit 5 *Taking Care of the Earth*. These core ideas will also be explicitly extended during the study of oceans in Unit 4 *Living Things & Their Environments*, as well as in Grade 4 Unit 4 *Geology*, Unit 5 *Meteorology*, and Grade 5 Unit 7 *Matter & Change*.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. *(1-ESS1-2 & 2-ESS2-2)*

MP.4 Model with mathematics. *(1-ESS1-2 & 2-ESS2-2)*

MP.5 Use appropriate tools strategically. *(1-ESS1-2)*

1.OA.A.1 Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using objects, drawings, and equations to represent the problem. *(1-ESS1-2)*

1.MD.C.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many are in each category, and how many more or less are in one category than in another. *(1-ESS1-2)*

1.NBT.B Understand place value. *(2-ESS2-2)*

POTENTIAL CCSS ELA Connections

SL.1.5 Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings. *(2-ESS2-2)*

W.1.6 With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. *(2-ESS2-3)*

W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). *(1-ESS1-2)*

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. *(1-ESS1-2 & 2-ESS2-3)*

POTENTIAL Cross-Curricular Connections

Potential Links:
Geography: Spatial Sense—Working with maps, globes, and other geographic tools

Mathematics: Geometry—Know and use terms of orientation and relative position, such as: *around, on, under, over, far from, near, in front, in back (behind), above, below, between, in the middle of to the right of, to the left of, next to, beside, here, there, inside, outside, closed, open*
Shapes—identify and describe solid shapes (i.e., characteristics of a sphere)

Visual Arts: Texture—Describe qualities of texture, for example: r*ough, smooth, bumpy, scratchy, slippery, etc.*

Prior Knowledge

Core Knowledge Kindergarten Sequence
Geography & An Overview of the Seven Continents

- Maps and globes: what they represent, how we use them
- Rivers, lakes, and mountains: what they are and how they are represented on maps/globes
- Locate the Atlantic and Pacific Oceans
- Locate the North and South Poles
- Identify and locate the seven continents on a map and globe
- Name and locate the town, city, or community, as well as the state where you live
- Locate North America, the continental United States, Alaska, and Hawaii

Core Knowledge Science (Previously taught units in the CK Science program)
Kindergarten Unit 4 *Seasons & Weather*

- Identify a tool that can be used to measure temperature
- Use thermometers to measure water and air temperature (ongoing)
- Predict when objects will have hotter and cooler temperatures
- Describe how the sun affects the temperature

Kindergarten Unit 5 *Taking Care of the Earth*

- Identify everyday objects that are made up of natural resources
- Describe how humans use the Earth's natural resources (K-ESS3-1)
- Identify common resources that are limited and nonrenewable
- Classify resources as renewable or nonrenewable
- Describe how humans have changed the environment around them in order to meet their needs (K-ESS3-2)

Grade 1 Unit 2 *Astronomy*

- Describe characteristics of the Earth
- Using a model, demonstrate how the Earth spins
- Explain what causes day and night

CKLA Grade 1 Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

Domain Anthology, *The History of the Earth*

- Identify geographical features of the earth's surface: oceans and continents
- Locate the North Pole, the South Pole, and the equator on a globe
- Describe the shape of the earth
- Explain that much of our knowledge of the earth and its history is the result of the work of many scientists
- Identify the layers of the earth: crust, mantle, and core (outer and inner)
- Describe the crust
- Describe the mantle and core inside the earth
- Describe volcanoes and geysers
- Describe how heat, pressure, and time cause many changes inside the earth
- Identify common minerals in the earth
- Explain how minerals are used by people
- Identify the three types of rocks: igneous, sedimentary, and metamorphic
- Describe how heat, pressure, and time cause the formation of igneous, sedimentary, and metamorphic rocks
- Describe fossils
- Explain how fossils provide information about the history of the earth
- Explain how we know about dinosaurs
- Describe various dinosaurs

What Students Will Learn in Future Grades

Core Knowledge Sequence
Grade 4 Geology: The Earth and Its Changes

Earth's Layers

- Crust, mantle, core (outer core and inner core)
- Movement of crustal plates
- Earthquakes:
  Faults, San Andreas fault
  Measuring intensity: seismograph and Richter scale
  Tsunamis
- Volcanoes:
  Magma
  Lava and lava flow
  Active, dormant, or extinct
  Famous volcanoes: Vesuvius, Krakatoa, Mount St. Helens
- Hot springs and geysers: Old Faithful (in Yellowstone National Park)
- Theories of how the continents and oceans were formed: Pangaea and continental drift

How Mountains are Formed

- Volcanic mountains, folded mountains, fault-block mountains, dome-shaped mountains
- Undersea mountain peaks and trenches (Mariana Trench)
- Major mountain ranges on different continents:
  South America: Andes
  North America: Rockies and Appalachians
  Asia: Himalayas and Urals
  Africa: Atlas Mountains
  Europe: Alps
- High mountains of the world:
  Asia: Everest
  North America: McKinley
  South America: Aconcagua
  Europe: Mont Blanc
  Africa: Kilimanjaro

Rocks

- Formation and characteristics of metamorphic, igneous, and sedimentary rocks

Weathering and Erosion

- Physical and chemical weathering
- Weathering and erosion by water, wind, and glaciers
- The formation of soil: topsoil, subsoil, bedrock

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Grade 1 unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Earth's Geographical Features

***surface**, exterior, shape, **horizon**, east, west, north, south, ocean, **continent**, Africa, Asia, Antarctica, Australia, Europe, North America, South America, equator, North/South Pole, water, land, liquid, solid, peninsula, harbor, bay, island, geology, **geologist**, geography, geographer, map, globe, **model**, picture, representation, volcano, molten, rock, lava, **magma**, heat, cool, **eruption**, destructive, Ring of Fire, geyser, plume, Old Faithful, Yellowstone*

Inside the Earth

interior**, inside, **layer**, section, crust, mantle, outer/inner core, liquid, solid, gas, pressure, **temperature**, heat, earthquake, seismic, **seismologist**, Richter Scale, measure, record, slip, fault, **natural hazard

Rocks, Minerals, and Soil

***mineral**, rock, stone, boulder, gravel, pebble, sand, soil, dirt, peat, substance, material, **matter**, solid, particle, piece, characteristic, trace, gemstone, gem, diamond, jade, crystal, geode, artifact, igneous, metamorphic, sedimentary, **cycle**, sediment, erode, wash away, break down, **weather**, compress, squeeze, heat, melt, solidify, crystallize, debris, air bubble/pocket, **fossil**, preserve, impression, paleontologist, **excavate**, extinct, fossilized, **fossil record**, dinosaur, meteor, meteorite*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "The sun revolves around the Earth causing day and night."
As is to be introduced in Unit 2 *Astronomy*, this unit offers an extended opportunity for students to explore the shape of the Earth and the phenomenon of the horizon. Many students find it counter-intuitive that it is the Earth that moves (rotates/spins) to cause day and night, and not the sun. The sun's apparent movement across the sky during the day can lead students to this common misconception. This concept can be a good opportunity for teachers and students to discuss the scope and timeframe of an investigation. That is, day-to-day observations of the sun from relatively the same location may not be enough to convince someone of the true relationship between the sun and the Earth. Instead, knowledge of time/daylight differences across the globe, discussions of the horizon and the shape of the Earth, and patterns of seasonal change in the day-night cycle can help to build a correct understanding over time.

Misconception: "Bricks are rocks."
Bricks are created by humans using natural materials, and may *contain* rock, but they are not considered to be rock in geological terms. Geologically, rocks are naturally occurring inorganic substances with a definite chemical composition of minerals. Students have been shown to have trouble distinguishing naturally occurring objects from those created and/or altered by humans (Happs, 1985; Keeley, 2013). Student understanding of natural versus human-made things can be explored by offering students time to develop an operational definition of the term *rock* before introducing the scientific definition (Keeley, 2013).

Misconception: "Soil is tiny pieces of rock."
This statement is an overgeneralization that omits a key ingredient of soil—living and once-living organisms. Soil is a mixture of both organic and inorganic matter such as bacteria, fungi, plant matter, minerals, and more. Researchers, such as Happs (1982), have found that the most common misconception regarding soil is that it is "just dirt" and that students do not understand the key roles that living organisms play in soil. Young children may think decaying plants and animals just disappear over time while some recognize that decaying matter fertilizes the soil, but do not understand that organic material becomes a part of the soil (Driver, et. al., 1994; Keeley, 2013). It is recommended that teachers help students to distinguish between the words *dirt* and *soil* (e.g., *dirt* is *soil* in places where humans do not want it). You may also help students understand soil by investigating various soils to observe the different mixtures and to discuss the component pieces of various samples (Keeley, 2013).

Key points for instruction:
Consider reading more about common misconceptions and key points for instruction offered by Ohio State University's College of Education and Human Ecology: Common Misconceptions about Rocks and Minerals. For example, "A major source of geologic misconceptions is the discrepancy between the use of geologic terms in everyday language versus scientific communication. In everyday usage, the term *rock* refers to a single, particular specimen; to a geologist, the term *[rock]* is used for a category of rock types. A single specimen, geologically speaking, is a *clast*." The OSU project, *Beyond Penguins and Polar Bears*, is an excellent resource for teachers to learn more about misconceptions and broader implications for learning about a variety of scientific topics.

Misconception: "Earth's mantle is liquid."
The Earth's mantle is mostly solid rock. The misconception of a liquid mantle arises from expressions such as "tectonic plates sinking into the mantle" or "continental drift," which implicitly refer to or are associated with liquid substances. The mantle is also described as "creeping" due to convection forces on a long-term timescale, which can strengthen the misconception of a liquid mantle without special instruction to avoid this misunderstanding. Student understanding of volcanoes is also likely to affect their descriptions of Earth's interior. Many students may assume that, because what they see coming from the interior of the Earth is a liquid (i.e., lava), this represents what is generally found beneath the surface of our Earth. Teachers should consider learning more about magma and how it is created to help avoid misconceptions and overgeneralizations about Earth's interior layers.

Potential Objectives for this Grade 1 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed. The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Describe the shape of the Earth
- Use a model to describe the Earth's surface (ESS1.B)
- Locate the North Pole, South Pole, and equator on a globe
- Describe the weather and climate of different regions of the Earth
- Identify and describe landforms and bodies of water in our local area
- Develop a model that represents the landforms and bodies of water in our local area (2-EE2-2)

Middle

- Identify three layers of the Earth
- Develop a model that describes the Earth's crust
- Describe the temperature of the Earth's mantle and core
- Compare and contrast volcanoes and geysers
- Develop a model that describes the Earth's mantle and core

End

- Describe how minerals are used in our everyday lives
- Describe how the minerals in soil help plants
- Sort rocks based on similar features
- Describe features of metamorphic, igneous, and sedimentary rocks
- Describe how metamorphic, igneous, and sedimentary rocks are formed
- Classify rocks as metamorphic, igneous, and sedimentary
- Describe how fossils tell us about the past

Potential Big Guiding Questions

Essential Questions:

- **How does the shape of the Earth affect your everyday life?**
- **What clues do volcanoes and geysers tell us about the interior of the Earth?**
- **What evidence do rocks and minerals offer us about the history of the Earth?**
- **Why is soil so important to living things?**

RE: Features of the Earth

- Why can't you reach the horizon?
- How close is your school to the equator?
- How far away are the North and South Poles from your school?
- Are there rocks in the Arctic?

RE: Inside the Earth

- Why can't you dig a hole to the other side of the Earth?
- What causes a volcano to erupt?
- Are there volcanoes on other planets?
- What causes geysers?

RE: Rocks, Minerals, and Soil

- If all rocks contain minerals, why do they have different features?
- How do you use rocks and minerals in your everyday life?
- What is a cycle?
- Do all plants need soil to grow?
- How do fossils tell us about the past?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example #1: (Beginning of Unit 3)

{**Evaluates Student Mastery of Objective:** Use a model to describe the Earth's surface} (ESS1.B)

Advance Preparation:

- Provide each small group of students with a globe or map of the world. The models should clearly label oceans, the seven continents, and other large bodies of water (e.g., the Mediterranean Sea, the Nile River, etc.,).
- Post-it Flags (2 colors per group). Prior to passing out the flags, it may be important to model how they should be used to mark an area on a globe/map (e.g., one Post-it Flag for the region of North America, one for the Atlantic Ocean, etc.,)
- Anecdotal record sheet to capture student responses.

Task Assessment: Ask each group to take their (yellow) Post-it Flags and affix them to the land they see on the Earth's surface. As students mark their globes/maps, walk around the room and ask them questions, such as:

- **How do you know this is land and not water?**
- **What do you notice about this area of land (e.g., large/small, shape, surrounded by water, etc.)?**
- **What do you call these large areas of land?**

Ask several groups of students to share their findings with the class.

Now ask students to use their (blue) Post-It Flags to mark large and smaller bodies of water. As students locate oceans, seas, lakes, and rivers, ask each group questions, such as:

- **Where can we find water on the Earth's surface?**
- **What do you notice about the size of an ocean compared to a lake or river?**
- **Can water ever be found in the form of a solid? What is the weather like when water is frozen?**
- **What do you notice about the water on the Earth's surface compared to the land?**

After you have met with each group, call on several groups to describe water on the Earth's surface.

Ask students to move to a central location in the classroom (e.g., on the carpet).

T - We learned a lot about the Earth's surface by taking a close look at the land and bodies of water found there. Think about how you would describe the Earth's surface. Let's try to come up with 3–4 sentences that describe the water and land found on the Earth. As students share thoughts, record ideas on chart paper.

Example #2: (End of Unit 3)

{**Evaluates Student Mastery of Objective:** Classify rocks as metamorphic, igneous,and sedimentary}

Advance Preparation:

You will need a metamorphic (e.g., soapstone), igneous (e.g., obsidian), and sedimentary rock (e.g., limestone).

Task Assessment: Present students with three rocks (e.g., obsidian, sandstone, and soapstone) and ask them to determine which is an example of igneous rock, sedimentary rock, and which is metamorphic. Have students select one rock at a time and take a few moments to examine its features. Ask students to

share which type of rock they believe it is and why. If students need prompting, ask them to tell you what they know about igneous/sedimentary/metamorphic rocks and guide them in identifying which of the rocks in front of them falls in line with those characteristics.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (End of Unit 3)

{**Contributes to the Objective:** "Sort rocks based on similar features"}

Advance Preparation:

- Assortment of **metamorphic rocks** (e.g., gneiss, phyllite, quartzite, schist, soapstone)
- Assortment of **igneous rocks** (e.g., scoria, pumice, peridotite, basalt, obsidian)
- Assortment of **sedimentary rocks** (e.g., breccia, conglomerate, limestone, rock salt, sandstone)
- Paper for each small group of students

Activity: Provide each small group of students with one rock.

T - As a group, you will closely observe your rock. What are some characteristics that we should look for? Guide students through a discussion that highlights the types of descriptive features they should examine and note about their rocks (e.g., the feel of the surface, the color(s), observable patterns, the shape, etc.). You may also include sentence starters (e.g., "It feels…, the shape is…, the colors are…, etc.) and/or the option of including illustrations as a means of supporting students with recording these observations.

After students have finished capturing their ideas on paper, call on a group to present the unique features of their rock. Ask the remaining students to look at their rocks and descriptions to see if they notice similarities.

T - Which of you believe that your rock shares similar features?

After these groups share their descriptions, guide the class with identifying what is similar and different about these rocks compared to the one shared by the first group. Ask the class if they think these may be the same type of rock. If they agree, place the rock in the same group as the first. If they believe it holds more differences, place the rock in a 'new' group (e.g., group 2). Explain that students can change their minds about what rocks belong in specific groups as more are reviewed. Continue this process with the groups that believe their rocks have similar features to the one presented first.

Call on one of the remaining groups to present what they observed about their rock. After students have shared their description, place that rock in a new group. Ask a remaining group if they believe their rock belongs in this group. Repeat this process until all of the rocks have been presented and added to a group.

Return to the groups of rocks. Guide students with pointing out similar features of each group. If you have 5 or more groups, support students with observing the rocks through a broader lens in order to reorganize

them into 3 or 4 groups. As students suggest specific rocks should be regrouped, ask them to explain their thinking.

T - Today you will be learning about three different types of rocks: igneous, sedimentary, and metamorphic. Each rock we looked at today is either an igneous, sedimentary, or metamorphic rock. Let's examine each of type of rock and then decide which of our rocks fall into that category...

Example #2: (End of Unit 3)

{**Contributes to the Objective:** "Describe how fossils tell us about the past"}

Advance Preparation

- In this activity, you will create casts of students' hands or feet in order to replicate the process of fossilization as well as concretely illustrate how closely a "fossil" resembles the structure of the original. Decide how many casts you will create (e.g., several volunteers or entire class). This will determine how much of the following you will need:
    - Homemade plaster
    - Sand
    - Cardboard boxes
- Images of fossils (e.g., dinosaurs, fish, ammonite, trilobites, etc.,)

Activity: Engage students in an activity that replicates the formation of fossils. Partially fill a shallow cardboard box with sand, and have several volunteers put a handprint or footprint in the sand. Pour plaster over the sand and explain that the plaster acts in the same way as sediment does to cover and preserve the prints. Let the plaster solidify and harden and then remove it from the box. Children should see an exact replica of their hand/foot print in the plaster.

Ask the students what the "fossil" of their hand or footprint would tell someone about them (e.g., they have five fingers/toes, their shoe size, that they are most likely to be a child compared to an adult., etc.).

Show images of a variety of fossils.

T - These are images of fossils of living things from long ago. How do you think paleontologists use fossils to learn about the past?

Websites & Media

NASA's Space Place: http://spaceplace.nasa.gov/

During this unit, consider reviewing NASA's Space Place section on our planet Earth. Information and media linked to this page can help you to connect this unit to previous learning with questions such as, "Are there volcanoes on other planets?"

National Geographic Society—Magma and How It Forms:
http://nationalgeographic.org/encyclopedia/magma/

Consider reviewing this webpage to learn about the formation of magma between Earth's crust and the mantle. Read about the ways magma can escape these boundaries and reach Earth's surface with tremendous and treacherous effects.

Supplemental Trade Books

- Digging Up Dinosaurs (Let's-Read-and-Find-Out Science 2), by Aliki (HarperCollins, 1988) ISBN 0064450783
- Dinosaurs (Magic Tree House Guide), by Will Osborne, Mary Pope Osborne, and Sal Murdocca (Random House Books for Young Readers, 2000) ISBN 0375802967
- Dinosaurs Before Dark (Magic Tree House, No. 1), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 1992) ISBN 0679824111
- Earthquake in the Early Morning (Magic Tree House, No. 24), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 2001) ISBN 067989070X
- Earthquakes (Let's-Read-and-Find-Out Science 2), by Franklyn M. Branley and Megan Lloyd (HarperCollins, 2005) ISBN 0064451887
- Fossils Tell of Long Ago (Let's-Read-and-Find-Out Science 2), by Aliki (HarperCollins, 1990) ISBN 0064450937
- Hill of Fire, by Thomas P. Lewis (HarperCollins, 1983) ISBN 0064440400
- How to Dig a Hole to the Other Side of the Earth, by Faith McNulty (HarperCollins, 1992) ISBN 0874992338
- If You Find a Rock, by Peggy Christian (Sandpiper, 2008) ISBN 0152063544
- Let's Go Rock Collecting (Let's-Read-and-Find-Out Science 2), by Roma Gans and Holly Keller (HarperCollins, 1997) ISBN 0064451704
- Mountains of Fire, by Lily Richardson (National Geographic Society, 2003) ISBN 0792242831
- Planet Earth/Inside Out, by Gail Gibbons (Morrow Junior Books, 1995) ISBN 0688096808
- Rocks in His Head, by Carol Otis Hurst and James Stevenson (HarperCollins, 2001) ISBN 0060294035
- Sabertooths and the Ice Age: A Nonfiction Companion to Sunset of the Sabertooth, by Mary Pope Osborne, Natalie Pope Boyce, and Sal Murdocca (Random House Books for Young Readers, 2005) ISBN 0375823808
- Sunset of the Sabertooth (Magic Tree House, No. 7), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 1996) ISBN 0679863737
- Soil, by George Wong (National Geographic Society, 2001) ASIN B0006S4Y26
- The Magic School Bus in the Time of the Dinosaurs, by Joanna Cole (Scholastic, 1995) ISBN 0590446894
- The Pebble in My Pocket: A History of Our Earth, by Meredith Hooper (Viking Juvenile, 1996) ISBN 0670862592

- Vacation Under the Volcano (Magic Tree House, No. 13), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 1998) ISBN 0679890505
- Volcanoes (Let's-Read-and-Find-Out Science 2), by Franklyn M. Branley and Megan Lloyd (Collins, 2008) ISBN 0064451895
- Volcanoes: Mountains That Blow Their Tops, by Nicholas Nirgiotis (Grosset and Dunlap, 1996) ISBN 0448411431

Core Knowledge Science Program—Domain Map

Science Content

Habitats

- Living things live in environments to which they are particularly suited
- Specific habitats and what lives there, for example:
  Forest [oak trees, squirrels, raccoons, snails, mice]
  Meadow and prairie [wildflowers, grasses, prairie dogs]
  Underground [fungi, moles, worms]
  Desert [cacti, lizards, scorpions]
  Water [fish, oysters, starfish]
- The food chain and food webs—a way of picturing the relationships between living things:
  Animals: big animals eat little ones, big animals die and are eaten by little ones
  Plants: nutrients, water, soil, air, sunlight

Oceans & Undersea Life

- Most of the earth is covered with water
- Locate oceans: Pacific, Atlantic, Indian, Arctic, Southern
- Oceans are salt water (unlike freshwater rivers and lakes)
- Coast, shore, waves, tides (high and low)
- Currents, the Gulf Stream
- Landscape of the ocean floor: mountain peaks and deep valleys (trenches)
- Diversity of ocean life: from organisms too small for the eye to see (plankton), to giant whales
- Dangers to ocean life (for example, overfishing, pollution, oil spills)

Environmental Change & Habitat Destruction

- Environments are constantly changing, and this can sometimes pose dangers to specific habitats, for example:
  Effects of population and development
  Rainforest clearing, pollution, litter
- A biography of Rachel Carson

Specific Classifications of Animals

- Herbivores: plant-eaters (e.g., elephants, cows, deer)
- Carnivores: flesh-eaters (e.g., lions, tigers, canines)
- Omnivores: plant and animal-eaters (e.g., bears, humans)
- Extinct animals (e.g., dinosaurs)

This unit contributes to meeting or exceeding the following Next Generation Science Standards:	
1-LS3-1*. Make observations to construct an evidence-based account that* ***young plants and animals are like, but not exactly like, their parents.***	***Rationale:*** This unit will extend previous learning from Kindergarten (Unit 2 *Animals & Their Needs* and Unit 3 *Plants & Farms*) as well as the Grade 1 Unit 1 *Human Body Systems*. Specifically, this unit will provide students the opportunity to deepen their learning about early progressions of LS3.A and LS3.B. As students build knowledge of special classifications of animals (e.g., carnivores) they will be asked to connect their understanding to early ideas of inheritance and variation in animals. For example, canines have a characteristic pattern of teeth, owing to their shared inheritance, but not all canines look exactly alike. When discussing habitats, students will be asked to describe that a habitat is made up of many different plants, including groups in which individuals look very similar, but not exactly alike.
1-LS1-2*. Read texts and use media to* ***determine patterns in behavior of parents and offspring that help offspring survive.***	This unit will build from the foundations laid in earlier units to prepare students for **1-LS1-2**. The core idea central to this standard, LS1.B, will be explored in this unit with examples and patterns of how animal parents care for their offspring as students explore different habitats and what lives there.
This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
Grade 2 Topic: Interdependent Relationships in Ecosystems	***Rationale:*** More so than any Grade 1 standard in the NGSS, this unit most directly serves this Grade 2 topic. It introduces examples, models, and concepts central to the core ideas of LS2.A (Interdependent Relationships) and LS4.D (Biodiversity) as students explore each of the subtopics within this domain-based unit (e.g., developing and using models in the form of food chains/webs in order to discuss cause and effect relationships within an ecosystem). This topic will be addressed and extended again in Grade 2 Unit 6 *Ecosystems*.

Grade 3 Topic: Interdependent Relationships in Ecosystems: Environmental Impacts on Organisms	***Rationale:*** Similar to this Grade 3 topic, this unit "bundles" the core ideas of LS2.C, LS4.A, LS4.C, LS4.D to provide a rich learning experience that will be extended across Grades 1–3 and beyond. These core ideas will be coherently addressed in this unit, as well as within Grade 2 Units 1 and 2—*Cycles in Nature* and *Insects*—and within Grade 3 Units 1 and 6—*Introduction to Classification* and *Ecology.* For example, the study of DCIs LS2.C and LS4.D in this early grade will help prepare students to meet or exceed **3-LS4-4** as students compare and discuss possible solutions to problems when a habitat changes.
Grade 5 Topic, Matter and Energy in Ecosystems	This unit offers the opportunity to foreshadow the NGSS Grade 5 topic, Matter and Energy in Ecosystems. This topic coherently progresses the core ideas already listed above by connecting these to other, related DCIs, including LS1.C (Energy Flow in Organisms), LS2.B (Cycles of Matter & Energy Flow in Ecosystems), and the early progression of PS3.D (Energy in Everyday Life). The early introduction of food chains and food webs within the context of deep study about habitats/ecosystems offers an excellent opportunity to introduce key vocabulary. This early introduction will ensure that students are adequately prepared with the language tools necessary to deeply study these ideas in later grades.
5-ESS2-1*. Develop a model using an example to* ***describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.***	This unit provides an opportunity to extend knowledge of ESS2.A (Earth's Materials & Systems), which is central to **5-ESS2-1** and first introduced during Grade 1 Unit 3 *Introduction to Geology*. The Grade 5 endpoint for this core idea states that students should understand, "The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate." (Framework, page 181) This core idea will be further extended in Grade 4 Unit 4 *Geology*, Unit 5 *Meteorology*, and Grade 5 Unit 7 *Matter & Change*.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen the understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. (1-LS3-1)

MP.5 Use appropriate tools strategically. (1-LS3-1)

1.MD.A.1 Order three objects by length; compare the lengths of two objects indirectly by using a third object. (1-LS3-1)

POTENTIAL CCSS ELA Connections

RI.1.1 Ask and answer questions about key details in a text. (1-LS3-1 & 1-LS1-2)

RI.1.2 Identify the main topic and retell key details of a text. (1-LS1-2)

RI.1.10 With prompting and support, read informational texts appropriately complex for grade. (1-LS1-2)

W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). (1-LS3-1)

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-LS3-1)

POTENTIAL Cross-Curricular Connections

Potential Links:

ELA: Poetry—"I Know All the Sounds That the Animals Make" by Jack Prelutski

Fiction—"Why the Owl Has Big Eyes" (An Iroquois legend)

Sayings and Phrases—"Fish out of water," "There's no place like home"

Geography: Spatial Sense—Working with maps, globes, and other geographic tools *(with regards to locating oceans, describing the landscape of the ocean floor, etc.)*

Prior Knowledge

Core Knowledge Kindergarten Sequence

- What plants need to grow: sufficient warmth, light, and water
- Basic parts of plants: seed, root, stem, branch, leaf
- Flowers and seeds: seeds as food for plants and animals (for example, rice, nuts, wheat, corn)
- Two kinds of plants: deciduous and evergreen
- Animals, like plants, need food, water, and space to live and grow
- Plants make their own food, but animals get food from eating plants or other living things
- Offspring are very much (but not exactly) like their parents
- Most animal babies need to be fed and cared for by their parents; human babies are especially in need of care when young
- Conservation: Some natural resources are limited, so people must be careful not to use too much of them (example: logging and reforestation)
- Pollution (for example, littering, smog, water pollution) can be harmful, but if people are careful they can help reduce pollution

CKLA Kindergarten

Domain Anthology, *Farms*

- Identify needs of farm animals: food, water, and space to live and grow
- Describe how farm animal babies need to be fed and cared for by their parents or by people
- Identify foods that come from animals
- Explain why farmers grow crops
- Identify crops as plants grown on farms for use as food
- Describe how some food comes from farms as crops
- Sequence the seasonal rhythm of planting, growing, and harvesting
- Describe how farmers protect their crops from drought and pests

Domain Anthology, *Plants*

- Explain that different kinds of plants grow in different environments
- Explain that plants are living things
- Describe what plants need to live and grow: food, water, air, and light
- Explain that the plant makes its food in its leaves
- Explain the basic life cycle of plants
- Explain that some plants produce fruit to hold seeds
- Compare and contrast the fruits and seeds of different plants
- Identify the parts of specific plants that are eaten by people
- Describe how bees collect nectar and pollen
- Describe how bees make and use honey
- Describe the important role bees play in plant pollination
- Compare and contrast deciduous and evergreen trees

Domain Anthology, *Plants (continued)*

- Explain that deciduous trees belong to types of plants that lose their leaves in the fall and become dormant in the winter
- Explain that evergreen trees belong to types of plants that stay green all year and do not become dormant in the winter
- Identify how deciduous trees are important to people and nature
- Identify things that plants provide to people: oxygen, food, and important products
- Describe the life and scientific achievements of George Washington Carver

Domain Anthology, *Taking Care of the Earth*

- Explain why people have a special responsibility to take care of the earth
- Explain that Earth is composed of natural resources (land, water, and air) and that humans, plants, and animals depend on Earth's natural resources to live
- Explain different types of pollution, including litter, air pollution, and water pollution, and how most types of pollution are caused by people
- Explain what happens to garbage from its creation to being dumped in the landfill; to recyclable materials from home to a recycling factory; to discarded food from the table to the compost pile to the garden; and the water cycle
- Identify possible solutions for the problems of garbage, litter, pollution, and the conservation of natural resources

Core Knowledge Science (Previously taught units in the CK Science program)
Kindergarten Unit 2 *Animals & Their Needs*

- Classify living things and nonliving things
- Compare and contrast humans and other animals
- Identify at least three basic needs of animals
- Describe how animals use specific body parts to meet their needs
- Describe at least two ways that animals protect themselves from other animals
- Describe how animals care for their young offspring
- Describe similar (and different) ways animals and humans take care of their young offspring
- Identify how scientists can learn about animal characteristics and behaviors
- State two defining characteristics of mammals
- Describe at least one difference between fish and mammals
- State two defining characteristics of birds
- Describe at least one difference between birds and insects
- Categorize pictures of birds, fish, insects, and mammals
- Describe animals' characteristics or behaviors that allow them to survive in the wild
- Describe the meaning of the term "habitat"
- Identify animals that can live in ocean, woodland, desert, and savanna habitats
- Describe how animals can change their habitats in order to meet their needs
- Categorize pictures of animals into groups (herbivores, carnivores, or omnivores) based on examples of food that they eat

Kindergarten Unit 3 *Plants & Farms*

- Describe how plants get and store energy
- Describe how plants grow
- Sequence the life cycle of a plant
- Identify characteristics of deciduous and evergreen plants
- Classify plants as deciduous or evergreen
- Identify what plants need in order to live and grow
- Compare and contrast plants' basic needs to the needs of animals and human beings
- Infer how plants may change their habitat in order to meet their needs
- Describe how George Washington Carver used plants to meet people's needs
- Identify the needs of crops on a farm
- Describe how farmers use natural resources to take care of their crops
- Identify common livestock that can live on a farm
- Describe how plants help livestock meet their needs
- Describe the process harvesting crops to people purchasing produce to consume
- Identify ways in which we can keep food fresh

Kindergarten Unit 5 *Taking Care of the Earth*

- Explain what a "natural resource" is and give at least three examples
- Identify everyday objects that are made from natural resources
- Describe how humans use the earth's natural resources
- Identify common resources that are limited and nonrenewable
- Classify resources as renewable or nonrenewable
- Describe how humans have changed the environment around them in order to meet their needs
- Identify examples of garbage produced by humans
- Describe why landfills pose a problem for humans, animals, and plants
- Identify different forms of pollution
- Describe why pollution poses a problem for humans, animals, and plants
- Describe why humans have a special responsibility to take care of the earth
- Describe how humans can reduce the pollution in their environment
- Identify items that can be used over and over again
- Identify materials that can be recycled
- Classify objects as recyclable or as garbage
- Compare and contrast the process of composting with the process of recycling
- Identify how we can conserve energy and resources
- Describe the significance of Earth Day
- Develop solutions that can protect Earth's natural resources

CKLA Grade 1 Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

Domain Anthology, *Animals & Habitats*

- Explain what a habitat is
- Explain why living things live in habitats to which they are particularly suited
- Identify the characteristics of the Arctic tundra habitat
- Identify the characteristics of the Arctic Ocean habitat
- Explain how Arctic animals have adapted to the Arctic tundra and Arctic Ocean habitats
- Identify the characteristics of the desert habitat
- Explain how desert animals have adapted to the desert habitat
- Classify animals on the basis of the types of food that they eat (herbivore, carnivore, omnivore)
- Identify the characteristics of the grassland habitat
- Explain how grassland animals have adapted to the grassland habitat
- Match specific plants and animals to their habitats
- Identify the characteristics of the temperate deciduous forest habitat
- Explain how temperate deciduous forest animals have adapted to the temperate deciduous forest habitat
- Identify the characteristics of the tropical rainforest habitat
- Explain how tropical rainforest animals have adapted to the tropical rainforest habitat
- Classify water habitats as either freshwater or saltwater habitats
- Identify the characteristics of the freshwater habitat
- Explain that salt water covers most of Earth and is found in oceans
- Identify and locate the oceans of the world on a globe: Arctic, Pacific, Atlantic, Indian, Southern
- Describe the landscape of the ocean floor
- Describe ocean life as very diverse
- Match saltwater plants and animals to the saltwater habitat
- Identify the characteristics of the bald eagles' habitat
- Explain why and how habitat destruction can cause extinction

What Students Will Learn in Future Grades

Core Knowledge Sequence
Grade 2 Cycles in Nature

- Seasonal Cycles
- Life Cycles of Plants and Animals
- The Water Cycle

Grade 3

Introduction to the Classification of Animals

- Scientists classify animals according to the characteristics they share, for example:
  Cold-blooded or warm-blooded
  Vertebrates (have backbones and internal skeletons) or invertebrates (do not have backbones or internal skeletons; for example, insects)
- Different classes of vertebrates, including fish, amphibians, reptiles, birds, and mammals

Ecology

- Habitats, interdependence of organisms and their environment
- The concept of a "balance of nature" (constantly changing, not a static condition)
- The food chain or food web: producers, consumers, decomposers
- Ecosystems: how they can be affected by changes in environment (for example, rainfall, food supply, etc.), and by human use of resources
- Human impact on the environment
- Air pollution: emissions, smog
- Water pollution: industrial waste, runoff from farming
- Measures we can take to protect the environment (for example, conservation, recycling)

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Grade 1 unit. **Boldfaced** terms could be introduced to and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Habitats

*environment, **habitat**, ecosystem, region, territory, zone, **climate**, tropical, temperate, arctic, living, survive, needs, adapted, characteristic, pattern, **trait**, parent, child(ren), offspring, species, organism, population, community, flora, fauna, (bio)diversity, coexist, protect, **camouflage**, shelter, hunt, feed, **predator**, prey, producer, decomposer, food chain/web, forest, oak, squirrel, raccoon, snail, mice, rainforest, canopy, grassland, meadow, prairie, wildflowers, grass, prairie dogs, underground, fungus, mole, worm, desert, cactus, lizard, scorpion, water, underwater, fish, oysters, starfish, [other things that live in the various habitats studied]*

Oceans and Undersea Life

*ocean, **aquatic**, sea, water, **saltwater, freshwater**, Pacific, Atlantic, Indian, Arctic, Southern Oceans, river, lake, pond, **coast**, **shore**, wave, tide, **current**, Gulf Stream, **landscape**, mountain, peak, valley, trench, diversity, danger, fishing, pollution, oil spills, creature, animal, life, fish, whale, shark, squid, octopus, coral, reef, plankton, [other names of ocean life], life zone*

Special classifications of animals

***herbivore, carnivore, omnivore**, teeth, feed, food, eat, chew, consume, extinct(ion), **fossil**, dinosaur, [other examples of extinct species], remains, preserve, impression, rock, stone, mineral, **paleontologist**, excavate, fossil record*

Environmental Change ***resource***, *(non-)renewable, change,* ***impact****, consequence, global, world,* ***cause****,* ***effect****, long-term, short-term,* ***system****, cycle, interact, conserve, sustain, reduce, lessen, save, help, clean, preserve, protect, aware(ness), careful, practical,* ***effective****, responsible, reminder, positive, negative, pollution, waste, garbage*	

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "Different kinds of organisms (species) do not compete for the same natural resources."

Students may conclude that *different species* use different resource "stores" to meet their needs of food, water, space, and/or light. This may be reinforced by oversimplified representations of food chains/webs without special instruction to uncover and address this misconception.

Misconception: "Organisms of the *same* species do not compete with each other for natural resources."

Similar to above, students may conclude that organisms of the *same species (or in similar groups or classes)* use different resource "stores" to meet their needs. For example, some students describe that plants do not compete with other plants for light, water, and space. This may be reinforced by simplified representations of food chains/webs without special instruction to uncover and address this misconception.

Misconception: "Organisms at the 'top of the food chain' are better, or 'better adapted' to their environment."

Common phrases in everyday language, such as "bottom of the food chain," may influence student descriptions of the interactions between organisms. Teachers should be mindful of their descriptions of how each organism in an environment (small or large, predator or prey) plays a critical role in maintaining the health and balance within an ecosystem.

Misconception: "The food chain has a beginning and an end."

Food chain diagrams are useful to illustrate how energy and matter flow between organisms, however the linear representation can also lead to this misconception. Teachers should probe for students' thinking and understanding about the limitations of food chains as a model.

	Key points for instruction: "Students of all ages… may have the tendency to imagine that all environmentally friendly actions help to solve all environmental problems (for example, the use of unleaded petrol reduces the risk of global warming)" (*Atlas of Science Literacy,* Vol. 2 pg. 20, AAAS Project 2061). As instruction progresses within and across the grades, teachers should attempt to clearly and accurately foster descriptions of cause and effect relationships.

Potential Objectives for this Grade 1 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed. The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Explain why different living things are found in different environments
- Identify oak trees, squirrels, and deer and describe their habitats*
- Identify toucans, jaguars, anacondas and describe their habitats*
- Compare and contrast the habitats of jaguars and deer
- Identify lions, antelopes, and zebra and describe their habitats*
- Identify armadillos, cacti, and lizards and describe their habitats*
- Compare and contrast the habitats of lizards and zebra
- Identify worms, moles, and fungi and describe their habitats*
- Identify dolphins, octopi, and starfish and describe their habitats*
- Identify freshwater fish (e.g., bass) and describe their habitats*
- Compare and contrast the habitats of starfish and freshwater fish
- Match plants and animals to their habitats
- Explain how various animals are adapted to their habitats
- Compare and contrast herbivores, carnivores, and omnivores
- Create food chains and food webs for specific habitats

Middle

- Describe the surface of the earth
- Describe the diversity of ocean life
- Explain how ocean water is different from fresh water
- Identify and locate the Pacific, Atlantic, Indian, Arctic, and Southern Oceans on a map
- Identify the coast, shore, waves, and tides (high and low) of an ocean
- Define the term current and provide an example
- Describe the landscape of the ocean floor

End

- Describe how the environment can change
- Explain how changing environments can sometimes pose dangers to specific habitats
- Describe what it means for an animal species to become extinct
- Identify Rachel Carson and describe her efforts to protect the environment

*The intent with these objectives is to choose 1–3 animals in each habitat so students will be able to explore their habitats, recognize the patterns of similarities between these few, and over time, to recognize the patterns of differences across different habitats.

Potential Big Guiding Questions

Essential Questions:

- **Why are plants and animals in different habitats so different?**
- **How do animals impact their habitats?**
- **How have humans impacted the environment?**
- **What types of natural resources are consumed by wild animals? What patterns do you notice?**

RE: Animals and Habitats

- What does a habitat provide for an animal?
- How do special characteristics of animals help them survive in their given habitats?
- How do characteristics of their habitats help animals survive?
- How are animals in a given habitat alike?

RE: Animal Classifications

- How can animals be grouped together based on how they meet their needs?
- In what ways are the things that animals eat alike and different?

RE: Oceans

- What makes up earth's surface?
- Why are there so many kinds of life under the sea?
- How does the landscape of the ocean compare to the landscape of the earth?
- What causes waves?

RE: Environmental Changes

- Is nature static or dynamic?
- What are some ways in which humans affect the environment?
- What can we do to limit the damage we cause to the environment?
- Why do some animals become extinct?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example: (Beginning of Unit 4)

{**Evaluates Student Mastery of Objectives:** Match plants and animals to their habitats; explain how various animals are adapted to their habitats}

Note: This assessment can be used after Potential Activity Example #1, described below.

Advance Preparation:

Image cards for 5–7 different animals (at least one for each habitat and one challenge: an animal they have not discussed before, optional)

In designated areas around your classroom, post student drawings/representations of each habitat that they created earlier in this unit.

Note: You may wish to use the Animals & Habitats chart (see Sample Activity # 1 below) as a reference for students during this assessment task. For a challenge, you may wish to cover up the Animals row/column of that chart.

As a culminating assessment activity for the Animals and Habitats section of this unit, have students identify the environments to which particular animals are well suited, and describe how the animals are well-adapted to each environment. For this activity, you can utilize designated areas around your classroom by arranging the student drawings/representations of each habitat from previous lessons.

T - For this activity, please stand. You may put on your safari hats (optional)**. Today, we'll be doing more than just exploring. You have created habitats in different areas of the room through your drawings/art. Can you tell me the name of each habitat you've explored so far, and where it's represented in the classroom?** After students have identified each habitat, show the first animal image card.

T - What is the name of this animal? What are some key characteristics of this animal? How does it look, get food, and where does it seek shelter? Give students time to answer these questions.

T - Using what you know now about this animal, move to the place in the room that represents the habitat where that animal makes its home. Allow students to arrange themselves in the area of the room representing the animal.

T - Why did you choose this habitat? Guide students to base their answers on the characteristics of the animal and habitat, and how they match. If any students have different answers than their peers, allow

them to voice their reasonings. Give students a chance to rearrange themselves once everyone has explained why they chose their respective habitats.

T - Describe the characteristics of this animal, its traits, that make it particularly suited to this habitat.

Repeat this process and line of questions for each of the image cards. If you have additional time, encourage each student (one at a time) to name an additional animal not represented by the image cards, and repeat the activity for those animals.

Remind students that living things have made their homes in many different environments. A habitat matches the animal, and the animal matches the habitat.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction where it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 4)

{**Contributes to the Objective:** Explain how various animals are adapted to their habitats}

Advance Preparation:

Safari hats (paper or plastic, optional)

Animals & Habitats chart (depicting each animal studied and the characteristics such as food and shelter that make up its habitat)

Image Cards for Habitats chart (optional)

Art supplies (paper, markers, etc.)

During early lessons of this unit, students will discuss particular animals and identify their habitats and their characteristics. Encourage students to explore and make connections about the habitats while providing structure to the conversation, using the following general steps.

Read a short story or share a description of the habitat with students.

T - You will be explorers today, so put on your safari hats and prepare for an adventure to meet a new animal and its habitat. Remind students of the things they have learned about several animals and the habitats already, using the Animals & Habitats chart as a guide.

T - Today, we are going to learn about an animal called the armadillo. Show image of armadillo.

T - What do you notice about this creature just by looking at it? Encourage students to describe its physical characteristics, such as tough shell, pointy nose/face, long tail. Then, show an image, a video,

and/or read a description of the armadillo in its environment. Ask students to describe the armadillo's habitat by leading them through questions of where it gets food, where it sleeps or has shelter, etc.

T - What can you tell me about where this animal lives? Ask students to describe the characteristics of its habitat, including food, shelter, and living and nonliving things.

T - What do you notice about this animal that might help it in its environment? (e.g., shell can help protect it from predators) Then help lead students to identify others that do not arise from discussion (e.g., **T - Why would a long snout be helpful to this animal? How does the armadillo deal with the temperature in the desert?**).

Have students answer questions to fill out the next line of the Animals & Habitats chart, and record their responses using decodable words and/or images.

Have students draw or otherwise construct a representation of the animal and its habitat. As students draw, check in with students around the room, asking about the characteristics they are including and not including, and why. When students are done, you may wish to gather these representations as a check for understanding. Arrange habitat drawings so each habitat is given a different location in the room.

Example #2: (Middle of Unit 4)

{**Contributes to the Objective:** Describe the diversity of ocean life *(specifically the diversity of size)*}

Advance Preparation:

Computer with internet access to visit a virtual tour of the ocean (whether an aquarium or video of the ocean)

Counting cubes or other items sized to represent the size of different animals as accurately as possible

Images and/or video depicting several different ocean animals (e.g., whale, shrimp, dolphin) and a child

For five minutes, allow students to walk through a virtual tour of the ocean. Ask students to describe their favorite creatures or plants, the most interesting things they saw, the most dangerous, the biggest, the smallest, etc.

T - The ocean is full of many, many interesting plants and animals. As we learned earlier, this is probably related to how much of Earth is covered by water. So since there is so much space, it makes sense there is a lot of ocean life. Today we are going to compare, or find differences between, different animals that live in the ocean. What are some ways we can do that? Guide students to decide on the particular characteristic at which they would like to look more closely (e.g., size of animals). Share with students images and/or videos of several different ocean animals.

T - The ocean is the home of some of the largest animals, and some of the smallest. Today we will look at one way animals in the ocean are very different: by looking at their size. How can we compare the size of these aquatic animals? Let students think of a few ideas for ways to do this. The ideal is for students to compare the animals using something with an easily identifiable size as a reference (e.g., the size of person or an everyday object). Alternatively, you could design an investigation for students to simply see the animals' sizes relative to one another.

T - We have this stack of cubes that represents you and your size. (It would help students if you paste a picture of a child on the cube stack to help them visualize this represents them.)

T - We have this cube over here that represents the size of a [fish]. (Again, it would help students if you paste a picture of the [fish] on the stack.) **What do you notice about the sizes of these two things? Is the [fish] bigger than you? Is it taller or wider?** Then introduce new animals (e.g., shrimp, whale, octopus, dolphin), one after another, asking comparison questions between them. Encourage students to compare their own sizes to the size of each of the animals they have seen. You may ask the students to arrange the cube stacks in order, from largest to smallest, or in other patterns to help them see the differences between animals in the ocean.

T - What does seeing all these different sizes of animals tell you about ocean life? (There's a lot of different sizes of animals in the ocean. The ocean must be big to house so many different, large creatures, etc.)

Websites & Media

San Diego Zoo—Habitats & Animals: http://animals.sandiegozoo.org/habitats

Select a habitat and scroll through images of animals that live there. This may help your students to begin learning about the diversity of life on earth. This webpage may have been previously shared with students during Kindergarten Unit 2 *Animals & Their Needs.*

Ocean Matching Game: http://www.sheppardsoftware.com/world_G0_Click.html

This game can be used to assess students' knowledge of the locations of the world's oceans. Teachers can also select an option to review the location of the continents if desired, which is a review from Kindergarten science and geography.

Endangered Animals:

http://www.sheppardsoftware.com/content/animals/kidscorner/endangered_animals/whats_the_problem.htm

"By learning about the problems that face animals, we can figure out how to save them!" You may wish to use this website to explore and discuss different threats to animals, such as habitat loss, pollution, and poaching.

American Museum of Natural History: http://www.amnh.org

The AMNH website houses wonderful information and ideas for projects and investigations about our natural world. For example, the AMNH online exhibit regarding Theodore Roosevelt may help Grade 1 teachers to connect previous learning about our 26th president (review from Kindergarten) and expand students' understanding of conservation and protecting the environment.

National Geographic Virtual Worlds—The Deep Sea:

http://animals.nationalgeographic.com/animals/crittercam-virtual-world-deep-sea/

This interactive simulation can help students to explore regions of the earth that very few people ever have the chance to visit—the depths of our oceans. Students and teachers use the computer mouse to find specific creatures and learn more about their features and their lifestyles in the ocean habitat.

National Geographic Interview with a Marine Scientist—Sylvia Earle:

http://kids.nationalgeographic.com/kids/photos/oceans/#/tierradelfuego-745734_15601_600x450.jpg

This brief interview can be read and discussed with students to learn more about scientists like Dr. Sylvia Earle who study marine life and our world's oceans.

Supplemental Trade Books

- About Birds: A Guide for Children, by Cathryn Sill and illustrated by John Sill (Peachtree Publishers, 1997) ISBN 1561451479
- Afternoon on the Amazon (Magic Tree House, No. 6), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 1995) ISBN 0679863729
- Rain Forests (Magic Tree House Research Guide), by Will Osborne and Mary Pope Osborne (A Stepping Stone Book, 2001) ISBN 0375813551
- Animal Homes (Luxury Lift the Flap Learners), by Debbie Martin, Jane Rigby, and Alan Baker (Usborne Books, 2004) ISBN 0794507158
- Buffalo Before Breakfast (Magic Tree House, No. 18), by Mary Pope Osborne and Sal Murdocca (Random House, 1999) ISBN 0679890645
- Cactus Hotel (An Owlet Book), by Brenda Z. Guiberson and Megan Lloyd (Henry Holt and Company, 1993) ISBN 0805029605
- Dark Day in the Deep Sea (Magic Tree House, No. 40), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 2009) ISBN 0375837329
- Sea Monsters: A Nonfiction Companion to Dark Day in the Deep Sea, by Mary Pope Osborne, Natalie Pope Boyce, and Sal Murdocca (Random House Books for Young Readers, 2008) ISBN 0375846638
- Desert Giant: The World of the Saguaro Cactus (Tree Tales), by Barbara Bash (Sierra Club Books for Children, 2002) ISBN 1578050855
- Dingoes at Dinnertime (Magic Tree House, No. 20), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 2000) ISBN 0679890661
- Dolphins and Sharks: A Magic Tree House Research Guide, by Mary Pope Osborne, Natalie Pope Boyce, and Sal Murdocca (Random House Books for Young Readers, 2003) ISBN 0375823778
- Dolphins at Daybreak (Magic Tree House, No. 9), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 1997) ISBN 067988338X

- Penguins and Antarctica (Magic Tree House Research Guides), by Mary Pope Osborne, Natalie Pope Boyce, and Sal Murdocca (Random House Books for Young Readers, 2008) ISBN 0375846646
- Eve of the Emperor Penguin (Magic Tree House, No. 40), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 2008) ISBN 0375837337
- Exploring Tide Pools, by Monica Halpern (National Geographic Society, 2002) ISBN 0792285131
- Good Morning, Gorillas (Magic Tree House, No. 26), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 2002) ISBN 0375806148
- Here Is the African Savanna (Web of Life), by Madeleine Dunphy (Web of Life Children's Books, 2006) ISBN 0977379523
- Here Is the Arctic Winter (Web of Life), by Madeleine Dunphy (Web of Life Children's Books, 2007) ISBN 0977753913
- Here Is the Coral Reef (Web of Life), by Madeleine Dunphy (Web of Life Children's Book, 2006) ISBN 097737954X
- How to Hide an Octopus and Other Sea Creatures (All Aboard Book), by Ruth Heller (Grosset and Dunlap, 1992) ISBN 0448404788
- Life in a Pond (Pebble Plus: Living in a Biome), by Carol K. Lindeen (Capstone Press, 2003) ISBN 0736834028
- Life in a Wetland (Living in a Biome), by Carol K. Lindeen (Capstone Press, 2006) ISBN 0736834052
- Lions at Lunchtime (Magic Tree House, No. 11), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 1998) ISBN 0679883401
- Oil Spill! (Soar to Success), by Melvin Berger (Houghton Mifflin Company, 2006) ISBN 0395779138
- Polar Bears and the Arctic (Magic Tree House Research Guide), by Mary Pope Osborne and Natalie Pope Boyce (A Stepping Stone Book, 2007) ISBN 037583222X
- Polar Bears Past Bedtime (Magic Tree House, No. 12), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 1998) ISBN 067988341X
- Seven Continents, by Elaine Morris (National Geographic Society, 2003) ISBN 0792243684
- Snakes Are Hunters (Let's-Read-and-Find-Out Science, Stage 2), by Patricia Lauber (HarperTrophy, 1989) ISBN 0064450910
- Starfish (Let's-Read-and-Find-Out-Science), by Edith Thacher Hurd and illustrated by Robin Brickman (HarperTrophy, 2000) ISBN 0064451984
- The Arctic Habitat, by Mary Aloian and Bobbie Kalman (Crabtree Publishing Company, 2006) ISBN 0778729818
- The Great Kapok Tree: A Tale of the Amazon Rainforest, by Lynne Cherry (Voyager Books, 2000) ISBN 0152026142
- Tigers at Twilight (Magic Tree House, No. 19), by Mary Pope Osborne and Sal Murdocca (Random House Books for Young Readers, 1999) ISBN 0679890653
- What is a Carnivore?, by Bobbie Kalman (Crabtree Publishing Company, 2010) ISBN 9780778732945

- What is Hibernation?, by John Crossingham and Bobbie Kalman (Crabtree Publishing Company, 2002) ISBN 0865059640
- What Lives in a Tide Pool?, by Lily Richardson (National Geographic Society, 2007) ISBN 0792243374
- Who Eats What? Food Chains and Food Webs (Let's-Read-and-Find-Out-Science, Stage 2), by Patricia Lauber and Holly Keller (HarperTrophy, 1994) ISBN 0064451305
- Why do Animals Migrate?, by Bobbie Kalman (Crabtree Publishing Company, 2009) ISBN 9780778733034

Core Knowledge Science Program—Domain Map

Science Content
• Everything is made of matter • All matter is made up of parts too small to see • Introduction to the basic concept of atoms • Names and common examples of three states of matter: solid (for example, wood, rocks) liquid (for example, water) gas (for example, air, steam) • Water as an example of changing states of matter of a single substance: solid ice, liquid water, and gas (i.e., air and water vapor) • Units of measurement: Length: centimeter, inch, foot Volume: gallon, quart • Temperature: degrees Fahrenheit

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:

Grade 2 Topic Structure & Properties of Matter, for example: ***2-PS1-1****. Plan and conduct an investigation to* ***describe and classify different kinds of materials by their observable properties.*** ***2-PS1-4****. Construct an argument with evidence that* ***some changes caused by heating or cooling can be reversed*** *and some cannot.*	***Rationale:*** This unit lays a significant foundation for learning about PS1.A (Structure & Properties of Matter) which was first introduced in Kindergarten during Units 5 and 6 (e.g., sorting recyclable objects and classifying objects that are or are not attracted by a magnet). As students investigate water, they will also be preparing for the early progression of core idea PS1.B (Chemical Reactions) which sets an expectation that primary students understand, "Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible (e.g., melting and freezing)..." (*Framework*, page 110) This will be extended during Grade 2 Unit 1 *Cycles in Nature* using this Grade 1 learning as a base. The Grade 2 Topic Structure & Properties of Matter will also be explicitly addressed during Grade 2 Unit 5 *Simple Machines* during which students will engage in at least one design challenge to apply these core ideas and connect to engineering, design, and the concept of Structure & Function.

2-ESS2-3**. Obtain information to **identify where water is found on Earth and that it can be solid or liquid.	***Rationale:*** This unit—coupled with the earlier Grade 1 units *Living Things & Their Environments* (Unit 4 re: water habitats) and *Introduction to Geology (*Unit 3 re: oceans)—will directly support the core idea ESS2.C (Roles of Water in Earth's Surface Processes). Students also have the opportunity to learn about water's importance and prevalence on Earth's surface during Grade 2 Unit 1 *Cycles in Nature* when students will review where they can find water and explore the concept that most of Earth's surface is covered in water.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen the understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. (2-PS1-2)

MP.4 Model with mathematics. (2-PS1-1) (2-PS1-2)

MP.5 Use appropriate tools strategically. (2-PS1-2)

1.MD.C.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another. (2-PS1-1),(2-PS1-2)

POTENTIAL CCSS ELA Connections

RI.1.1 Ask and answer questions about key details in a text. *(2-PS1-4)*

RI.1.3 Describe the connection between two individuals, events, ideas, or pieces of information in a text. *(2-PS1-4)*

RI.1.8 Identify the reasons an author gives to support points in a text. *(2-PS1-2 and 2-PS1-4)*

W.1.1 Write opinion pieces in which they introduce the topic or name the book they are writing about, state an opinion, supply a reason for the opinion, and provide some sense of closure. *(2-PS1-4)*

W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). *(2-PS1-1, 2-PS1-2, and 2-PS1-3)*

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. *(2-PS1-1, 2-PS1-2, and 2-PS1-3)*

POTENTIAL Cross-Curricular Connections

Potential Links:

Mathematics: Measurement—Identify familiar instruments of measurement, such as ruler, scale, thermometer. Compare objects according to: linear measure (e.g., using non-standard units as well as inches, feet, and centimeters), weight (e.g., using non-standard units and pounds, using a balance scale), and capacity (e.g., estimate and measure capacity [volume] in cups and identify a quart and gallon).

Prior Knowledge

Core Knowledge Kindergarten Sequence
IV. Introduction to Magnetism

- Magnetism is a property of matter
- Identify familiar everyday uses of magnets (for example, in toys, in cabinet locks, in "refrigerator magnets," etc.)
- Classify materials according to whether they are or are not attracted by a magnet

VI. Taking Care of the Earth

- Some materials can be recycled (for example, aluminum, glass, paper)

CKLA Kindergarten Listening & Learning
Domain Anthology, *Taking Care of the Earth*

- Identify common recyclable materials, including glass, plastic, aluminum, cardboard, and pape.

Core Knowledge Science (Previously taught units in the CK Science program)
Kindergarten
Unit 5 *Taking Care of the Earth*

- Identify everyday objects that are made up of natural resources
- Identify common resources that are limited and nonrenewable
- Classify resources as renewable or nonrenewable
- Identify items that can be used over and over again
- Identify materials that can be recycle. *(2-PS1-1)*
- Classify objects as recyclable or as garbage

Unit 6 *Pushes, Pulls, and an Introduction to Magnets*

- Describe different ways magnets are used in everyday life
- Describe the term *attract*
- Classify materials according to whether they are or are not attracted by a magnet
- Describe the term *repel*
- Apply your knowledge of forces and magnets to solve a problem

Grade 1

Unit 3 *Introduction to Geology*

- Describe the weather and climate of different regions of Earth
- Identify and describe landforms and bodies of water in our local area
- Develop a model that represents the landforms and bodies of water in our local area (2-EE2-2)
- Compare and contrast volcanoes and geysers
- Sort rocks based on similar features
- Describe features of metamorphic, igneous, and sedimentary rocks
- Describe how metamorphic, igneous, and sedimentary rocks are formed
- Classify rocks as metamorphic, igneous, and sedimentary

Unit 4 *Living Things & Their Environments*

- Identify dolphins, octopi, and starfish and describe their habitats*
- Identify freshwater fish (e.g., bass) and describe their habitats*
- Compare and contrast the habitats of starfish and freshwater fish
- Describe the surface of Earth
- Explain how ocean water is different from fresh water
- Identify and locate the Pacific, Atlantic, Indian, Arctic, and Southern Oceans on a map
- Identify the coast, shore, waves, and tides (high and low) of an ocean
- Define the term *current* and provide an example

CKLA Grade 1 Objectives—Not Applicable

The Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history, ***does not include the study of matter and its properties****. In order to prepare students to meet or exceed the NGSS Grade 2 Topic Structure & Properties of Matter, this unit (as well as Grade 2 Unit 5* Simple Machines*) is critical to advance students' understanding of the physical sciences. To learn more about how and why the Listening & Learning Strand of CKLA approaches certain science content through read-alouds and ELA instruction, read more about the CKLA program.*

What Students Will Learn in Future Grades

Core Knowledge Sequence
Grades 2, 3, and 4 Measurement

- linear measurement
- weight
- volume
- temperature

Grade 2 Magnetism

- Magnetism demonstrates that there are forces we cannot see that act upon objects
- Most magnets contain iron
- Lodestones: naturally occurring magnets
- Magnetic poles: north-seeking and south-seeking poles
- Magnetic field (strongest at the poles)
- Law of magnetic attraction: unlike poles attract, like poles repel
- The earth behaves as if it were a huge magnet: north and south magnetic poles (near, but not the same as, geographic North Pole and South Pole)
- Orienteering: use of a magnetized needle in a compass, which will always point to the north

Grade 2 Simple Machines

- Types of simple machines (e.g., wheel-and-axle, gears [wheels with teeth and notches], how gears work, and familiar uses such as bicycles)
- Friction, and ways to reduce friction (lubricants, rollers, etc.)

Grade 3 Sound

- Sound is caused by an object vibrating rapidly
- Sounds travel through solids, liquids, and gases
- Sound waves are much slower than light waves

Grade 4 Electricity

- Conductors versus insulators
- Electromagnets: how they work and their common uses

Grade 4 Chemistry

- atoms, molecules, and compounds
- properties of matter
- mass, volume, density, and vacuums
- elements
- solutions

Grade 5 Chemistry

- molecules and compounds
- chemical and physical changes

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Grade 1 unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Matter	Properties of matter
***atom**, element, compound, molecule, electron, neutron, proton, nucleus, **particle**, unit, matter, **substance**, material, piece, part, component, solid, liquid, gas, **state**, example, water, ice, **vapor**, **(in)visible**, steam, **mixture**, combination, pure, (un)common, rare, subatomic, positive, negative, neutral, charge, electric, chemical, combine, **characteristic**, **property**, **melt**, **freeze**, solidify, **boil**, vaporize, evaporation, condense, condensation, **change**, **heat,** thermal, hydrogen, helium, oxygen, iron, gold, calcium, [names of other common elements and compounds]*	***property**, **characteristic**, unique, different, similar, alike, **tool**, instrument, unit, standard, **shape**, [names of geometric shapes], **size**, dimension, width, height, **inch**, **foot**, meter, centimeter, **ruler,** measuring stick, yardstick, [other words associated with length], **weight**, pounds, ounces, scale, balance, **volume**, space, **capacity**, gallon, quart, cup, pint, liter, color, [names of different colors], **texture**, feeling, sensation, rough, smooth, bumpy, slick, soft, fuzzy, [examples of materials with different textures], **temperature**, **thermometer**, **degree**, Fahrenheit, Celsius, **heat**, hot, warm, cold, cool, expand, contract, **pattern**, **observe**, measure, **record**, note, **classify**, communicate, present, **evidence**, argument, **explain**, **describe***

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "Clouds and fog are gases." or "Visible steam/mist is an example of gas."
When in its gaseous state, water is invisible to the naked eye. Visible steam, clouds, and fog are examples of *mixtures* of invisible water vapor and small liquid water droplets that are suspended in air. Teachers and textbooks often overgeneralize the concept of "mixing clouds," formally referred to as colloids and aerosols, and inaccurately classify a steam cloud rising from a tea kettle or even fog as just a gas. The existence of water vapor in the atmosphere can be difficult for students to understand even into the middle school grades (Lee. et. al, 1993; Johnson, 1998). The focus of this Grade 1 unit should be on an introduction to water vapor as an example of the gaseous state of water. Grades 2 and 4 will provide specialized instruction to address potential misconceptions such as, "When water evaporates it ceases to exist" and "Evaporated water is still liquid, but it has changed locations." Using examples of steam and clouds can provide concrete examples of phenomena that often occur when water transitions between one state of matter and another.

Misconception: "Ice cubes give off cold."
Students often think of 'cold' as being it's own force or phenomena, rather than as the absence of heat.

Misconception: "Air and oxygen are the same thing."
Air is a mixture of gases, including nitrogen, oxygen, argon, carbon dioxide, and water vapor. The concept of mixtures, especially invisible mixtures, are abstract for students and difficult to describe and understand accurately. Teachers should plan their language of instruction carefully to avoid inadvertently reinforcing misconceptions.

Key points for instruction:
Common usage of the terms *material* and *stuff* may surface during discussions with students about matter. "Although the word *stuff* may not be accepted as a scientific word, it has tangible connotations for students and therefore is useful for developing the idea that there are different kinds of 'stuff' with different properties." (Keeley, 2013) Students may also use the term *material* to mean the component pieces of an object—for example, fabrics are made of smaller material. (Driver, et. al., 1994) Students may also classify only things that they can feel (i.e., that have "felt weight") as being matter. Many students may believe that gases are not matter because they cannot feel their weight and/or describe and classify matter based upon the weight of the samples at hand.

Consider reading more about common misconceptions and key points for instruction offered by Ohio State University's College of Education and Human Ecology: Common Misconceptions about States and Changes of Matter. The OSU project, *Beyond Penguins and Polar Bears*, is an excellent resource for teachers to learn more about misconceptions and broader implications for learning about a variety of scientific topics.

Potential Objectives for this Grade 1 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed. The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Describe characteristics of matter
- Identify common features found among solids (2-ESS2-3)
- Describe characteristics of liquids (2-PS1-4 and 2-ESS2-3)
- Describe water vapor (2-PS1-4 and 2-ESS2-3)

Middle

- Develop a method by which we can classify matter (2-PS1-1)
- Classify different kinds of matter by their observable properties (2-PS1-1)
- Describe how physical properties of matter can be measured

End

- Measure objects using nonstandard units
- Determine when objects should be measured in inches or feet
- Compare the volume of pints, quarts, and gallons
- Describe how measuring the temperature helps us in our everyday lives

Potential Big Guiding Questions

Essential Questions:

- **What are physical properties of matter?**
- **How can measuring properties of matter help us describe and classify objects?**

RE: States of Matter

- How do we describe objects?
- How do you think the ice cubes (a solid) changed into a liquid?
- Where are ice cubes stored? Why do you think that is important?
- How is the shape of liquids different from solids?

RE: Measurement

- How can we measure matter?
- Why are standards of measure important?
- This object is very long/short—should we measure it in inches or feet?
- Why can't we measure water with a ruler?
- Do solids have volume?
- What are some items you may buy from the grocery store that come in gallon/quart?
- Why would we want to measure the temperature?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example: (End of Unit 5)

{Evaluates Student Mastery of Objectives*: Determine when objects should be measured in inches or feet* and *Measure objects using non-standard units***}**

Advance Preparation:

- Clearly label "measuring stations" around your classroom — items in the classroom that you would like students to measure (e.g., a pencil, a desk, a table, chart paper, eraser for a chalkboard or whiteboard, a book, etc.).
- Place in a folder/envelope approximately 9–12 non-standard "inch" measuring tools (i.e., paper cut-outs measuring one inch each) for each small group of students.
- Place in a folder/envelope approximately 4–5 non-standard "foot" measuring tools (i.e., paper cut-outs measuring one foot each) for each small group of students (Consider printing these "foot" measuring tools in a different color than the "inch" measuring tools.).
- Create an assessment handout for students to 1) identify the measuring tool used, 2) record the object's (approximate) measurements in non-standard units, and 3) describe their rationale using pictures, phrases, or sentences. **Note:** Since these are real objects around your room, the expected student answers will not measure exactly to "x" number of inches or feet. Therefore, it will be important to explain to students that their measurements are approximations. They should only include the whole number of inches or feet that fit within the object—refraining from going over.
- Acquire a notebook or note-taking sheet to record student responses/descriptions (i.e., why they decided to measure their object in feet or inches).

Task Assessment: Invite students to measure different items in the classroom in feet or inches and to use the assessment handout to record their measurements and thinking.

Provide each small group of students with both a set of "inch" measuring tools and a set of "feet" measuring tools. Assign, or ask students to select, items they wish to measure in small groups. Once students are positioned at their stations, ask them to determine if they should measure the objects in inches or feet, and then measure the items using the corresponding tools. As necessary, remind students (or model) how to line up the measuring tools in order to accurately measure the objects. As you rotate and meet with each group, ask them to explain their rationales for measuring in feet or inches. The goal is for students to recognize that items that appear to be longer (i.e., longer than one foot) can be easily measured with a longer measuring tool—in feet. Likewise, if the object appears short in length, it may be easier to try a shorter measurement tool—inches. If students try to measure long objects in inches, ask

them to think about the benefit to measuring in feet (e.g., they can measure in feet more quickly because they would need fewer "feet" than "inches" to measure the entire objects, so they are less likely to make errors, etc.). Allow students the opportunity to rotate to different stations and record their findings for various objects. Be sure to meet with each group as they work.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction where it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (End of Unit 5)

{Contributes to the Objective: *Measure objects using non-standard units***}**

Activity: Show the students two sets of sentence strips. Ask them to describe what they see. One set is comprised of sentence strips that are all the exact same length. The other group contains strips of different lengths.

T - What do you notice about these two groups of strips? (Students should indicate that each strip in the first pile is the same length and the lengths differ in the second pile.)

T - Let's measure the length an object, and see what happens when I measure it using units of the same length compared to units of varying lengths.

Using a long strip of paper (e.g., a sentence strip) explain that you will model how to use a measuring tool to accurately measure the length of an object. Begin by lining up the edge of the sentence strip with the edge of an object, then place a second sentence strip right up against where the first ended. Continue until you have measured the full length of the object. Ask the students to count the strips.

T - How many sentence strips did we use? That means that the object is x sentence strips long. Let's see what happens when I measure using strips of varying lengths. (Repeat the process from above.)

T - What happened? (Students should indicate that they recorded two different lengths [x sentence strips long and x sentence strips long]).

Using student volunteers, repeat this process with a different pile of sentence strips (same size as the first) and another pile with different sizes. Use this second opportunity to model how to appropriately measure objects.

T - What happened the second time? Which measurement stayed the same, which was different?

Encourage students to think about problems that might arise if people were to measure objects (e.g., furniture, building materials, property lines, etc.) using units of different lengths.

T - We are going to take turns measuring similar objects using paper clips, which are all the same length. What should happen? (Students should indicate that their measurements should all be the same)

Conduct the activity. As students work, rotate around the room to provide feedback and support. After students have had the opportunity to measure several objects, ask them to share the length of each object in paper clips. If some groups arrived at different measurements, lead students in a discussion to brainstorm how this could have happened (e.g., students may not have properly lined up the paper clips, overlapped paper clips, etc.).

Example #2: (End of Unit 5)

{Contributes to the Objective: *Compare the volume of pints, quarts, and gallons***}**

Advance Preparation: In order to complete this activity students will need to have access to water, measuring tools (i.e., cup[s], pint[s[, quart[s], and gallon[s], a writing utensil, and a recording sheet [see examples]).

1 cup	
1 pint	= _____ cups
1 quart	= _____ pints
1 gallon	= _____ quarts

Activity: Invite children to investigate the relationship between cups, pints, quarts, and gallons. Provide children with a measuring cup and a pint, a quart, and a gallon container as well as a recording sheet and writing utensil. Ask them to fill the cup with water and transfer the water to the pint. Tell them to continue this until the pint is full. Have them note the number of cups it took to fill the pint on their recording sheet. Next have them pour the water from the pint into the quart. Encourage them to fill the pint with water and transfer it to the quart until the quart is full. Again ask them to record the number of pints it took to fill the quart. They can then repeat this process to see how many quarts it takes to fill a gallon.

Websites & Media

Images of the States of Matter:

Multimedia examples of the states of matter can be powerful discussion starters that can kickstart your students' thinking. For example, macro images of snowflakes and water droplets can offer something concrete for students to connect their learning to past experiences. You might also consider connecting this unit to your students' previous study of geysers (Unit 3 *Introduction to Geology*) by using images and/or video of a geyser such as the Castle Geyser in Yellowstone National Park, to introduce or extend your discussions of gases and mixing clouds. Images and videos of high winds can also be effective examples to engage students in early discussions about invisible gases.

BrainPop Video—The States of Matter:
https://www.brainpop.com/science/matterandchemistry/statesofmatter/

Consider discussing this video with your Grade 1 students, especially the section beginning at 00:27 seconds and ending at minute 03:23. This 3-minute portion can offer your students a sneak peak into the causes of the different states of matter. While this video goes beyond the expectations of what your students will be required to explain at this grade level, it offers an excellent introduction to important vocabulary and examples that will be extended in upper elementary units, such as Grade 4 Unit 2 *Chemistry: Basic Terms & Concepts*. Be sure to consider the possible misconceptions that students may have and/or generate during this unit and craft your questions carefully to tease out what your students are thinking.

Supplemental Trade Books

- *How Big is a Foot?*, by Rolf Myller (Random House Children's Books, 1991). ISBN 0440404959
- *How Tall, How Short, How Faraway,* by David Adler (Holiday House, 1999). ISBN 0823416321
- *Room for Ripley,* by Stuart Murphy (HarperCollins, 1999). ISBN 0060276207
- *Super Sand Castle Saturday,* by Stuart Murphy (Harper Trophy, 1999). ISBN 0064467201
- *Twelve Snails to One Lizard: A Tale of Mischief and Measurement,* by Susan Hightower (Simon and Schuster, 1997). ISBN 0689804520

Core Knowledge Science Program—Domain Map

Science Content
• Introduction to static electricity • Basic parts of simple electric circuits (for example, batteries, wire, bulb or buzzer, switch) • Conductive and nonconductive materials • Safety rules for electricity (for example, never put your finger, or anything metallic, in an electrical outlet; never touch a switch or electrical appliance when your hands are wet or when you're in the bathtub; never put your finger in a lamp socket; etc.) • A biography of Thomas Edison

This unit contributes to meeting or exceeding the following Next Generation Science Standards: *Standards noted with an asterisk (*) are those that incorporate engineering and design*	
K–2 Topic *Engineering Design*, for example: ***K-2-ETS1-2****. Develop a simple sketch, drawing, or physical model to* ***illustrate how the shape of an object helps it function as needed to solve a given problem.******	***Rationale:*** The study of basic electrical circuits; Thomas Edison, and his development of a lightbulb will offer students the explicit opportunity to engage in this primary grade topic of engineering and design. This unit will also explore ETS2.B (Influence of Engineering, Technology, and Science on Society) which is classified by the NGSS as a cross-cutting concept (e.g., see 4-PS3-4) and is a disciplinary core idea within the *Framework for K–12 Science Education* (page 212). These standards will be further addressed in Grade 2 as outlined below.

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
2-PS1-1*. Plan and conduct an investigation to* ***describe and classify different kinds of materials by their observable properties.***	***Rationale:*** Students will have the opportunity to explore and extend their knowledge of PS1.A (Structure & Properties of Matter) in a new context during this unit while classifying materials as either conductive or nonconductive. This combines with previous learning from Kindergarten (e.g., Unit 5 re: recyclable materials and Unit 6 re: objects that are or are not attracted by a magnet) to prepare students for further study of this DCI in Grade 2 (e.g., Unit 5 *Simple Machines* where students will complete a design challenge using their knowledge of the properties of matter).

3-PS2-3. *Ask questions to determine cause and effect* ***relationships of electric*** *or magnetic* ***interactions between two objects not in contact with each other.***	***Rationale:*** Grade 1 *Introduction to Electricity,* along with several other units of the CK Science program, will engage students with the core idea PS2.B (Types of Interactions). These units include Grade 2 Unit 4 *Magnetism*, Grade 3 Unit 5 *Astronomy*, and Grade 4 Unit 3 *Electricity*. Over time, students will explore electricity, magnetism, and gravity as forces "between a pair of objects that do not require that the objects be in contact." (*Framework*, page 117) Examples of interactions that will be introduced in this unit are, for example, electrical forces between your hair and an electrically-charged balloon and/or a charged rod and small pieces of paper.
4-PS3-2. Make observations to provide evidence that **energy can be transferred from place to place by sound, light, heat, and electric currents**. **4-PS3-4.** Apply scientific ideas to design, test, and **refine a device that converts energy from one form to another**.*	The early study of electricity also offers an excellent start to the progressions for the DCIs of PS3.B (Energy Transfer) and PS3.D (Energy in Everyday Life). These ideas will be formally assessed by the NGSS in Grade 4, during which students are expected to understand that, "Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light." These ideas will be extended in Grade 1 Unit 7 *Introduction to Light & Sound,* during Grade 3 Unit 3 *Light* and Unit 4 *Sound,* as well as Grade 4 Unit 3 *Electricity*.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen the understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. *(K-2-ETS1-1 and K-2-ETS1-3)*

MP.4 Model with mathematics. *(K-2-ETS1-1 and K-2-ETS1-3)*

MP.5 Use appropriate tools strategically. *(K-2-ETS1-1 and K-2-ETS1-3)*

1.MD.C.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another. *(K-2-ETS1-1 and K-2-ETS1-3)*

POTENTIAL CCSS ELA Connections

RI.1.1 Ask and answer questions about key details in a text. *(K-2-ETS1-1)*

W.1.6 With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. *(K-2-ETS1-1 and K-2-ETS1-3)*

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. *(K-2-ETS1-1 and K-2-ETS1-3)*

SL.1.5 Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings. *(K-2-ETS1-2)*

POTENTIAL Cross-Curricular Connections

Potential Link:
ELA: Sayings & Phrases—"If at first you don't succeed, try, try again." *(This saying is particularly applicable during the study of Thomas Edison's work and when learning about his approach to the process of design and invention. For example, it has been reported by a close friend of Edison's that—after nine thousand attempts to design an improved storage battery—the friend asked, "Isn't it a shame that with the tremendous amount of work you have done you haven't been able to get any results?" To which Edison replied, "Results! Why, man, I have gotten a lot of results! I know several thousand things that won't work."*
American History: Benjamin Franklin: patriot, inventor, writer *(Franklin's inventions included the lightning rod to protect houses from catching fire when struck by lightning.)*

Prior Knowledge

Core Knowledge Kindergarten Sequence
IV. Introduction to Magnetism

- Magnetism is a property of matter
- Identify familiar everyday uses of magnets (for example, in toys, in cabinet locks, in "refrigerator magnets," etc.)
- Classify materials according to whether they are or are not attracted by a magnet

VI. Taking Care of the Earth

- Some materials can be recycled (for example, aluminum, glass, paper)

CKLA Kindergarten
Domain Anthology, *Taking Care of the Earth*

- Identify common recyclable materials, including glass, plastic, aluminum, cardboard, and paper

Core Knowledge Science (Previously taught units in the CK Science program)
Kindergarten
Unit 5 *Taking Care of the Earth*

- Identify everyday objects that are made up of natural resources
- Classify resources as renewable or nonrenewable
- Classify objects as recyclable or as garbage

Unit 6 *Pushes, Pulls, and an Introduction to Magnets*

- Describe different ways magnets are used in everyday life
- Classify materials according to whether they are or are not attracted by a magnet
- Apply your knowledge of forces and magnets to solve a problem

Grade 1 Unit 5 *Matter & Its Properties*

- Describe characteristics of matter
- Identify common features found among solids (2-ESS2-3)
- Develop a method by which we can classify matter (2-PS1-1)
- Classify different kinds of matter by their observable properties (2-PS1-1)
- Describe how physical properties of matter can be measured
- Measure objects using nonstandard units
- Determine when objects should be measured in inches or feet

CKLA Grade 1 Objectives—Not Applicable

The Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history, does not include the study of electricity. In order to prepare students to meet or exceed the NGSS Grade 2 Topic Structure & Properties of Matter, this unit (as well as Grade 2 Unit 5 Simple Machines*) is critical to advance students' understanding of the physical sciences. To learn more about how and why the Listening & Learning Strand of CKLA approaches certain science content through read-alouds and ELA instruction, read more about the CKLA program.*

What Students Will Learn in Future Grades

Core Knowledge Sequence
Grade 2 Magnetism

- Magnetism demonstrates that there are forces we cannot see that act upon objects

Grade 3 Astronomy

- Gravity, gravitational pull:
  Gravitational pull of the moon (and to a lesser degree, the sun) causes ocean tides on earth
  Gravitational pull of "black holes" prevents even light from escaping

Grade 4 Electricity

- Electricity as the charge of electrons
- Static electricity
- Electric current
- Electric circuits, and experiments with simple circuits (battery, wire, light bulb, filament, switch, fuse)
- Closed circuit, open circuit, short circuit
- Conductors and insulators
- Electromagnets: how they work and common uses
- Using electricity safely

Grade 4 Chemistry—Atoms and Elements

- All matter is made up of particles too small for the eye to see, called atoms
- Scientists have developed models of atoms; while these models have changed over time as scientists make new discoveries, the models help us imagine what we cannot see
- Atoms are made up of even tinier particles: protons, neutrons, electrons
- The concept of electrical charge:
  Positive charge (+): proton
  Negative charge (-): electron
  Neutral (neither positive nor negative): neutron
  "Unlike charges attract, like charges repel" (relate to magnetic attraction and repulsion)
- Elements are the basic kinds of matter, of which there are a little more than one hundred
- There are many different kinds of atoms, but an element has only one kind of atom
- Familiar elements, such as gold, copper, aluminum, oxygen, iron
- Most things are made up of a combination of elements

Core Vocabulary

The following list contains the core vocabulary words suggested for purposeful integration across this Grade 1 unit. ***Boldfaced*** *terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Electricity	Safety with Electricity
***energy**, charge, **source**, electron, static, buildup, **change**, friction, positive, negative, **attract**, **repel**, opposite, alike, release, discharge, electrical, **current**, path, circuit, flow, closed, series, parallel, wire, generator, **battery**, cell, terminal, contact, touch, fuse, (non)conductive, insulator, conductor, switch, on, off, device, appliance, [examples of appliances that use electricity]*	*precaution, safety, **hazard**, dangerous, **shock**, electrocute, **caution**, harmful, hurt, careful, rules, warning, habit, socket, outlet, plug, cord, wires, conductor, appliance, current, flow, metal, water, wet, lightning, storm*
Thomas Edison ***engineer**, **design**, develop, build, problem, question, laboratory, **investigate**, test, trial, success, fail, **persistence**, error, **criteria**, invention, lightbulb, lamp, drawing, sketch, **model**, transform, transfer, energy, heat, light, dark, burn, bright, **filament**, bamboo, platinum, metal*	

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "Thomas Edison invented the electric lightbulb."
Historians agree that Edison did not invent the first electric lightbulb as others had succeeded as early 1802, almost eight decades before Edison's seminal design. He did, however, produce the first commercially-viable model of a lightbulb after his extensive experimentation to identify a long-lasting filament that was affordable and safe—a carbonized bamboo filament that replaced his earlier designs.

Misconception: "All electric currents are flows of electrons."
Electric currents are caused by the flow of any charged particle, ions, that contain an imbalance of protons or electrons. In fact, commonly used electric currents that depend on the flow of positive charged ions include fluorescent bulbs, neon signs, and battery acid. Electric currents in salt water are also due to the flow of "extra" protons.

Edison's design using carbonized Japanese bamboo, which replaced earlier models using platinum and which could "burn" for over 1200 hours, is recognized as a key development that transformed how (and for how long) humans interact with each other and their world after dark.

Misconception: "Electricity and power are the same thing."
The NRC *Framework for K–12 Science Education* points out that, "Young children are likely to have difficulty studying the concept of energy in depth—everyday language surrounding energy contains many shortcuts that lead to misunderstandings." (pg. 94) The terms *power* and *energy* have specific scientific meanings that most young students have not experienced or learned in depth. The focus of this unit will directly align with the elementary learning progressions about energy and electricity set out by the *Framework*, specifically by the disciplinary core ideas of PS2.B (Types of Interactions), PS3.B (Energy Transfer), and PS3.D (Energy in Everyday Life).

Misconception: "Batteries and generators are the source of an electric current."
This statement is an overgeneralization because batteries and generators do not supply ions or electrons, but rather ***energy*** to an electric circuit. Specifically, an electrochemical cell supplies the energy needed to move a charge from a low potential location to a high potential location. The particles that move are, in fact, found in the components of the circuits, such as the wires, *even before the battery is connected!*

Key points for instruction:
Students of all ages have difficulty accurately describing the phenomena of electricity, and energy in general (*Framework,* pages 94–96 and 128–130). The focus of this early grade unit should be on macroscopic phenomena with which young students can engage meaningfully (e.g., examples of static electricity, building and using simple electric circuits, and safety with electricity). This unit will intentionally foreshadow the technical explanations of electric currents and related vocabulary, but students are not expected to explain the exact science at this early age.

Potential Objectives for this Grade 1 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed. The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Describe how electricity impacts our everyday life
- Identify actions that keep us safe around electricity
- Describe the effect of static electricity
- Describe how objects repel and attract

Middle

- Distinguish between electric charges that repel and electric charges that attract
- Compare and contrast open and closed circuits
- Classify objects as insulators or conductors
- Describe characteristics of materials that act as conductors and materials that act as insulators

End

- Describe how Thomas Edison's inventions are used today
- Identify problems that could be solved with new or improved tools
- Develop a tool (model or illustration) that can be used to solve an identified problem
- Describe how a tool can be used to solve an identified problem

Potential Big Guiding Questions

Essential Questions:

- **What kinds of materials conduct electricity?**
- **What can you do to use electricity safely?**

Re: Electricity in Everyday Life:

- Why is electricity important to us?
- How can we stay safe around electricity?

Re: Static Electricity:

- How are magnetic poles similar to electric charges?
- If two objects have the same electric charge, do you think they will attract or repel? Why?

Re: Electric Current and Circuits:

- Can an electric current flow through a gas or a liquid?
- What happens when there is a gap in a circuit?

Re: Conductors and Insulators:

- Do you think electricity can flow through any object?
- What do you notice about the material of most conductors? How are they different from materials that serve as insulators?

Re: Thomas Edison

- How do Thomas Edison's inventions resemble some of the tools and technology we use today?
- Why is persistence an important trait for scientists?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example #1: (Middle of Unit 6)

{Evaluates Student Mastery of Objective*:* Classify objects as insulators or conductors**}**

Advance Preparation: You will need to acquire the following items in order to create a simple circuit:

- Three wires
- A battery
- A light bulb
- Several "everyday items" made up of different materials (e.g., bar of soap, copper penny, piece of silverware, wooden block, etc.)
- Pieces of folded cardstock (e.g., resembling a "table tent"). One labeled, "insulator" and the other labeled, "conductor."

Assessment Task: Set up the circuit, attaching one wire to the negative terminal (on the battery) and a separate wire to the light bulb. Attach the free ends of the two wires to one of the metal "everyday items." Ask the students to think about what they learned regarding open and closed circuits, and share what's happening. If students need support, ask questions that guide them to the realization that the light bulb glows because electricity is flowing through the (open) circuit. Now repeat the experiment with a non-metal object (e.g., wooden block).

T - Our circuit appears closed. The wires are attached to the battery, light bulb, and (object name)**. Why isn't the light turning on? What changed?** (Provide students with at least 30 second of think time, and then hear ideas.) **The object that I attached to the wires changed.**

T - (Holding up the metal object) **Electricity was able to flow through this object, but** (holding up the wooden object) **it was not able to flow through this one. When electricity is permitted to flow through an object, that object is called a conductor.** (Place the metal object on a table, visible to students, in front of the cardstock labeled, "conductor.") **If the object does not allow electricity to flow through it is called an insulator.** (Place the object by the "insulator" cardstock.)

T - We are going to "test" each of these remaining items. I need you to tell me if the object is working as a conductor or insulator and we will categorize them into their respective groups.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction where it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 6)

{Contributes to the Objective: Describe how electricity impacts our everyday life**}**

Activity: Invite students to record the number of electrical devices they use on a daily basis. Explain that any device that runs on batteries or that is plugged into the wall uses electricity to work. Children can also record how long they use each device. Encourage children to then imagine a time before electricity was available. Remind them that none of the devices they recorded could be used before electricity was available. What would their lives be like? How might their daily routines be different? How would they

listen to music? Where would they find their entertainment? How would they read at night, wash clothes, or keep food from going bad?

Example #2: (Beginning of Unit 6)

{Contributes to the Objective: Distinguish between electric charges that repel and electric charges that attract**}**

Advance Preparation:

- **Fill multiple balloons with air (**one for you and one for every student or pair of students).
    - Before the start of the lesson, model for students how to handle balloons appropriately.
- **Acquire two magnets**

Activity: Provide each child (or pair of children) with a balloon. Ask them to touch the balloon to the classroom wall and let it go..

T - What happened? (The balloon fell to the floor.) I **want you to rub the balloon against your hair like this.** (Model then allow students approximately 10–20 seconds to do the same.). **We are going to try to place the balloon near the wall. What do you think is going to happen?** (Listen to several responses. Encourage students to explain their thinking.) **Now place your balloon near the wall.**

Children will see that the balloons stick to the wall.

T - What happened? Why do you think the balloon stuck to the wall? (Encourage students to explain their thinking.)

T - This was caused by static electricity. What do you think created the static electricity? (If students need guidance, ask them to think about what they did differently between the first time they placed the balloon by the wall and the second time--rubbing the balloon on hair.) **That built a charge on the balloon.**

Hand two students magnets.

T - What did we learn happens when we tried to place the two magnets together? Students should indicate that they repelled each other (Have students with the magnets model this effect.)

T - Similar poles repel. The balloon fell (model again) **because it and the wall exert the same charge.**

T - But after we rubbed the balloon on our hair, it stuck to the wall. What does that tell us? Students should conclude that the balloon and wall had different charges because the balloon stuck to the wall—they were attracted.

Websites & Media

YouTube video for teachers—Plastic Comb Rubbed With a Cotton Cloth Attracts Small Pieces of Paper: https://youtu.be/rtl9TyMZSP8

This short video (approximately 1.5 minutes) offers an example of a demonstration that you might conduct with your young students. Consider using this sort of anchoring event to engage them with the concept of electrical charge and static electricity.

Supplemental Trade Books

- *The Magic School Bus and the Electric Field Trip* by Joanna Cole and Bruce Degen (Scholastic, 1999) ISBN 0590446835
- *Switch On, Switch Off* by Melvin Berger (HarperTrophy, 2001) ISBN 006445097X

Recommended by the National Science Teachers Association

- Teacher Resource: *Energy—Stop Faking It! Finally Understanding Science So You Can Teach It* by William C. Robertson (NSTA, 2002) ISBN 9780873552141

Core Knowledge Science Program—Domain Map

Science Content	
Light • Objects can be seen if light is available to illuminate them or if they give off their own light • Light travels from place to place • Transparent, translucent, and opaque objects: Some materials allow light to pass through them, others allow only some light through, and others block the light and create shadows on any surface on the other side where direct light cannot reach • Mirrors and prisms can be used to redirect a light beam **Sound** • Sound can make matter vibrate • Vibrating matter can make sound • Introduction to sound waves	
This unit contributes to meeting or exceeding the following Next Generation Science Standards:	
***Grade 1 Topic Waves: Light & Sound**, for example:* ***1-PS4-1**. Plan and conduct investigations to provide evidence that **vibrating materials can make sound and that sound can make materials vibrate**.* AND ***1-PS4-3**. Plan and conduct investigations to determine **the effect of placing objects made with different materials in the path of a beam of light**.*	This unit will support students as they develop early understandings of the core ideas PS4.B (Electromagnetic Radiation), PS4.A (Wave Properties), and PS4.C (Information Technologies). This unit "bundles" these core ideas as found in this Grade 1 Topic from the NGSS. For example, the idea that light travels from place to place, which is an early progression of PS4.B, will be developed through experiences with light sources, mirrors, and shadows cast by various objects.
This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
***Grade 4 Topic Waves**, for example:* ***4-PS4-1**. Develop a model of waves to **describe patterns in terms of amplitude and wavelength and that waves can cause objects to move**.*	PS4.A, PS4.B, and PS4.C will each be studied further in Grade 3 during Units 3 and 4, *Light* and *Sound* respectively. This early study of these core ideas in Grade 1 will prepare students with the vocabulary and background knowledge so that they can build upon and apply their understandings of waves during upper elementary activities and assessments.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen the understanding of this domain.

POTENTIAL CCSS Math Connections

MP.5 Use appropriate tools strategically. *(1-PS4-4)*

1.MD.A.1 Order three objects by length; compare the lengths of two objects indirectly by using a third object. *(1-PS4-4)*

1.MD.A.2 Express the length of an object as a whole number of length units, by layering multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps. *(1-PS4-4)*

POTENTIAL CCSS ELA Connections

W.1.2 Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure. *(1-PS4-2)*

W.1.7 Participate in shared research and writing projects (e.g., explore a number of "how-to" books on a given topic and use them to write a sequence of instructions). *(1-PS4-1, 1-PS4-2, 1-PS4-3, and 1-PS4-4)*

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. *(1-PS4-1, 1-PS4-2, and 1-PS4-3)*

SL.1.1 Participate in collaborative conversations with diverse partners about grade 1 topics and texts with peers and adults in small and larger groups. *(1-PS4-1, 1-PS4-2, and 1-PS4-3)*

POTENTIAL Cross-Curricular Connections

Potential Links:

Visual Art: Elements of Art—Color; review from Kindergarten the idea of "warm" and "cool" colors. Know that red, yellow, and blue are commonly referred to as the "primary colors," and that combinations of these colors can produce green, orange, and purple. Observe the use of color in:

- Claude Monet's *Tulips in Holland*
- James A. McNeill Whistler's *Arrangement in Black and Gray* (also known as *Whistler's Mother*)
- Diego Rivera's *Piñata*

Music: Elements of Music—Discriminate between obvious differences in pitch: high and low. Discriminate between loud and soft (volume/intensity). Become familiar with the families of instruments in an orchestra: strings, brass, woodwinds, percussion.

Prior Knowledge

Core Knowledge Preschool Sequence
Scientific Reasoning and the Physical World
Goal: Demonstrate an initial understanding of the living world

- Observe, describe and record some basic properties of light, its presence and its effects in the physical world

Core Knowledge Kindergarten Sequence
V. Seasons & Weather

- The sun: source of light and warmth

Core Knowledge Science (Previously taught units in the CK Science program)
Kindergarten Unit 4 *Seasons & Weather*

- Describe how the sun affects the temperature
- Describe how sunlight affects materials on Earth (K-PS3-1)

CKLA Grade 1 Objectives—Not Applicable

The Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history, does not include the study of light and sound at this grade level. In order to prepare students to meet or exceed the NGSS Grade 1 Topic Waves: Light & Sound, this CK Science unit is critical to advance students' understanding of the physical sciences. To learn more about how and why the Listening & Learning Strand of CKLA approaches certain science content through read-alouds and ELA instruction, read more about the CKLA program.

What Students Will Learn in Future Grades

Core Knowledge Grade 3 Sequence

II. The Human Body—Vision and Hearing

Vision: How the Eye Works

- Parts of the eye: cornea, iris and pupil, lens, retina
- Optic nerve
- Farsighted and nearsighted

Hearing: How the Ear Works

- Sound as vibration
- Outer ear, ear canal, and eardrum
- Three tiny bones (hammer, anvil, and stirrup) pass vibrations to the cochlea
- Auditory nerve

III. Light and Optics

- Through experimentation and observation, introduce children to some of the basic physical phenomena of light, with associated vocabulary
- The speed of light: light travels at an amazingly high speed
- Light travels in straight lines (as can be demonstrated by forming shadows)
- Transparent and opaque objects
- Reflection:
  Mirrors: plane, concave, convex
  Uses of mirrors in telescopes and some microscopes
- The spectrum: use a prism to demonstrate that white light is made up of a spectrum of colors
- Lenses can be used for magnifying and bending light (as in magnifying glass, microscope, camera, telescope, binoculars)

IV. Sound

- Through experimentation and observation, introduce children to some of the basic physical phenomena of sound, with associated vocabulary
- Sound is caused by an object vibrating rapidly
- Sounds travel through solids, liquids, and gases
- Sound waves are much slower than light waves
- Qualities of sound:
  Pitch: high or low, faster vibrations = higher pitch, slower vibrations = lower pitch
  Intensity: loudness and quietness
- Human voice:
  Larynx (voice box)
  Vibrating vocal cords: longer, thicker vocal cords create lower, deeper voices
- Sound and how the human ear works
- Protecting your hearing

Core Vocabulary

The following list contains the core vocabulary words suggested for purposeful integration across this Grade 1 unit. ***Boldfaced*** *terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Light	Sound
sunlight, ray, ***beam****, path, direction, straight, source, shine,* ***illuminate****, bright, emit, energy, type, travel, transmit, wave, rainbow, prism, [names of different colors], mirror, surface,* ***reflect****, refract, absorb, bounce, deflect, bend, angle, reflection, image,* ***transparent****,* ***translucent****,* ***opaque****, obscure, fuzzy, blur, clear, sharp, object, matter, media, shadow, shade, cast, dark, silhouette, eclipse*	*wave,* ***compression****, energy, matter,* ***medium****,* ***substance****, quality, characteristic,* ***description****,* ***pitch****, frequency, intensity,* ***volume****, loud, soft, high, low,* ***vibrate****, vibration, noise, [examples of objects that make noise]*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "The heat of the sun is transferred to the Earth."	Key points for instruction:
This is an overgeneralization that students of all ages often repeat and misunderstand. Thermal energy from the sun does not reach the Earth in any significant amount. Instead, it is the electromagnetic radiation emitted from the sun, sunlight, that traverses the expanse of space and provides energy to the Earth and its atmosphere. This includes wavelengths of radiation that are invisible to the eye, such as infrared, ultraviolet	"The majority of elementary students… tend to identify light with its source (e.g., light is in the bulb) or its effects (e.g., patch of light)" (AAAS Atlas of Science Literacy Vol. 1, 2001, pg. 64). These students generally have difficulty explaining reflections, for example color as the reflection of light, and/or the direction and formation of shadows.

(UV), and gamma radiation. This electromagnetic radiation interacts with our atmosphere, and with the Earth, in a complex system of energy transfer, which results in the natural warming of the Earth. For more information, consider watching this short YouTube video (~3-minutes) provided by Duane Friend of the University of Illinois Extension: How the Sun Heats the Earth.

Key Points for Instruction: (continued)

The focus of this unit is for students to engage in hands-on learning activities and assessments to interact with light and sound as they can experience it in the real world. The Next Generation Science Standards reference examples such as tuning forks, stretched strings, clear plastics, translucent wax paper, and reflective mirrors be used to engage students in evidence-based discussions about sound and light.

Potential Objectives for this Grade 1 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed. The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Describe how the presence of light affects objects (1-PS4-2)
- Describe how light travels
- Describe materials that block light and materials that allow light to pass through (1-PS4-3)

Middle

- Identify objects that reflect light (1-PS4-3)
- Compare and contrast light and sound waves **(ongoing)**

End

- Describe the relationship between vibrations and sound (1-PS4-1)
- Design a device that uses light or sound to communicate over a distance (1-PS4-4)

Potential Big Guiding Questions

Essential Questions:

- **What causes a shadow?**
- **How does light travel?**
- **What causes sound?**

RE: Light

- Why can't we see in the dark?
- Do you think light can travel through water? Why?
- Why do some objects block light, but not others?

RE: Sound

- How are sound waves different from light waves?
- Can sound make an object vibrate?
- Can a vibration make a sound?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example #1: (Beginning of Unit 7)

{Evaluates Student Mastery of Objective*: Describe materials that block light and materials that allow light to pass through***}** (1-PS4-3)

Advance Preparation: See example #2 in the next section.

Assessment Task:

Walk students through the investigation steps they established as a class. Provide each group with needed materials (e.g., flashlight, objects, and category cards).

T - At your table you have a flashlight and several objects. When I cue you to begin, I would like you to take turns following the steps of our investigation (e.g., shining your flashlight on each object, looking carefully at the amount of light coming through each object, categorizing the objects).

Dim the lights and allow students time to shine their flashlights on each object.

T - What did you notice? (Students should identify that some objects allow light to pass through and others do not)

As a whole group debrief findings. If students disagree about to which category an object belongs, model for the group, calling students' attention to the amount of light passing through. You may also want to compare the object with one from another category (e.g., compare a transparent and translucent object).

Ask students to look at the objects that block the light and share what they notice.

T - What are the characteristics of these objects? Why do you think light cannot pass through them? After students share their observations and thinking, explain that these objects are opaque. Repeat this process with the other two categories (transparent and translucent).

T - So, what happens when objects made of different materials are placed in front of a beam of light?

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction where it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 7)

{Contributes to the Objective: Describe how light travels**}**

Advance Preparation: You will need the following materials in order to conduct this activity:

- Three pieces of cardstock or large index cards. Layer the cards and punch a hole on the far left side. Remove one card from the pile and punch a hole in the middle of the remaining two. Then punch a hole (on the far right side) in only one of the two cards (see diagram).
- Three balls of playdough or putty. Use the playdough or putty to stand each of the cards up on a table. Position the cards so the holes on the far left of each card all align.
- Flashlight lights for each pair (or small group of students)

Activity: Explain that today you will learning about how light travels.

T - How many of you have ever used a flashlight before? Take a minute and think about what that light looks like (where it goes) when you or another person turns on a flashlight.

Let's make predictions about how light travels. If students have difficulty describing their ideas, provide prompts (e.g., do you think it moves in squiggly or straight lines? Do you think it remains uniform as it travels or changes shape?).

Provide each pair (or small group) of students with a flashlight. Review safety directions (e.g., never point the flashlight in someone's eyes). Position students around the perimeter of the room (between 2 and 3 feet from the wall). Dim the lights in the classroom. Instruct one member from each group or pair to turn on the flashlight and point it at the wall. Ask the remaining students (standing on the side) to look at the beam of light and describe what they see.

T - Look at the light coming from your flashlight. How far does it travel (across the room)? What does its path look like? Where does it stop?

Collect the flashlights and ask students to stand on the sides of the table where you have propped the index cards.

T - I'm going to shine this small flashlight on this first card. I want you to take a close look at how the light travels.

Turn on the flashlight. Students should see one straight beam of light stream through all three cards on the far left, they should see another beam of light travel through the middle and stop at the last card, and observe one beam of light (on the far right) shine through the first card, stopping at the second.

T- Turn to your partner and describe what the light looks like. Provide students with at least 60 seconds to talk and then ask several pairs to share their descriptions. **What are characteristics that we can clearly see here, but may not have been as clear when we shined our flashlights on the wall?** Students should indicate that the light is traveling in a straight line, and that it keeps moving until something blocks it.

Example #2: (Beginning of Unit 7)

{Contributes to the Objective: *Describe materials that block light and materials that allow light to pass through***}** (1-PS4-3)

Advance Preparation: You will need the following materials in order to conduct this activity:

- 2 transparent objects (e.g., glasses, plastic wrap, paper protector, or water) for each group of students
- 2 translucent objects (e.g., sunglasses, notebook paper, wax paper, plastic bag, stained glass, a lampshade, or vegetable oil) for each group of students
- 2 opaque objects (e.g., cardboard, book, aluminum paper, carpet/fabric, or metal spoon/knife) for each group of students
- A flashlight for each group of students
- Index cards, paper, post-it notes, and other materials that students may decide to use in order to conduct the investigation.

Activity:

T - What do you think happens to a beam of light if you place an object directly in front of it? Do you think objects made of different materials would cause different results? As you pose each question, allow students think-time to process. Ask them to explain their reasoning.

T - Today we are going to form an investigation to find out what happens when objects made of different materials are placed in front of a beam of light. Write the question on a piece of chart paper, "What happens when objects made of different materials are placed in front of a beam of light?" You may also wish to draw a symbol representing this question.

T - What would we need to conduct this investigation (to answer this question)? Ask students to share ideas with a partner and then call on several pairs to share. List students' ideas on the chart paper. Guide and prompt students to think of what could act as the "source of light" (e.g., a flashlight), brainstorming an array of objects, and determining how they categorize or organize the objects. If students brainstorm objects in the classroom of which you have multiple sets, use that item instead of one that you already prepared.

Place a set of objects along with a flashlight in front of students. Ask students to describe what they think the steps should be to answer the question. As students list their ideas, capture them on chart paper.

After the class has compiled a list of steps, ask students to assist with reordering/combining steps. Try to limit the list to five to seven steps. Rewrite the steps on a new piece of chart paper. . .

Websites & Media

YouTube video for teachers—How the Sun Heats the Earth:

https://www.youtube.com/watch?v=dg_DOM1OQoo

This short video (approximately 3 minutes) offers an illustrated explanation of how the Earth is actually heated by the Sun.

Science Netlinks Lesson offered free by the AAAS—The Warmth of the Sun:

http://sciencenetlinks.com/lessons/the-warmth-of-the-sun/

This model lesson is offered for free download by the American Academy for the Advancement of Science (AAAS) through its Science Netlinks program. This activity can provide additional support to students as they address early learning objectives within this unit (e.g., Describe how the presence of light affects objects, *1-PS4-2*). Students observe and record the relative temperature of water located in three different locations: inside the classroom, outside in the

Supplemental Trade Books

Recommended by the National Science Teachers Association

- *Light: Shadows, Mirrors, and Rainbows* by Natalie M. Roslinsky and Sheree Boyd (Picture Window Books, 2002) ISBN 9781404803329
- *Light and Color* by Lawrence F. Lowery and Muriel Wood (NSTA Kids, 2014) ISBN 9781938946516
- Teacher Resource: *Energy—Stop Faking It! Finally Understanding Science So You Can Teach It* by William C. Robertson (NSTA, 2002) ISBN 9780873552141

Core Knowledge Science Program—Domain Map

Science Content
Seasonal Cycles • The four seasons and earth's orbit around the sun (one year) • Seasons and life processes: Spring—sprouting, sap flow in plants, mating and hatching Summer—growth Fall—ripening, migration Winter—plant dormancy, animal hibernation **Life Cycles** • The life cycle: birth, growth, reproduction, death • Reproduction in plants and animals: From seed to seed with a plant From egg to egg with a chicken From frog to frog From butterfly to butterfly—metamorphosis (Also see Unit 2 *Insects*) **The Water Cycle** • Most of the earth's surface is covered by water • The water cycle: Evaporation and condensation Water vapor in the air, humidity Clouds: cirrus, cumulus, stratus Precipitation, groundwater

This unit contributes to meeting or exceeding the following Next Generation Science Standards:
Standards noted with an asterisk (*) are those that incorporate engineering and design

2-LS2-1**. Plan and conduct an investigation to determine if **plants need sunlight and water to grow.	***Rationale:*** This unit will ask students to apply what they know about the basic needs of plants (LS2.A, which was first investigated in Kindergarten Unit 3 *Plants & Farms*) as they also explore the early core ideas of LS1.B (Growth & Development of Organisms) and LS2.B (Cycles of Matter). These ideas will be extended in Grade 3 Unit 6 *Ecology* to further investigate these DCIs while also addressing the standard *3-LS1-1* (see page 2).
2-ESS2-3**. **Obtain information to identify where water is found on Earth and that it	***Rationale:*** This unit will extend learning about water, specifically the core ideas ESS2.C (Roles of Water on Earth's

can be solid or liquid. ***2-PS1-4****. Construct an argument with evidence that* ***some changes caused by heating or cooling can be reversed and some cannot.***	Processes) and PS1.A (Structure & Properties of Matter), which started during Grade 1 Unit 5 *Matter & Its Properties.* Early investigations of the water cycle will allow students to address these standards and to connect the concepts of Patterns and Cause & Effect.
2-ESS2-1*. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.** ***2-ESS2-2****. Develop a model to represent the shapes and kinds of land and bodies of water in an area.*	While exploring precipitation and groundwater during this unit—extending their learning from Kindergarten Unit 4 *Seasons & Weather*—students will develop models and maps of land and water (ESS2.B Large-Scale Interactions) as they investigate ways to reduce the unwanted effects of rainfall (ESS2.A Earth's Materials & Systems).
This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
3-LS1-1*. Develop models to describe that* ***organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.***	***Rationale:*** As noted on page 1, this unit will explicitly address the core idea LS1.B (Growth & Development of Organisms). Specifically, students will investigate patterns across the life cycles of various organisms (e.g., chickens, frogs, butterflies) as well as compare and contrast representations of these cycles. The models developed by second grade students will also be used to support future learning during Grade 3 Unit 1 *Introduction to Classification* and Unit 6 *Ecology* as students tie together the ideas of growth, inheritance, and the interdependence of organisms, as modeled by the NGSS Grade 3 Topics of Life Cycles & Traits and Environmental Impacts on Organisms.
3-ESS2-1*. Represent data in tables and graphical displays to* ***describe typical weather conditions expected during a particular season.***	This unit offers the opportunity to foreshadow early learning of ESS2.D (Weather & Climate) as students investigate characteristics of each season and extend their learning from Kindergarten Unit 4 *Seasons & Weather.* This can also extend ESS1.B (Earth & The Solar System), which can reinforce previous learning from Grade 1 Unit 2 *Astronomy: Introduction to Our Solar System*.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. *(2-LS2-1, 2-ESS2-1, and 2-ESS2-2)*

MP.4 Model with mathematics. *(2-LS2-1, 2-ESS2-1, and 2-ESS2-2)*

MP.5 Use appropriate tools strategically. *(2-LS2-1 and 2-ESS2-1)*

2.MD.B.5 Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units, e.g., by using drawings (such as drawings of rulers) and equations with a symbol for the unknown number to represent the problem. *(2-ESS2-1)*

2.NBT.A.3 Read and write numbers to 1000 using base-ten numerals, number names, and expanded form. *(2-ESS2-2)*

POTENTIAL CCSS ELA Connections

RI.2.1 Ask and answer such questions as *who, what, where, when, why,* and *how* to demonstrate understanding of key details in a text. *(2-PS1-4)*

RI.2.3 Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. (*2-PS1-4 and 2-ESS2-1)*

RI.2.8 Describe how reasons support specific points the author makes in a text. *(2-PS1-4)*

RI.2.9 Compare and contrast the most important points presented by two texts on the same topic. *(2-ESS2-1)*

W.2.1 Write opinion pieces in which they introduce the topic or book they are writing about, state an opinion, supply reasons that support the opinion, use linking words (e.g., *because, and, also*) to connect opinion and reasons, and provide a concluding statement or section. *(2-PS1-4)*

W.2.6 With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. *(2-ESS2-3)*

W.2.7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). *(2-LS2-1)*

W.2.8 Recall information from experiences or gather information from provided sources to answer a question. *(2-LS2-1 and 2-ESS2-3)*

SL.2.5 Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. *(2-ESS2-2)*

POTENTIAL Cross-Curricular Connections

Potential Links:

ELA: Poetry—"Something Told the Wild Geese" by Rachel Field and "Caterpillars" by Aileen Fisher

Music: Composers & Their Music—Antonio Vivaldi's *The Four Seasons*
Mathematics: Measuring Time—Calendars

Prior Knowledge

Core Knowledge Language Arts (CKLA)
Kindergarten Listening & Learning Strand

Plants

- Explain that seeds are the beginnings of new plants
- Explain that some plants produce fruit to hold seeds
- Compare and contrast fruits and seeds of different plants
- Explain the basic life cycle of plants
- Describe how bees collect nectar and pollen
- Describe the important role bees play in plant pollination
- Compare and contrast deciduous and evergreen plants
- Sequence the seasonal rhythm of planting, growing, and harvesting

Seasons & Weather

- Name the four seasons in cyclical order, as experienced in the United States, and correctly name a few characteristics of each season
- Characterize winter as generally the coldest season, summer as generally the warmest season, and spring and autumn as transitional seasons
- Describe any unique seasonal differences that are characteristic of their own locality (change of color and dropping of leaves in autumn; snow or ice in winter; increased rain and/or flooding in spring; etc.)
- Identify ways in which weather affects daily routines, such as dress, activities, etc.
- Describe daily weather conditions of their own locality in terms of temperature (hot, warm, cool, cold); cloud cover (sunny, cloudy); and precipitation (rain, snow, or sleet)
- Identify the four seasons, and name activities that are associated with those seasons
- Explain why weather prediction is important in their daily lives

Taking Care of the Earth

- Compare and contrast fresh water, salt water, and wastewater
- Explain that many living things, including humans, need freshwater to survive, and that there is a limited supply of freshwater on Earth
- Explain why people have a special responsibility to take care of the earth

Grade 1 Listening & Learning Strand

Astronomy

- Explain that our solar system includes the sun and the planets that orbit the sun

Animals & Habitats

- Explain why living things live in habitats to which they are specifically suited
- Classify water habitats as either freshwater or saltwater habitats
- Identify the characteristics of the freshwater habitat
- Explain that salt water covers most of Earth and is found in several oceans

Core Knowledge Science (Previously taught CK Science units)
Kindergarten

Unit 3 *Plants & Farms*

- Identify the basic parts of a plant
- Describe how plants get and store energy
- Describe how plants grow
- Sequence the life cycle of a plant
- Identify characteristics of deciduous and evergreen plants
- Classify plants as deciduous or evergreen
- Identify what plants need in order to live and grow
- Compare and contrast plants' basic needs (to survive) to the needs of animals and human beings
- Infer how plants may change their habitat in order to meet their needs

Unit 4 *Seasons & Weather*

- Describe weather patterns and temperature at different times of the year
- Identify the four seasons
- Describe weather patterns associated with fall and winter
- Describe weather patterns associated with spring and summer
- Identify a tool that can be used to measure temperature
- Use thermometers to measure water and air temperature
- Predict when objects will have hotter and cooler temperatures
- Describe how the sun affects the temperature
- Describe how sunlight affects materials on Earth (K-PS3-1)
- Describe characteristics of clouds
- Describe what clouds tell us about the weather
- Describe how weather conditions change over time (e.g., over the course of several days/weeks) (K-ESS2-1)

Unit 5 *Taking Care of the Earth*

- Explain what a "natural resource" is and give at least three examples
- Describe how humans use the earth's natural resources (K-ESS3-1)
- Describe how humans have changed the environment around them in order to meet their needs (K-ESS3-2)
- Describe why humans have a special responsibility to take care of the earth
- Identify how we can conserve energy and resources
- Develop solutions that can protect the earth's natural resources (K-ESS3-3)

Grade 1 (previously taught CKSci units, continued)

Unit 2 *Astronomy—Introduction to Our Solar System*

- Describe how the sun affects living things on the Earth
- Describe characteristics of the Earth
- Using a model, demonstrate how the Earth spins
- Explain what causes day and night
- Examine patterns in order to identify the season (i.e., winter, spring, summer, or fall) with the longest/shortest amount of daylight (1-ESS1-2)
- Describe the Earth's orbit

Unit 4 *Living Things & Their Environments*

- Explain why different living things are found in different environments
- Identify oak trees, squirrels, and deer and describe their habitats
- Identify toucans, jaguars, anacondas and describe their habitats
- Compare and contrast the habitats of jaguars and deer
- Identify lions, antelopes, and zebra and describe their habitats
- Identify armadillos, cacti, and lizards and describe their habitats
- Compare and contrast the habitats of lizards and zebra
- Identify worms, moles, and fungi and describe their habitats
- Identify dolphins, octopi, and starfish and describe their habitats
- Identify freshwater fish (e.g., bass) and describe their habitats
- Compare and contrast the habitats of starfish and freshwater fish
- Match plants and animals to their habitats
- Explain how various animals are adapted to their habitats
- Compare and contrast herbivores, carnivores, and omnivores
- Create food chains and food webs for specific habitats
- Describe the surface of the earth
- Describe the diversity of ocean life
- Explain how ocean water is different from fresh water
- Identify and locate the Pacific, Atlantic, Indian, Arctic, and Southern Oceans on a map
- Identify the coast, shore, waves, and tides (high and low) of an ocean
- Define the term current and provide an example
- Describe the landscape of the ocean floor
- Describe how the environment can change
- Explain how changing environments can sometimes pose dangers to specific habitats
- Describe what it means for an animal species to become extinct
- Identify Rachel Carson and describe her efforts to protect the environment

CKLA Grade 2 Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

Domain Anthology, *Cycles in Nature*

- Explain that a cycle is a sequence of events that repeats itself again and again

- Recognize that the rotation of Earth causes daytime and nighttime
- Explain that it takes twenty-four hours for the earth to rotate once on its axis
- Recognize that living things have a life cycle
- Demonstrate familiarity with the poem "Bed in Summer"
- Recognize that Earth orbits the sun
- Explain that it takes one year for Earth to orbit the sun
- Describe the seasonal cycle: spring, summer, autumn, winter
- Identify that the tilt of Earth's axis in relation to the sun causes the seasons
- Explain effects of seasonal changes on plants and animals
- Demonstrate familiarity with the poem "Bee! I'm expecting you!"
- Describe animal processes in spring, summer, autumn, winter
- Define the term *life cycle*
- Identify the stages of the life cycle of a flowering plant (seed to seed)
- Identify the stages of the life cycle of a tree (seed to seed)
- Identify the stages of the life cycle of a chicken (egg to egg)
- Identify the stages of the life cycle of a frog (egg to egg)
- Explain metamorphosis
- Identify the stages of the life cycle of a butterfly (egg to egg)
- Define the term *water cycle*
- Explain that there is a limited amount of water on Earth
- Describe evaporation and condensation
- Identify forms and importance of precipitation
- Describe the formation of clouds
- Identify three types of clouds: cirrus, cumulus, and stratus

What Students Will Learn in Future Grades

Future CK Science Units

Grade 3 Unit 1 *Introduction to the Classification of Animals*
Grade 3 Unit 5 *Astronomy*
Grade 3 Unit 6 *Ecology*
Grade 4 Unit 5 *Meteorology*
Grade 5 Unit 2 *Plants & Classification*
Grade 5 Unit 3 *Life Cycles & Reproduction*

Core Knowledge Sequence

I. Introduction to Classification of Animals (Grade 3)

- Scientists classify animals according to the characteristics they share, for example:
  Cold-blooded or warm-blooded
  Vertebrates (have backbones and internal skeletons) or invertebrates (do not have backbones or internal skeletons)
- Different classes of vertebrates:
  Fish: aquatic animals, breathe through gills, cold-blooded, most have scales, most develop from eggs that the female lays outside her body
  Amphibians: live part of their lives in water and part on land, have gills when young, later

develop lungs, cold-blooded, usually have moist skin

Reptiles: hatch from eggs, cold-blooded, have dry, thick, scaly skin

Birds: warm-blooded, most can fly, have feathers and wings, most build nests, hatch from eggs, most baby birds must be fed by parents and cared for until they can survive on their own (though some, like baby chickens and quail, can search for food a few hours after hatching)

Mammals: warm-blooded, have hair on their bodies, parents care for the young, females produce milk for their babies, breathe through lungs, most are terrestrial (live on land) though some are aquatic

V. Ecology (Grade 3)

- Habitats, interdependence of organisms and their environment
- The concept of a "balance of nature" (constantly changing, not a static condition)
- The food chain or food web: producers, consumers, decomposers (Although the tendency is to recognize the limits of these models as well. See also Grade 1.)
- Ecosystems: how they can be affected by changes in environment (for example, rainfall, food supply, etc.), and by man-made changes
- Man-made threats to the environment:
  Air pollution: emissions, smog
  Water pollution: industrial waste, run-off from farming
- Measures we can take to protect the environment (for example, conservation, recycling)

VI. Astronomy (Grade 3)

- Our solar system:
  Sun: source of energy (heat and light)
  The eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
- Planetary motion:
  How day and night on earth are caused by the earth's rotation
  Sunrise in the east and sunset in the west
  How the seasons are caused by the tilt of earth's axis as it orbits around the sun

V. Meteorology (Grade 4)

- The water cycle and clouds:
  review from Grade 2 (*Cycles in Nature*)
  evaporation, condensation, and precipitation
  cirrus, stratus, cumulus
- The atmosphere:
  troposphere, stratosphere, mesosphere, thermosphere, exosphere
  how the sun and the earth heat the atmosphere
- Air movement:
  wind direction and speed, prevailing winds
  air pressure, low and high pressure, air masses
- Cold and warm fronts:

thunderheads, lightning and electric charge, thunder
tornadoes and hurricanes

- Forecasting the weather:
  barometers (relation between changes in atmospheric pressure and weather)
  weather maps and weather satellites
- Weather and climate:
  "weather" refers to daily changes in temperature, rainfall, sunshine, etc.
  "climate" refers to weather trends that are longer than the cycle of the seasons

I. Classifying Living Things (Grade 5)

- Scientists have divided living things into five large groups called kingdoms, as follows:
  Plant, Animal, Fungus (mushrooms, yeast, mold, mildew), Protist (algae, protozoans, amoeba, euglena), Moneran, also called Prokaryote (bacteria, blue-green algae/cyanobacteria)

- Each kingdom is divided into smaller groupings as follows:
  Kingdom, Phylum, Class, Order, Family, Genus, Species, (Variety)

- When classifying living things, scientists use special names made up of Latin words (or words made to sound like Latin words), which help scientists around the world understand each other and ensure that they are using the same names for the same living things.

  Homo sapiens: the scientific name for the species to which human beings belong (genus Homo, species sapiens)

  Taxonomists: biologists who specialize in classification

- Different classes of vertebrates and major characteristics: fish, amphibians, reptiles, birds, mammals (review from grade 3)

- Introduce an example of how an animal is classified, in order for students to become familiar with the system of classification, not to memorize specific names.

III. Plant Structures & Processes (Grade 5)

A. Structure: Non-vascular and Vascular Plants

- Non-vascular plants (for example, algae)
- Vascular plants
- Vascular plants have tubelike structures that allow water and dissolved nutrients to move through the plant
- Parts and functions of vascular plants: roots, stems and buds, leaves

B. Photosynthesis

- Photosynthesis is an important life process that occurs in plant cells, but not animal cells (photo = light; synthesis = putting together)
- Unlike animals, plants make their own food, through the process of photosynthesis
- Role in photosynthesis of: energy from sunlight, chlorophyll, carbon dioxide and water, xylem and phloem, stomata, oxygen, sugar (glucose)

C. Reproduction

- Asexual reproduction

Example: algae
Vegetative reproduction: runners (for example, strawberries) and bulbs (for example, onions), growing plants from eyes, buds, leaves, roots, and stems

- Sexual reproduction by spore-bearing plants (for example, mosses and ferns)
- Sexual reproduction of non-flowering seed plants: conifers (for example, pines), male and female cones, wind pollination
- Sexual reproduction of flowering plants (for example, peas)
- Functions of sepals and petals, stamen (male), anther, pistil (female), ovary (or ovule)
- Process of seed and fruit production: pollen, wind, insect and bird pollination, fertilization, growth of ovary, mature fruit
- Seed germination and plant growth: seed coat, embryo and endosperm, germination (sprouting of new plant), monocots (for example, corn) and dicots (for example, beans)

IV. Life Cycles & Reproduction (Grade 5)

A. The Life Cycle and Reproduction

- Life cycle: development of an organism from birth to growth, reproduction, death
- Example: Growth stages of a human: embryo, fetus, newborn, infancy, childhood, adolescence, adulthood, old age
- All living things reproduce themselves. Reproduction may be asexual or sexual.
- Examples of asexual reproduction: fission (splitting) of bacteria, spores from mildews, molds, and mushrooms, budding of yeast cells, regeneration and cloning
- Sexual reproduction requires the joining of special male and female cells, called gametes, to form a fertilized egg

B. Sexual Reproduction in Animals

- Reproductive organs: testes (sperm) and ovaries (eggs)
- External fertilization: spawning
- Internal fertilization: birds, mammals
- Development of the embryo: egg, zygote, embryo, growth in uterus, fetus, newborn

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Grade 2 unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Seasonal Cycles	Life Cycles
***cycle**, change, pattern, spring, summer, fall, winter, **axis**, rotate, orbit, revolve, annual, **tilt**, angle, equator, **hemisphere**, (in)direct, sunlight, heat, energy, seasonal, annual,*	*(non)living, **organism**, biosphere, adapted, birth, growth, reproduction, death, **develop**, ripen, migrate, hibernate, dormant, metamorphosis, photosynthesis, oxygen, carbon dioxide, sprout,*

average, *predict, ...* **The Water Cycle** *precipitation, condensation,* ***evaporation****, deposition,* ***atmosphere****, air, humidity,* ***vapor****, Earth, surface, percent, covered, gas, solid, liquid, ice, puddle, groundwater, aquifer, vernal pool, river, lake, pond, stream, ocean, cloud, cirrus, cumulus, stratus, ...*	*adult, offspring, baby, child, infant, juvenile, (im)mature, basic needs, animal, insect, amphibian, plant, seed, nut, fruit, sap, sprout, sapling, egg, hatch, chick, chicken, tadpole, tail, legs, frog, toad, caterpillar, butterfly, cocoon, chrysalis, ...*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "The seasons are caused by the earth's changing distance from the sun."
Students of all ages (including college and adult learners) have difficulty understanding and explaining the causes of the seasons. The root misconception behind this has been identified as a belief that the earth orbits the sun in an elongated elliptical path (Galili & Lavrik, 1998; Sadler, 1998). Other students, citing the tilt of the Earth on its axis, believe that the changing distance between a hemisphere and the sun is the cause of seasons (e.g., "summer occurs because our hemisphere is closer to the sun"). Teachers should be sure to understand that the distance to the sun changes relatively little, and that these minor changes cannot explain seasonal variations.

Misconception: "The seasons cause the weather to change."
Certain weather patterns and temperatures are associated with a particular season. A season is a classification of a period of time, not a force that causes weather.

Misconception: "When water evaporates it ceases to exist."

Misconception: "Cocoons and chrysali are the same thing." or "All butterflies emerge from cocoons."
A *cocoon* is an external structure of silk, and sometimes other items such as hair and leaves, constructed by larvae (e.g., moth and ant larvae) to protect the animal during the pupal stage. A *chrysalis* is actually the hardened skin of a butterfly pupa/caterpillar that is shed and used to protect the developing animal. *Most* butterflies ***do not*** create cocoons, but instead use a small disk of silk to attach their chrysali "skin" to the underside of a leaf or branch. Eric Carle's beloved story *The Very*

	Hungry Caterpillar depicts a butterfly that emerges from a cocoon, which is not typical of butterflies except in a specific alpine family called Parnassian, or Apollo, Butterflies. **Key points for instruction:**

Potential Objectives for this Grade 2 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed.The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Define the term *cycle*
- Identify four components of the life cycle
- Identify the stages in the life cycle of a plant
- Identify the stages in the life cycle of a chicken
- Identify the stages in the life cycle of a frog
- Identify the stages in the life cycle of a butterfly

Middle

- Describe earth's surface
- Describe the water cycle
- Explain how water changes in different temperatures and pressures
- Explain how water behaves in the air
- Identify cirrus, cumulus, and stratus cloud types
- Describe how water forms and moves on earth

End

- Identify the four seasons
- Describe weather patterns common to each of the four seasons.
- Describe how living things behave during the summer, fall, winter, and spring.
- Identify patterns in animal and plant behavior for each season.
- Describe earth's orbit
- Identify and demonstrate the cause of the seasons
- Describe effects of seasonal changes on plants and animals

Potential Big Guiding Questions

Essential Questions:

- **What is a cycle?**
- **How do the seasons affect living things?**

- **How does the water cycle affect life on Earth?**

RE: Life Cycles

- Do all living things reproduce?
- How does a small seed become a full plant?
- How does an animal grow and change throughout its life cycle?
- What is metamorphosis?
- How is the life cycle of a plant similar to that of an animal? How is it different?

RE: The Water Cycle

- Where can water be found on and around earth?
- What causes water to take different forms (liquid, water vapor)?
- How does water form and move around earth?
- What are clouds made of?
- What do different kinds of clouds indicate?

RE: Seasonal Cycles

- How are the summer and winter different?
- How are the spring and autumn (fall) similar?
- What types of plants and parts of plants can you see in the summer, but not in the winter?
- What types of animal behaviors would you expect to observe during the fall, but not in the spring?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example #1: (Beginning of Unit 1)

{**Evaluates Student Mastery of Objectives:** Identify the stages in the life cycle of a plant}

Advance Preparation:

Botanist's Logbook (optional, see preparation instructions in activity below)

Image card sets for the stages of the life cycle of a plant (seed, germination, seedling, plant, reproduction/pollination/dispersal)

Paper, glue, markers (optional)

Note: This assessment may work best in small groups to allow for more individualized attention. It should be used following the completion of the plant life cycle activity found below. This assessment may also be used (with different, relevant, image cards) for other life cycles, such as a chicken, frog, or butterfly.

Give each student a set of plant cycle image cards. Ask students to arrange the cards to show the life

cycle of a plant. Check in with students. Point to one of the stages of the cycle and ask questions around the cycle as follows. **T - Describe what you see in this image.** (The idea here is to get students to use what they see in the image to answer the next questions.) **T - What stage is shown in this image?** Student should be able to identify the stage of the plant cycle. If not, scaffold by asking students to describe what they see happening in the image. **T - Describe what you see in the image that helps you know what stage this is.** After students have identified, and explained what is happening in that stage, move to the next one in the cycle. Help students relate what they saw in the previous image with this next one (e.g., **T - What looks different about the plant as a seedling than as a seed?**). Continue this throughout the full cycle. Then ask students to explain what shape their diagram of the life cycle has taken and why. It doesn't have to be a circle, the important thing is that students see that it is a continuous cycle, not a linear path. If they have not arranged their plant cycle in such a way, scaffold to help them see identify reproduction/pollination/dispersal as a precursor to a new seed's life.

Example #2: (End of Unit 1)

{**Evaluates Student Mastery of Objectives:** Describe how living things behave during the summer, fall, winter, and spring.}

Note: This activity will likely span at least two lessons.

Advance Preparation:

4 large sheets for creating murals on

Drawing supplies

Reference books for each season (spring, summer, fall, winter)

Divide the class into small groups. Each group will focus on one of the four seasons, and create a mural that illustrates how plants and animals behave during this season. Students can reference books (about their assigned season) as they work.
As students work, teacher checks in with students in each group. **T - Describe to me what you are showing in your illustration**. Encourage students to describe the plants, animals, weather patterns, activities. **T - Why are the plants and animals doing these things/in these states?** Encourage students to explain that the seasons affect the plants' and animals' activities.

The next day/lesson, post the murals in a circular fashion. **T - What do you notice about the way I've shown the four seasons here?** Allows students to describe the similarities and differences of the seasons, but guide them to understand the seasons represent a cycle. Then, call student attention to animal and plant behavior in each season. Ask them to identify patterns. (e.g., **T - What do you notice happening with the plants in spring?** They are sprouting, sap is flowing, etc. **T - What do you notice about animal behavior in the spring?** Babies are being born (mating and hatching).)

Note: As a year-long extension activity, allow students one day each season to journal what they can observe of plant and animal life near the school. This could be done by taking students outside, or by observing from a classroom/school window. Provide students a notebook with four pages, one for each

season. Ask them to draw what they observe of plant and/or animal life. Then help them to record the name of the season at the top of the drawing. The next season, ask students to describe what they drew previously and take note of the same plants or animals they drew last season (as possible). When students have recorded something for all four seasons, ask them to describe what they observed of plant and animal behavior over the course of the four seasons. Encourage them to describe how the seasons affected plant and animal behavior.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction where it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 4)

{**Evaluates Student Mastery of Objectives:** Identify the stages in the life cycle of a plant}

Advance Preparation:

Fast-germinating seeds (beans, melon, or squash are good options for second graders)

Dirt

Water

Pot or other container

A sunny window to place the potted seed

Gloves and/or hand wipes for keeping hands clean

Botanist's Logbook (prepare a small booklet with several pages for students to record their plant as it grows)

Note: This activity will take several days, or at least some time over the course of several lessons as the seeds grow and mature. If your school has garden, take advantage and do this activity outside. Just allow students occasional checkins to make their observations. As a challenge extension, you may wish them to explore and experiment with two elements commonly needed for plant growth: sun and water.

For this activity, students will have an opportunity to explore the stages of the life cycle of a plant directly, and record their observations in a logbook. **T - For the next several days, you will get to be work with plants. Do you know of any jobs or hobbies that involve growing plants?** (e.g., farmers, gardeners) **The job that you will get to do, is the job of a botanist. And what makes this job special is that you will be observing plants you grow as a scientist, making observations and learning from what you observe.** After making it clear students will be growing plants and keeping a logbook of their observations, pass out the Botanist's Logbooks, one for each student. Review the logbooks and then give each student a seed. Encourage students to touch, smell, and look at the seed. **T - Describe your seeds to me.** After students have described the color, texture, patterns,

and shape of the seeds, ask them to record these observations in the first page of their logbooks. T - **What do plants need to grow?** (water, sunlight, soil) Lead students in planting their seeds, watering them, and placing them in a sunlit location. Ask students why they are doing each of these things as they are doing them.

In the days following, check on seeds and ask students to make observations as seedlings form, grow into plants, and if possible, the plants grow fruit or seedpods (reproduce), and then perish.

Example #2: (Middle of Unit 4)

{**Evaluates Student Mastery of Objectives:** Describe the water cycle; Explain how water changes in different temperatures and pressures; Explain how water behaves in the air; Describe how water forms and moves on earth}

Advance Preparation:

Experiment notebooks or worksheets

Several large, clear bowls

Plastic wrap

Permanent marker

Rubber band

Water Cycle poster

Additional object (optional)

Note: This activity should be set up in a sunny place. It may take several lessons, or at least would will best on a day when students can check back in on their experiments a few times throughout the day.

Tell students they will do an experiment today to examine how the elements of condensation and precipitation are part of the water cycle on earth, and how temperature affects these.

Using their experiment worksheets or notebooks, have students record a prediction of what they think will happen when they put a bowl of water in the hot sun. Then, place one of the bowls in a sunny place in your classroom and fill it with water. Mark on the side of the bowl a line indicating the water level. Every few hours, check on the bowl to see where the water level is compared to the line you marked. **T - What has happened to the water level?** (It has gone below where it once was.) **T - What might explain what has happened to the water?** If students are able to identify that evaporation or the formation of water vapor has taken place, ask them to describe the process and why this means they cannot see the water any more. If students are not able to answer the question, tell them you will do another experiment next to better see what happens to the water from the bowl. Using their experiment worksheets or notebooks, have students record what happened when the put the bowl of water in the hot sun.

Next, have students record a prediction of what they think will happen when they put a bowl of water in the hot sun and cover it with a piece of plastic wrap. Then, place a bowl in a sunny place in the classroom and fill it with water. Place plastic wrap over top and secure it using the rubber band. Every few hours, check on the bowl to see where the water level is and if water droplets have formed on the plastic. **T - What has happened to the water here?** (Some of the water has formed into water droplets

on the plastic wrap.) **T - How did the water get there?** (It formed water vapor and moved up, until it pooled into water droplets on the plastic wrap.) Using their experiment worksheets or notebooks, have students record what happened to the water.

Then, have students record a prediction of what will happen when the bowl continues to sit in the hot sun. Continue to let the bowl sit until water droplets can be seen dropping down into the water below. **T - What is happening to the water now?** (The water is dropping down, back into the bowl.) **T - Does this remind you of any weather pattern you have seen before?** Help students draw parallels to rain, and identify it by the name *precipitation*. **T - Why did the water fall?** (It became too heavy to stay up on the plastic wrap, since it was just "hanging" there.) Using their experiment worksheets or notebooks, have students record what happened to the water.

Refer to the Water Cycle poster in your classroom. **T - What parts of the water cycle did you see during the experiments today?** Help students identify the formation of water vapor, condensation, and precipitation during the experiment. In their experiment notebooks or worksheets, have students record the name of each next to the experiment in which it was demonstrated.

If time allows, encourage students to explore ways of modifying their experiment to make it better resemble the earth and atmosphere. For example, students could place another object inside the bowl that is not filled with water to represent land.

Websites & Media

Annenberg Learner's Journey North: A Global Study of Wildlife Migration and Seasonal Change

http://www.learner.org/jnorth/

Caterpillar to Butterfly

https://www.youtube.com/watch?v=5Tvl6wz7e9M

Creature Feature: American Bullfrog

http://kids.nationalgeographic.com/animals/american-bullfrog/#american-bullfrog-swimming.jpg

Interactive Earth Rotation

http://www.bbc.co.uk/schools/scienceclips/ages/9_10/earth_sun_moon.shtml

***March of the Penguins* DVD, with Morgan Freeman (Warner Bros., 2005) ASIN: B000NJUYHM**

Monarch Watch

http://www.monarchwatch.org/

Water Cycle Song

https://www.youtube.com/watch?v=TWb4KIM2vts

Supplemental Trade Books

Seasonal Cycles

Earth Cycles, by Michael Elsohn Ross (Millbrook Press, 2001) ISBN 978-0761319771

Four Seasons Make a Year, by Anne Rockwell (Walker & Company, 2004) ISBN 978-0802788832

How Do Birds Find Their Way?, by Roma Gans (Harper Collins, 1996) ISBN 978-0064451505

The Reasons for Seasons, by Gail Gibbons (Holiday House, 1995) ISBN 978-0823412389

Red Leaf, Yellow Leaf, by Lois Ehlert (Harcourt, Inc., 1991) ISBN 978-0152661977

What Makes Day and Night, by Franklyn Branley (Harper Collins, 1986) ISBN 978-0064450508

Plant and Animal Life Cycles

Butterfly (How Does it Grow?), by Jinny Johnson (Smart Apple Media, 2010) ISBN 978-1599203522

Frogs (How Does it Grow?), by Jinny Johnson (Smart Apple Media, 2010) ISBN 978-1599203553

From Caterpillar to Butterfly (Let's-Read-and-Find-Out- Science), by Deborah Heiligman (Harper Collins Publishers, 1996) ISBN 978-0064451291

From Seed to Plant, by Gail Gibbons (Holiday House, 1991) ISBN 978-0823410255

From Seed to Sunflower, by Dr. Gerald Legg (Franklin Watts, 1998) ISBN 978-0531153345

How a Seed Grows, by Helene J. Jordan (Harper Collins, 2000) ISBN 978-0064451079

The Life Cycle of an Oak Tree, by Linda Tagliaferro (Capstone Press, 2007) ISBN 978-0736867115

A Log's Life, by Wendy Pfeffer (Aladdin Paperbacks, 1997) ISBN 978-141693483

Monarch Butterfly, by Gail Gibbons (Holiday House, 1995) ISBN 978-0823409099

A Nest Full of Eggs, by Priscilla Belz Jenkins (Harper Collins, 1995) ISBN 978-0064451277

One Bean, by Anne Rockwell (Walker Publishing Company, 1998) ISBN 978-0802775726

The Reason for a Flower, by Ruth Heller (Penguin Putnam Books for Young Readers, 1999) ISBN 978-0698115590

Water Cycle

Down Comes the Rain (Let's-Read-and-Find-Out-Science), by Franklyn M. Branley (Harper Collins Publishers, 1997) ISBN 978-0064451666

The Snowflake: A Water Cycle Story, by Neil Waldman (Milbrook Press, 2003) ISBN 978-0761323471

Water (Nature's Cycles) [Spanish & English], by Dana Meachen Rau (Marshall Cavendish Corporation, 2010) ISBN 978-0761447924

The Water Cycle, by Helen Frost (Pebble Books, 2000) ISBN 978-0736804097

The Water Cycle, by Rebecca Olien (Capstone Press, 2005) ISBN 978-0736851824

Water, Water Everywhere, Mark J. Rauzon and Cynthia Overbeck Bix (Sierra Club Books for Children, 1994) ISBN 978-0871563835

Core Knowledge Science Program—Domain Map

Science Content
• Insects can be helpful and harmful to people: Helpful—pollination; products like honey, beeswax, and silk; eat harmful insects Harmful—destroy crops, trees, wooden buildings, clothes; carry disease; bite or sting • Distinguishing characteristics of insects: Exoskeleton, chitin Six legs and three body parts—head, thorax, and abdomen Most but not all insects have wings • Life cycles—metamorphosis: Some insects look like miniature adults when born from eggs, and they molt to grow (examples: grasshopper, cricket) Some insects go through distinct stages of egg, larva, pupa, adult (examples: butterflies, ants) • Social insects: Most insects live solitary lives, but some are social (such as ants, honeybees, termites, wasps) Ants—colonies Honeybees—workers, drones, queen

This unit contributes to meeting or exceeding the following Next Generation Science Standards:
Standards noted with an asterisk (*) are those that incorporate engineering and design

2-LS2-2**. Develop a simple model that mimics **the function of an animal in dispersing seeds or pollinating plants.*	***Rationale:*** This unit will extend student learning about plant life cycles (Unit 1 *Cycles in Nature*) to address LS2.A (Interdependent Relationships in Ecosystems) and to prepare students to meet or exceed *2-LS2-2*. Students will have the opportunity to create simple model representations of how insects (e.g., honeybees) support particular plant life cycles through pollination and/or seed distribution.

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:

3-LS1-1**. Develop models to describe that **organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. ***4-LS1-1**. Construct an argument that **plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.***	This unit builds additional examples that support the core ideas LS1.A (Structure & Function) and LS1.B (Growth & Development of Organisms) which can bridge learning from Grade 1 (e.g., NGSS 1-LS1-1 and 1-LS1-2) and provide starting points for extension and application in Grades 3 and 4. For example, learning and experience from this unit, as well as Unit 1 *Cycles in Nature*, will provide a foundation for students in Grade 3 Unit 1 *Introduction to Classification* during which they will apply their understanding of life cycles and extend their learning progressions of Patterns, Structure & Function, and Growth & Development, explicitly addressing standard *3-LS1-1* in the process.
***4-ESS3-1**. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.*	Although this standard focuses on "energy and fuels" it is important to recognize that the core idea central to this expectation is ESS3.A (Natural Resources), which includes the understanding that humans also rely on the biosphere (i.e., other organisms) to meet our needs. This unit offers an explicit opportunity for students to investigate this core idea while learning about how insects are helpful to people and, in doing so, to foreshadow the NRC's *Framework* endpoints for ESS3.A at future grade levels.
5-ESS3-1**. Obtain and combine information about ways individual **communities use science ideas to protect the Earth's resources and environment.	Similar to ESS3.A above, this unit offers teachers the opportunity to connect student learning about insects to ESS3.C (Human Impacts on Earth Systems), which was introduced in earlier units such as Grade 1 Unit 4 *Living Things & Their Environments* while students learn about Rachel Carson. This core idea will be further explored during Grade 2 Unit 6 *Ecosystems* as well as during Grade 3 Unit 6 *Ecology* and Grade 4 Unit 4 *Geology* as students explore causes of erosion. These multiple exposures to ESS3.C will offer an excellent foundation for students to later apply this core idea and meet this standard during Grade 5 Units 3 and 4, *Plants* and *Life Cycles & Reproduction*.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

MP.4 Model with mathematics. *(2-LS2-2 and 3-LS1-1)*

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. *(2-LS2-2)*

2.NBT Number and Operations in Base Ten *(3-LS1-1)*

POTENTIAL CCSS ELA Connections

RI.2.7 Explain how specific images (e.g., a diagram showing how a machine works) contribute to and clarify a text. *(3-LS1-1)*

SL.2.5 Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings. *(2-LS2-2 and 3-LS1-1)*

W.2.1 Write opinion pieces in which they introduce the topic or book they are writing about, state an opinion, supply reasons that support the opinion, use linking words (e.g., because, and, also) to connect opinion and reasons, and provide a concluding statement or section. *(4-LS1-1)*

POTENTIAL Cross-Curricular Connections

Potential Links:

ELA: Poetry—"Caterpillars" by Aileen Fisher

Prior Knowledge

Core Knowledge Sequence

Core Knowledge Language Arts (CKLA)

Core Knowledge Science (Previously taught Kindergarten units)

CKLA Grade 2 Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

Domain Anthology, *Insects*

What Students Will Learn in Future Grades

Core Knowledge Sequence

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Grade 2 unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Helpful and Harmful Insects

*helpful, harmful, (un)wanted, **pollination**, bee, honey, beeswax, silk, silkworm, **protect**, eat, **destroy**, **crops**, locust, trees, wood, termite, clothes, moth, disease, mosquito, tick, bite, sting, itchy, ...*

Distinguishing Characteristics

*legs, body segment, **exoskeleton**, chitin, head, thorax, **abdomen**, wings, ...*

Life Cycles

*egg, hatch, grow, **molt**, adult, **offspring**, **metamorphosis**, larva, pupa, butterfly, ant, grasshopper, cricket, ...*

Social Insects

***social**, colony, hive, **solitary**, alone, ...*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "All insects are bugs."

Misconception: "Small insects with wings are

The term *bug* is often misused in everyday language. The term is actually used scientifically to refer to a specific group (i.e., order) of insects—Hemiptera, which is a term derived from Latin meaning half (*hemi*) wings (*ptera*) and which refers to specific characteristics of these insects. Bugs include cicadas, aphids, and "true bugs" such as water striders, stink bugs, and bed bugs. Teachers have the opportunity in this unit to help students compare and contrast what the term *bug* means to entomologists (i.e., scientists who study insects) relative to common usage.

Misconception: "Spiders, mites, and ticks are insects."

The fact that spiders and ticks are often grouped by students with insects has also been attributed to common usage of the term *bug*. Spiders, ticks, and mites are not insects, but rather *arachnids* which include other animals such as scorpions. Characteristics shared by arachnids and insects may be used as evidence when students explain their thinking, for example all of these animals have segmented bodies, exoskeletons, as well as paired and jointed appendages. These common structures are actually shared by all *arthropods*, a broader phylum of animals which includes insects, arachnids, centipedes, millipedes, and even crustaceans such as crabs, lobsters, and shrimp.

Misconception: "Insects aren't animals."

In research studies, students have been shown to classify organisms based on the scope and sequence of previous instruction. For example, some students reported that they classify insects as non-animals because they learned about insects during a separate unit. It will be important for teachers to connect learning in this unit to previous ideas and experiences (e.g., Kindergarten Unit 2 *Animals & Their Needs* and reviewing the basic needs of animals) in order to

babies."

An insect with wings is actually considered an adult regardless of size. Species that have wings are considered to have reached adulthood once the wings have developed.

Misconception: "Cocoons and chrysali are the same thing." or "Butterflies emerge from cocoons."

A *cocoon* is an external structure of silk, and sometimes other items such as hair and leaves, constructed by larvae (e.g., moth and ant larvae) to protect the animal during the pupal stage. A *chrysalis* is actually the hardened skin of a butterfly pupa/caterpillar that is shed and used to protect the developing animal. *Most* butterflies do not create cocoons, but instead use a small disk of silk to attach their chrysali "skin" to the underside of a leaf or branch. Eric Carle's beloved story *The Very Hungry Caterpillar* depicts a butterfly that emerges from a cocoon, which is not typical of butterflies except in a specific alpine family called Parnassian, or Apollo, Butterflies.

Key points for instruction:

actively address this potential misconception. **Misconception: "Bees gather honey from flowers."** **Misconception: "Insects only live on land."** **Misconception: "You can determine the age of a lady bug by counting its spots."**	

Potential Objectives for this Grade 2 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed.The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Describe common features and behaviors of insects
- Identify characteristics of insects (through observation)
- Identify the body parts of an insect
- Create a 'new' species of insects

Middle

- Identify each stage within the lifecycle of an insect
- Define the term, "metamorphosis"
- Create a model depicting the metamorphosis of a butterfly
- Describe the process of metamorphosis (using a model)
- Identify examples of social insects
- Describe the behaviors of social insects

End

- Describe insect behavior that is harmful to living things
- Describe insect behavior that is helpful to living things
- Create a model that illustrates the pollination of plants (2-LS2-2)
- Describe a bee's role in pollinating plants (using a model) (2-LS2-2)

Potential Big Guiding Questions

Essential Questions:

- How are insects different from other animals?
- How do insects impact the world around them?

RE: Insect Characteristics

- How are insects different from you?
- Do you think insects are animals? Why or why not?
- What similar features does each insect have?
- Are there features that many insects have, but not all?

RE: Insect Life Cycles

- How is the life cycle of a grasshopper similar to the life cycles of a human being? How are they different?

RE: Social Insects

- What does it mean to be part of a society?
- Can insects work together?

RE: Insects Helpful or Harmful

- Can bees be both helpful and harmful?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example #1: (Beginning of Unit 2)

{**Evaluates Student Mastery of Objectives:** Create a 'new' insect species.}

Advance Preparation:

Characteristics of insects list (from previous lesson)

Construction or unlined paper for insect illustration

Markers, crayons, and/or colored pencils

Lined paper for writing

Students will create their own insect that includes all of the defining characteristics studied. Post the list of distinguishing characteristics that the class observed in a previous as well as the body parts from another previous lesson. Review the list and ask students a few questions to help them recollect these defining characteristics of insects. Tell students that today they will work in pairs to create their own insects. Tell students these insects should have all the defining features of insects, as they have uncovered in previous lessons. Give students time to brainstorm, illustrate, label the parts, and name their insects.

Check in with student pairs, asking them to identify the parts of their insects, their characteristics, and noting any unique features. After students have completed their new insects, invite several student pairs to share with the class. Encourage students to ask about insect parts and characteristics of their peers' creations.

Finally, have students individually write a short (2–3 sentence) descriptive paragraph about their insect.

Encourage them to use their drawings, labels, and names in the description. While students are writing, you may check in to help students brainstorm adjectives and phrases for their descriptions. Collect the paragraphs and insect illustrations to read and assess.

Example #2: (End of Unit 2)

{**Evaluates Student Mastery of Objectives:** Describe insect behavior that is harmful to living things; Describe insect behavior that is helpful to living things.}

Advance Preparation:

T-chart outline

T-chart worksheets for students (as desired)

After learning about how insect behavior can be helpful and/or harmful, work together to create a T-chart showing the helpful and harmful effects of insect behavior on living things. Encourage students to explore previous read-alouds and diagrams to come up with a list of several items that would be considered helpful or harmful to other living things.

For example (Encourage students to come up with more specific examples of these as well, but help them focus on the trends after the list has been created):

Helpful	Harmful
pollination	destroy crops, trees, wooden buildings, clothes
products like honey, beeswax, and silk	carry disease
eat harmfu	bite or sting

| insects	

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction where it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 2)

{**Evaluates Student Mastery of Objectives:** Identify characteristics of insects through observation.}

Advance Preparation:

Image cards for a variety of insects

Board or chart paper

Note: This activity focuses on the following distinguishing features of insects: exoskeleton, chitin, six legs, most but not all insects have wings. Students may come to realize through this exercise that insects also have three main body segments. You needn't focus on this particular characteristic—it will be explored in depth in the next lesson. But if students recognize the segmentation, acknowledge it and focus more closely on the other characteristics as you will have more time for body segmentation understanding later.

Remind students that they contrasted insects with other animals in the previous lesson. Tell them that today they will see how insects compare with one another, to answer the big question: "What characteristics are common to all insects? (In other words, "What makes an insect an insect?"). Display or otherwise share the image cards of various insects one at a time. Ask students to describe the animals in the pictures one by one. **T - What features does each insect have?** (Encourage student responses, offering vocabulary words such as antennae for parts they haven't named before, but can describe. If a student *does* know the name of a feature not previously discussed, be sure to ask about the description of the feature and repeat the name together as a class to help encourage vocabulary growth as a whole.) Then ask students to compare the insect images to one another. **T - What do you notice is the same about these creatures?** Keep a running list of student responses. You may even wish to circle or otherwise highlight anything that is the same across all images. Encourage students to recognize the body segmentation in insects by asking questions such as: **T - What do you notice about the shape of the bodies? Do you see any body parts that look like your own? Do you see the heads? What kind of covering do the insects have over their bodies? Does it look hard or soft? How many legs can you count?** Then ask students to look for any distinguishing features that appear in most, but perhaps not all, of the insect images. **T - Are there features that many insects (in the images) have, but not all?** Encourage students to recognize the wings that many insects have. Add this to the list of student responses. Tell students you will read them the list they have developed

of the characteristics of insects, and ask them to check that these features are found in all (or most) of the images shown. Allow students to make any corrections to the list based on their findings.

Example #2: (End of Unit 2)

{**Evaluates Student Mastery of Objectives:** Describe a bee's role in pollinating plants (using a model).}

Advance Preparation:

Read-aloud text (e.g., *The Flight of the Honey Bee*)

Pollination diagram

Construction paper or cardboard

Scissors and tape/glue

Q-tips, straws, pom poms, and other means for students to simulate a stamen and pistil

Small styrofoam balls (one for each student)

Q-tips, pipe cleaners, or other means of simulating bee legs

Powdered sugar, ground cheese puffs, or another means of simulating pollen

Note: This is a three-lesson activity. There are natural break points, but you should modify the lesson according to time constraints.

Review the parts of a flower and the process of pollination with students through a read-aloud. Tell them that over the next several lessons, they will work to create a model of bee pollination. Remind students of the stages of bee pollination using the pollination diagram you've displayed. Tell students that first, they will create a model of the flower that they will pollinate. Then they will create a model of a bee. Last, they will work in pairs, using their bees to pollinate their flowers.

Encourage students to cut out (and if they wish, color) a simple flower shape from the cardboard/construction paper. Then, show them the pollen you have brought in. Encourage students to use the pollination diagram for support as they answer these questions and build their models. **T - What do you think this powdery substance could be used represent on our models?** (Pollen) **On the flower, where is the pollen found?** (Stamen) **So how can we represent the flower stamen with our flower diagrams? What is important about the stamen that we'll need for holding and transferring pollen?** (It needs to be sticky enough for the pollen to stick to, but also needs to come off pretty easily.) **When a bee pollinates a flower, where does the pollen then end up on the flower?** (Pistil.) **What is important about the pistil that we'll need to show with our models? What helps the pollen end up on it?** (The pollen is able to transfer to the pistil. It's not so slick the pollen won't stick.) After students come up with some ideas direct them to explore the materials at their desks to find something that could be used to represent the flower stamen and pistil. Once they have selected their material(s), ask several students to explain why they chose that material. (It will be important for allowing the pollen to stick to and come off of the material.) Then allow students to craft their flowers using these parts (cut-out, stamen, pistil, and pollen). For example, students could dip the stamen in

the pollen and then poke the stamen through cardboard.

Next, tell students they will create a model of the bee who will pollinate their flowers. Have students set aside their flowers for now. Encourage students to draw on their styrofoam balls to make them look like bees. **T - Okay, so now you have your bees' bodies. What is important about the bee to the process of pollination?** (Bees transfer pollen on their legs from the stamen to the pistil.) Show students the materials in front of them. **What materials here could be used to represent the bee's special way of transferring the pollen from the stamen to the pistil?** (Some material that is capable of both picking up and transferring the powdery substance.) Allow students to continue making their bee models, using the given materials and adding to them as desired, and as time allows. Once students have finished crafting their bees, ask several students to share their models and explain why they chose the materials they did.

Then, tell students they will use their bee and flower models to pollinate their neighbor's flowers. Ask students how they can use their bee to pollinate a flower. (The bee will pick up pollen from a flower stamen and transfer it to a pistin.) Remind students that some flowers are self-pollinating and others are cross-pollinating. Ask students to explain these terms and demonstrate how they would practice each with their models. Finally, have students practice pollinating their own flowers with their models (self-pollination). Then, have students work in partners, groups, or "buzz" around the classroom to pollinate other flowers.

Note: If you have live flowers available, you could even demonstrate using the real flowers and your own model, or let a few students try (depending on the quantity available).

Debrief with students, asking them to recap how each of their pollination models accurately represents the pollination process. Finally, ask them if there is anything else they could have done to make their models more accurate.

Websites & Media

Insect and Bug Word Search

http://www.primarygames.com/science/insects/games/word_search/ search.htm

Insect Riddles

http://www.bugs.com/kids_corner/insect_riddles.asp

San Diego Zoo Insect Page

http://kids.sandiegozoo.org/animals/insects

University of Michigan Wasps, Bees, and Ants

http://www.biokids.umich.edu/critters/Hymenoptera/pictures

Insects

http://www.insects.org

Supplemental Trade Books

About Insects, by Cathryn Sill and illustrated by John Sill (Peachtree Publishers Ltd., 2003) ISBN 978-1561452323

Ant Cities, by Arthur Dorros (HarperCollins Publishers, 1987) ISBN 978-0064450799

Are You a Bee?, by Judy Allen and Tudor Humphries (King sher, 2001) ISBN 978-0753458044

Are You a Butterfly?, by Judy Allen and Tudor Humphries (King sher, 2003) ISBN 978-0753456088

Are You a Dragonfly?, by Judy Allen and Tudor Humphries (King sher, 2001) ISBN 978-0753458051

Are You a Grasshopper?, by Judy Allen and Tudor Humphries (King sher, 2002) ISBN 978-0753458051

Are You a Ladybug?, by Judy Allen and Tudor Humphries (King sher, 2000) ISBN 978-0753456033

Are You an Ant?, by Judy Allen and Tudor Humphries (King sher, 2002) ISBN 978-0753458037

Bee Life, by Lynette Evans (Insight Editions, 2013) ISBN 978-1608871988

Beetles, by Cheryl Coughlan (Capstone Press, 1999) ISBN 978-0736802352

Bugs are Insects, by Anne Rockwell and illustrated by Steve Jenkins (HarperCollins Publishers, 2001) ISBN 978-0064452038

Children's Guide to Insects and Spiders, by Jinny Johnson (Simon & Schuster, 1996) ISBN 978-0689811630

Chirping Crickets, by Melvin Berger and illustrated by Megan Lloyd (HarperCollins Publishers, 1998) ISBN 978-0064451802

Clara Caterpillar, by Pamela Duncan Edwards (HarperTrophy, 2001) ISBN 978-0064436915

Crickets, by Cheryl Coughlan (Capstone Press, 1999) ISBN 978-0736882088

The Dragonfly Door, by John Adams and illustrated by Barbara L. Gibson (Feather Rock Books, Inc., 2007) ISBN 978-1934066126

Eliza and the Dragonfly, by Susie Caldwell Rinehart and illustrated by Anisa Claire Hovemann (Dawn Publications, 2004) ISBN 978-1584690597

From Caterpillar to Butterfly, by Deborah Heiligman and illustrated by Bari Weissman (HarperCollins Publishers, 1996) ISBN 978-0064451291

Grasshopper on the Road, by Arnold Lobel (HarperCollins Publishers, 1978) ISBN 978-0064440943

Grasshoppers, by Margaret Hall (Capstone Press, 2005) ISBN 978-0736850964

Helpful and Harmful Insects, by Molly Aloian and Bobbie Kalman (Crabtree Publishing Company, 2005) ISBN 978-0778723752

Hey Little Ant, by Phillip and Hannah Hoose illustrated by Debbie Tilley (Tricycle Press, 1998) ISBN 978-1883672546

Honey in a Hive, by Anne Rockwell and illustrated by S.D. Schindler (HarperCollins Publishers, 2005) ISBN 978-0064452045

The Honey Makers, by Gail Gibbons (Mulberry Books, 1997) ISBN 978-0688175313

Honeybees, by Joyce Milton and illustrated by Pete Mueller (Grosset & Dunlap, 2003) ISBN 978-

0448428468

How to Hide a Butterfly, by Ruth Heller (Grosset & Dunlap, 1992) ISBN 978-0448404776

Hurry and the Monarch, by Antoine Ó Flatharta illustrated Meilo So (Dragon y Books, 2009) ISBN 978-0385737197

Insects: Six-Legged Animals, by Suzanne Slade and Rosiland Solomon (Picture Window Books, 2010) ISBN 978-1404855243

The Insect Book, by Connie Zakowski (Rainbow Books, Inc., 1997) ISBN 978-1568250373

Insect Bodies, by Molly Aloian and Bobbie Kalman (Crabtree Publishing Company, 2005) ISBN 978-0778723745

Insect Life Cycles, by Molly Aloian and Bobbie Kalman (Crabtree Publishing Company, 2005) ISBN 978-0778776239

Inside an Ant Colony, by Allan Fowler (Children's Press, 1998) ISBN 978-0516263656

The Flight of the Honey Bee (Read and Wonder Series), by Raymond Huber (Candlewick, 2015) ISBN 978-0763676483

The Life and Times of the Ant, by Charles Micucci (Houghton Mif in, 2003) ISBN 978-0618689491

The Life and Times of the Honeybee, by Charles Micucci (Houghton Mif in, 1995) ISBN 978-0395861394

The Life Cycle of a Butterfly, by Bobbie Kalman (Crabtree Publishing Company, 2002) ISBN 978-0778706809

*TheLifeCycleofaHoneybee,*byBobbieKalman(Crabtree Publishing Company, 2004) ISBN 978-0778706946

The Life Cycle of an Ant, by Bobbie Kalman and Hadley Dyer (Crabtree Publishing Company, 2006) ISBN 978-0778707004

The Magic School Bus: Inside a Beehive, by Joanna Cole and Bruce Degen (Scholastic Inc., 1996) ISBN 978-0590257213

Monarch Butterfly, by David M. Schwartz and photography by Dwight Kuhn (Creative Teaching Press, Inc., 1999) ISBN 978-1574715798

Monarch Butterfly, by Gail Gibbons (Holiday House, 1989) ISBN 978-0823409099

A Monarch Butterfly's Life, by John Himmelman (Children's Press, 1999) ISBN 978-0516265377

Old Cricket, by Lisa Wheeler and illustrated by Ponder Goembel (Aladdin Paperbacks, 2003) ISBN 978-1416918554

On Beyond Bugs!, by Tish Rabe and illustrated by Aristides Ruiz (Random House, 1999) ISBN 978-0679873037

Sarah's Story, by Harley Bill and illustrated by Eve Aldridge (Tricycle Press, 1996) ISBN 978-1582461786

The Very Quiet Cricket, by Eric Carle (Penguin Group, 1990) ISBN 978-0399218859

Where Butterflies Grow, by Joanne Ryder and illustrated by Lynne Cherry (Puf n Books, 1989) ISBN 978-0140558586

A World Without Bees, by Kenneth Peters and illustrated by Sonya Opal (Ken W. Peters, 2011) ISBN 978-0986615818

Joyful Noise: Poems for Two Voices, by Paul Fleischman (HarperCollins, 1988) ISBN 978-0060218522

Core Knowledge Science Program—Domain Map

Science Content
Cells • All living things are made up of cells, too small to be seen without a microscope • A biography of Anton Van Leeuwenhoek • Organization of cells in the human body: Cells make up tissues Tissues make up organs Organs work in systems **The Digestive and Excretory Systems** • What happens to the food we eat • Body parts and functions involved in taking in food and getting rid of waste: Salivary glands and taste buds Teeth—incisors, bicuspids, and molars Esophagus, stomach, liver, small intestine, and large intestine Kidneys, urine, bladder, urethra, anus, and appendix **Taking care of your body** • A healthy diet • The "food pyramid" and/or "MyPlate" • Vitamins and minerals • A biography of Florence Nightingale • A biography of Daniel H. Williams

This unit contributes to meeting or exceeding the following Next Generation Science Standards:	
	, LS1.D, ETS2.B

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
4-LS1-1*. Construct an argument that plants and* ***animals have internal and external structures that function to support survival, growth, behavior, and reproduction.***	***Rationale:*** This unit will explicitly engage students with the core idea LS1.A (Structure & Function) as they extend their knowledge and understanding of the human body. This unit also extends and connects general understanding of the growth and development (LS1.B) of humans as students continue to refine their

	understanding of a healthy diet and taking care of their bodies.
5-PS3-1**. Use models to describe that* ***energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.	This unit offers an opportunity for students to extend their learning about the basic needs of humans and other animals and continue their progression of understanding the core ideas PS3.D (Energy in Chemical Processes & Everyday Life) and LS1.C (Organization for Matter & Energy Flow in Organisms). These ideas are explicitly assessed by this Grade 5 standard, 5-PS3-1, however students in Core Knowledge classrooms will be engaged with these ideas in every grade K–5 with units such as Kindergarten Unit 3 *Plants & Farms*, Grade 1 Unit 1 *Human Body Systems*, and Grade 5 Units 3 and 4, *Plants* and *Life Cycles & Reproduction*.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

POTENTIAL CCSS ELA Connections

RI.2.1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.

RI.2.3 Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text.

RI.2.4 Determine the meaning of words and phrases in a text relevant to a Grade 2 topic or subject area.

RI.2.7 Explain how specific images (e.g., a diagram showing how a machine works) contribute to and clarify a text.

RI.2.8 Describe how reasons support specific points the author makes in a text.

RI.2.9 Compare and contrast the most important points presented by two texts on the same topic.

RI.2.10 By the end of year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the Grades 2–3 text complexity band proficiently, with scaffolding as needed at the high end of the range.

W.2.3 Write narratives in which they recount a well-elaborated event or short sequence of events, include details to describe actions, thoughts, and feelings, use temporal words to signal event order, and provide a sense of closure.

W.2.6 With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers.

W.2.7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations).

W.2.8 Recall information from experiences or gather information from provided sources to answer a question.

SL.2.1 Participate in collaborative conversations with diverse partners about Grade 2 topics and texts with peers and adults in small and large groups.

SL.2.4 Tell a story or recount an experience with appropriate facts and relevant, descriptive details, speaking audibly in coherent sentences.

SL.2.5 Create audio recordings of stories or poems; add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings.

L.2.6 Tell a story or recount an experience with appropriate facts and relevant, descriptive details, speaking audibly in coherent sentences.

POTENTIAL Cross-Curricular Connections

- Anton van Leeuwenhoek (invented the microscope)
- Florence Nightingale (helped the wounded in the Crimean War/made hospitals more sanitary)
- Daniel Hale Williams (performed the first open-chest surgery)
- Identify solid figures—sphere, cube, pyramid, cone, cylinder—and associate solid figures with planar shapes: sphere (circle), cube (square), pyramid (triangle).
- All living things are made up of cells, too small to be seen without a microscope

Prior Knowledge

Core Knowledge Sequence

The Human Body (Kindergarten)

- Taking care of your body: exercise, cleanliness, healthy foods, rest

Animals and Their Needs (Kindergarten)

- Animals, like plants, need food, water, and space to live and grow.
- Plants make their own food, but animals get food from eating plants or other living things.

Science Biographies (Grade 1)

- Edward Jenner (found a way to stop smallpox)
- Louis Pasteur (made milk safe to drink)

The Human Body (Grade 1)

A. BODY SYSTEMS

- Teachers: Introduce the idea of body systems, and have children identify basic parts of the following body systems:
- Skeletal system: skeleton, bones, skull
- Muscular system: muscles
- Digestive system: mouth, stomach
- Circulatory system: heart and blood
- Nervous system: brain, nerves

B. GERMS, DISEASES, AND PREVENTING ILLNESS

- Taking care of your body: exercise, cleanliness, healthy foods, rest
- Vaccinations

Core Knowledge Language Arts (CKLA)

The Five Senses (Kindergarten)

- Identify and describe the five senses: sight, hearing, smell, taste, and touch
- Identify the body parts associated with the five senses
- Provide simple explanations about how the eyes, ears, nose, tongue, and skin work
- Describe how the ve senses help people learn about their world
- Describe some ways the ve senses help protect people from harm
- Describe ways people take care of their bodies and protect them from harm
- Describe the experiences and challenges of someone who is blind or deaf

The Human Body (Grade 1)

- Explain that the human body is a network of systems
- Identify the skeletal, muscular, digestive, circulatory, and nervous systems
- Recall basic facts about the skeletal, muscular, digestive, circulatory, and nervous systems
- Identify the heart as a muscle that never stops working
- Explain the importance of exercise and a balanced diet for bodily health
- Identify the brain as the body's control center
- Explain that germs can cause disease in the body
- Identify Edward Jenner as the man who developed the rst vaccine
- Identify Louis Pasteur as the man who discovered pasteurization
- Explain the importance of exercise, cleanliness, a balanced diet, and rest for bodily health
- Explain the importance of regular checkups
- Explain how vaccinations can prevent disease
- Explain that the food pyramid is one way to depict a balanced diet
- Identify the component food groups in a balanced diet

Core Knowledge Science (Previously taught Kindergarten units)

CKLA Grade 2 Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

Domain Anthology, *The Human Body: Building Blocks & Nutrition*

- Identify the five senses and associated body parts
- Identify the skeletal, muscular, circulatory, nervous, digestive, and excretory systems as important systems in the human body
- Describe the significant contributions of Anton van Leeuwenhoek
- Explain that all living things are made of microscopic cells
- Describe the relationship among cells, tissues, organs, and systems
- Identify important components of the digestive system and their functions
- Describe the process of nourishing the body from the time food is taken into the mouth until waste is removed from the body
- Identify important components of the excretory system and their functions
- Describe how the digestive and excretory systems work together
- Explain the importance of vitamins and minerals to the body
- Explain the importance of eating a balanced diet
- Classify foods as healthy or unhealthy
- Plan a daily balanced diet

What Students Will Learn in Future Grades

Core Knowledge Sequence

The Human Body (Grade 3)

The Muscular System

- Muscles
- Involuntary and voluntary muscles

The Skeletal System

- Skeleton, bones, marrow
- Musculo-skeletal connections
  - Ligaments
  - Tendons, Achilles tendon
  - Cartilage
- Skull, cranium
- Spinal column, vertebrae
- Joints
- Ribs, rib cage, sternum
- Scapula (shoulder blades), pelvis, tibia, fibula

- Broken bones, x-rays

The Nervous System
- Brain: medulla, cerebellum, cerebrum, cerebral cortex • Spinal cord
- Nerves
- Reflexes

Vision: How the Ear Works
- Parts of the eye: cornea, iris and pupil, lens, retina • Optic nerve
- Farsighted and nearsighted

Hearing: How the Ear Works
- Sound as vibration
- Outer ear, ear canal
- Eardrum
- Three tiny bones (hammer, anvil, and stirrup) pass vibrations to the cochlea
- Auditory nerve

The Human Body (Grade 4)

The Circulatory System
- Pioneering work of William Harvey
- Heart: four chambers (atrium/atria or atriums [plural] and ventricle/ventricles), aorta
- Blood
- Red blood cells (corpuscles), white blood cells (corpuscles), platelets, hemoglobin, plasma, antibodies
- Blood vessels: arteries, veins, capillaries Blood pressure, pulse
- Coagulation (clotting)
- Filtering function of liver and spleen
- Fatty deposits can clog blood vessels and cause a heart attack. • Blood types (four basic types: A, B, AB, O) and transfusions

The Respiratory System
- Process of taking in oxygen and getting rid of carbon dioxide
- Nose, throat, voice box, trachea (windpipe)
- Lungs, bronchi, bronchial tubes, diaphragm, ribs, alveoli (air sacs) • Smoking: damage to lung tissue, lung cancer

Science Biographies (Grade 4)
- Benjamin Banneker (published almanac; reproduced plans to build Washington, D.C. entirely from memory)
- Elizabeth Blackwell (first female to graduate from medical school in the United States) Charles Drew (pioneered work in blood research, blood transfusions, and the development of blood banks)

Cells: Structures and Processes (Grade 5)
- All living things are made up of cells.
- Structure of cells (both plant and animal)
    - Cell membrane: selectively allows substances in and out
    - Nucleus: surrounded by nuclear membrane, contains genetic material, divides for reproduction
    - Cytoplasm contains organelles, small structures that carry out the chemical activities of the cell, including mitochondria (which produce the cell's energy) and vacuoles (which store food, water, or wastes).
- Plant cells, unlike animal cells, have cell walls and chloroplasts.

- Cells without nuclei: monerans (bacteria)
- Some organisms consist of only a single cell: for example, amoeba, protozoans, some algae.
- Cells are shaped differently in order to perform different functions. • Organization of cells into tissues, organs, and systems:
    - In complex organisms, groups of cells form tissues (for example, in animals, skin tissue or muscle tissue; in plants, the skin of an onion or the bark of a tree).
    - Tissues with similar functions form organs (for example, in some animals, the heart, stomach, or brain; in some plants, the root or flower).
    - In complex organisms, organs work together in a system (recall, for example, from earlier studies of the human body, the digestive, circulatory, and respiratory systems).

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Grade 2 unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Cells

*Organs, **systems**, bacteria, lens, magnify, microscope, **observation**, cell, function, microscopic, stimulus, tissue, villi, network, tissue*

A Healthy Diet

*Nutrients, nutrition, nutritionist, diet, vaccinations, vitamins, minerals, **nourish**, carbohydrates, **essential**, proteins, fats, fiber, moderation, scan, **variety**, calories*

Digestive and Excretory Systems

*Kidney, digestive, excretory, **absorb**, esophagus, filtering, saliva, salivary glands, bladder, excrete, regulate, sweat, **toxic**, stomach, small/large intestine, anus, taste buds, incisors, bicuspids, molars, liver, urine, urethra, appendix*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "The body systems operate separately from each other."	**Key points for instruction:**
This idea can be inadvertently emphasized by	Primary grade students may begin instruction with

instruction that does not carefully probe for student ideas about the relationships between systems in the body. For example, the linear timeline of a unit may focus on how a system is supported by those previously studied, but teachers should be sure to explore student thinking about the reciprocal and interconnected nature of the body as a whole.

Misconception: "Energy is a substance in food." or "Food turns into energy in your body."
Chemical reactions during the process of digestion and cellular respiration release stored chemical energy in food. Teachers should be mindful of how they describe the process of digestion because overgeneralizations, like the misconceptions above, are common in everyday speech. The definition of energy is complex (e.g., read the *Framework's* core ideas PS3.A–D) and the scientific definitions of chemical energy and stored energy are reserved for study in middle and high school grades. The goal for this early grade is to introduce key terms and ideas about the digestive system and its parts relative to LS1.A (Structure and Function). It is recommended that Grade 2 teachers refer to food as a source of energy and that energy is released when food is digested.

little knowledge of their internal organs and think that the contents of the body are only what they have seen going in or coming out of it—e.g., food and blood (Gellert, 1962).

When asked to locate the approximate position on a model or drawing of a human body, students of all ages have trouble identifying the location of organs such as the stomach, intestines, and/or liver (Blum, 1977). Teachers should be mindful of how they refer to and model the location of internal organs during discussions and investigations.

Potential Objectives for this Grade 2 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed.The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Create a learning plan/experimental design for answering a scientific question.
- Identify the digestive system as part of an organism, and made up of cells, tissues, and organs.
- Explain what happens to the food we eat as it moves through our bodies.
- Explain how taste buds, salivary glands, and teeth affect how humans eat and digest.
- Explain how the esophagus, stomach, and small intestine affect how humans digest.
- Explain how the large intestine and anus affect how humans digest.

- Identify body parts in the excretory system and explain how it relates to digestion.

Middle

- Identify digestion as a body process that is accomplished by the digestive system.
- Identify the characteristics of cells
- Explain that cells are best seen with a microscope.
- Identify Anton Van Leeuwenhoek's accomplishments.
- Find and identify cells using a microscope.
- Explain how cells make up an organism.

End

- Identify healthy diets.
- Identify and explain the MyPlate system for healthy dieting.
- Identify vitamins and minerals.
- Explain the health value of vitamins and minerals.
- Explain how Florence Nightingale and Daniel WIlliams tried to help keep people healthy.

Potential Big Guiding Questions

Essential Questions:

- How does what I choose to eat affect my health?
- What foods can I eat to help me stay healthy?
- What happens to the food I eat?

RE: Digestion

- What is digestion?
- When does digestion begin?
- What happens to food as it moves through my body?

RE: Cells and Systems

- What is a cell?
- How small is a cell?
- What did Anton Van Leeuwenhoek discover about cells?
- How do cells combine to form an organism like me?

RE: Taking Care of Your Body

- What makes up a healthy diet?
- How can I eat more healthy?
- What are vitamins and minerals, and what do they do for me?
- Who were Florence Nightingale and Daniel H. Williams?
- How do people like them help me stay healthy?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example #1: (Beginning of Unit 3)

{**Evaluates Student Mastery of Objectives:** Explain what happens to the food we eat as it moves through our bodies; Explain how taste buds, salivary glands, and teeth affect how humans eat and digest; Explain how the esophagus, stomach, and small intestine affect how humans digest; Explain how the large intestine and anus affect how humans digest; Identify body parts in the excretory system and explain how it relates to digestion.}

Advance Preparation:

Paper and pen

Crayons or colored pencils

Note: If you need to save some giggles, you may want to do the excretory system yourself, and contribute it to the group discussion.

Now that students have learned about the digestion process, tell them they will have a chance to put their understanding of different body parts and systems together to visualize the process as a whole. Put students in small groups, assign each group a body part in the digestive system, and task each with drawing and writing a sentence explaining what that body part contributes to digestion (how it processes food). As students work, check in with groups to ask about their work. When students have completed their drawings and statements, have each group present. Ask a representative to post the drawing/statement on the board in the order of the digestive process. Engage the whole group in determining where the drawing/statement should be placed. Continue until you have the full digestive system on the board. Then ask students some questions about what happens to food as it moves through the body, tracing it along the digestive system parts as they answer. **T - What is digestion? When does digestion begin? What happens to food as it moves through the body?**

Example #2: (End of Unit 3)

{**Evaluates Student Mastery of Objectives:** Identify healthy diets.}

Advance Preparation:

MyPlate worksheet

Crayons or colored pencils

Remind students of the MyPlate system for planning a healthy meal. Tell students that today they will plan a healthy meal using the parts of the MyPlate. Ask students what each section of the MyPlate represents, and have them fill in the sections with these labels (e.g., grains, dairy, fruit). Tell students that now they will create their own healthy meals based on these principles. Have students draw in

examples of the types of food that would make up a healthy meal using the section labels as a guide.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction where it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (Middle of Unit 3)

{**Evaluates Student Mastery of Objectives:** Find and identify cells using a microscope.}

Advance Preparation:

Microscope

Worksheet for recording observations

Prepared slides with easily identifiable cells

Several books about microscopes and cells

Share a visual of a cell as seen through a microscope. Tell students that today they will get to use a microscope--more advanced than what Anton van Leeuwenhoek used, but with the same purposes--to view a cell. **T - Why would you use a microscope to view a cell?** (It is too small to be seen with the naked eye.) **How does a microscope help you see it?** (It will magnify the cell so it is visible.) Have students take turns viewing the prepared slides with identifiable cells. Have them record their observations of the cells on their worksheet. Encourage students to ask questions about what they see, and answer what you can. Have a handful of books on cells presents for students to continue their pursuit of answers as they wish.

Example #2: (End of Unit 3)

{**Evaluates Student Mastery of Objectives:** Explain how Florence Nightingale and Daniel WIlliams tried to help keep people healthy.}

Advance Preparation:

Paper and pencil

Books about Florence Nightingale and Daniel H. Williams

Note: Share the stories of Florence Nightingale and Daniel H. Williams with students, in the context of people who tried to help others to stay healthy through their work.

After sharing the biographies of these two humanitarians, have students compose a journal entry posing as one of the two. Allow students to choose which they would like to write as, or divide the class in half assigning one to each half.

Begin by brainstorming as a class. Ask students writing for each individual to come up with ideas for what they would write about and how it would relate to the science of staying healthy, and generate a list of words that can be used, both vocabulary and historical.

Ask students to write a few sentences in a journal entry from the perspective of their individual. Encourage them to draw pictures and expand on their entries as time allows, using the brainstorming record to help them come up with ideas.

After students have finished writing their entries, have a handful of students share theirs. Allow other students to ask questions and give feedback about the entries.

Websites & Media

Visible Body—Free eBooks: http://go.visiblebody.com/vb-free-ebooks

Visible Body offers a collection of interactive animation apps that are available for purchase, including My Incredible Body which is geared toward elementary students. This website also offers free eBooks and activities packed with images and amazing details about the human body.

Choose My Plate: http://www.choosemyplate.gov/kids

This website includes games, activities, videos, and songs that can build children's understanding of the food groups and how to choose a nutritious diet.

How the Human Body Works (various systems)

http://kidshealth.org/kid/htbw/htbw_main_page.html

I Know That

http://www.iknowthat.com/com/L3?Area=Science%20Lab

Supplemental Trade Books

Bones: Our Skeletal System, by Seymour Simon (HarperCollins, 2000) ISBN 978-0688177218

The Bones Book and Skeleton, by Stephen Cumbaa (Workman Publishing Company, 2006) ISBN 978-0761142188

The Brain: Our Nervous System, by Seymour Simon (HarperCollins, 2006) ISBN 978-0060877194

Cells, Tissues, and Organs, by Richard Spilsbury (Heinemann Library, 2008) ISBN 978-1432909048

The Digestive System, by Rebecca L. Johnson (Lerner Publications Company, 2005) ISBN 978-0822512479

The Digestive System, by Kirstin Petrie MS, RD (ABDO Publishing Company, 2007) ISBN 978-159679710

The Digestive System, by Christine Taylor-Butler (Scholastic Inc., 2008) ISBN 978-0531207314

Dinosaurs Alive and Well!: A Guide to Good Health, by Marc Brown and Laurie Krasny Brown (Little, Brown Books for Young Readers, 1992) ISBN 978-0316110099

The Dynamic Digestive System: How Does My Stomach Work?, by John Burnstein (Crabtree Publishing Company, 2009) ISBN 978-0778744290

The Edible Pyramid: Good Eating Every Day, by Loreen Leedy (Holiday House, 1994) ISBN 978-0823420742

Food and Digestion, by Andrew Solway (Sea-to-Sea Publications, 2011) ISBN 978-1597712644

Good Enough to Eat: A Kid's Guide to Food and Nutrition, by Lizzy Rockwell (HarperCollins, 2009) ISBN 978-0064451741

Greg's Microscope, by Millicent E. Selsam, illustrated by Arnold Lobel (HarperCollins, 1990) ISBN 978-0064441445

Gurgles and Growls: Learning About Your Stomach, by Pamela Hill Nettleton (Picture Window Books, 2004) ISBN 978-1404805040

Guts: Our Digestive System, by Seymour Simon (HarperCollins Publishers, 2005) ISBN 978-0060546519

The Human Body, by Seymour Simon (Collins, 2008) ISBN 978-0060555412

The Magic School Bus: Inside the Human Body, by Joanna Cole, illustrated by Bruce Degen (Scholastic Audio Books, 2011) ISBN 978-0545240833

Muscles: Our Muscular System, by Seymour Simon (HarperCollins, 2000) ISBN 978-0688177201

My Food Pyramid: Eat Right. Exercise. Have Fun., by Alisha Niehaus (Dorling Kindersley Limited, 2007) ISBN 978-0756629939

My Organ Buddies, by Lee Downing and Felice Downing (Organ Buddies, Inc, 2010) ISBN 978-0615329406

Parts, by Tedd Arnold (Puf n, 2000) ISBN 978-0140565331

The Race Against Junk Food (Adventures in Good Nutrition), by Anthony Buono and Roy Nemerson (HCOM Inc., 1997) ISBN 978-0965810807

The Quest to Digest, by Mary K. Corcoran (Charlesbridge, 2006) ISBN 978-1570916649

Ultra-Organized Cell Systems, by Rebecca L. Johnson (Millbrook Press, 2008) ISBN 978-0822571384

What Am I Made Of?, by David Bennett, illustrated by Stuart Trotter (Aladdin Paperbacks, 1991) ISBN 978-0689714900

Where Does Your Food Go?, by Wiley Blevins (Scholastic Inc., 2003) ISBN 978-0516258607

Core Knowledge Science Program—Domain Map

Science Content
• Magnetism demonstrates that there are forces we cannot see that act upon objects • Most magnets contain iron • Lodestones: naturally occurring magnets • Magnetic poles: north-seeking and south-seeking poles • Magnetic field (strongest at the poles) • Law of magnetic attraction: unlike poles attract, like poles repel • The earth behaves as if it were a huge magnet: north and south magnetic poles (near, but not the same as, geographic North Pole and South Pole) • Orienteering: use of a magnetized needle in a compass, which will always point to the north

This unit contributes to meeting or exceeding the following Next Generation Science Standards:
Standards noted with an asterisk (*) are those that incorporate engineering and design

2-PS1-1**. Plan and conduct an investigation to **describe and classify different kinds of materials by their observable properties. ***2-PS1-2**. Analyze data obtained from testing different materials to **determine which materials have the properties that are best suited for an intended purpose.****	***Rationale:*** This unit will extend students' early learning of the core idea PS1.A (Structure & Properties of Matter), which was first explored in Kindergarten Unit 7 *Introduction to Magnets* and again in Grade 1 Unit 5 *Matter & Its Properties*. By applying their prior knowledge and experiences to the study of magnets and magnetism, students will have the opportunity in this unit to classify magnets (and materials that are attracted by magnets) while also learning about metals like iron, cobalt, nickel, and lodestones. They will also critically discuss how/why a homemade compass works, foreshadowing how 2-PS1-2 will be further addressed during Unit 5 *Simple Machines*. Students will also have the opportunity to connect this domain to ETS2.B (Influence of Engineering, Technology, and Science on Society) as they learn about the importance of orienteering in history (e.g., linking to other Grade 2 topics such as Ancient Greece and Early Asian Civilizations).

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:

3-PS2-3. Ask questions to determine cause and effect relationships of electric or ***magnetic interactions between two objects not in contact with each other.*** *3-PS2-4. Define a simple design problem that can be solved by* ***applying scientific ideas about magnets****.**	***Rationale:*** The content of this unit directly applies to the core idea PS2.B (Types of Interactions), which will also be extended and applied again during Grade 3 Unit 7 *Forces & Interactions*. Primary grade experiences investigating magnets, magnetism, and the application of these scientific phenomena will help students to better meet/exceed these Grade 3 expectations while simultaneously exploring PS1.A as noted above. This unit also provides students with an early foundation for later learning about DCI ESS2.A (Earth's Materials & Systems) as students expand upon Grade 1 Unit 3 *Introduction to Geology* and apply their knowledge of Earth's interior to build an early understanding of Earth's magnetic field. Similarly, this unit offers concrete experiences that can be drawn upon in later grades to investigate PS3.C (Relationship between Energy & Forces).

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

POTENTIAL CCSS ELA Connections

POTENTIAL Cross-Curricular Connections

Geography (Grade 2)

Spatial Sense (Working with Maps, Globes, and Other Geographic Tools)

- Find directions on a map: east, west, north, south.
- Locate: the Equator, Northern Hemisphere and Southern Hemisphere, North and South Poles.

Prior Knowledge

Core Knowledge Sequence

Kindergarten
Introduction to Magnetism
- Identifying familiar everyday uses of magnets (for example, in toys, in cabinet locks, in "refrigerator magnets," etc.)
- Classifying materials according to whether they are or are not attracted by a magnet

Core Knowledge Language Arts (CKLA)

Core Knowledge Science (Previously taught Kindergarten units)
- Describe different ways magnets are used in everyday life.
- Describe the term 'attract.'
- Classify materials according to whether they are or are not attracted by a magnet.
- Describe the term 'repel.'
- Apply your knowledge of forces and magnets to solve a problem.

CKLA Grade 2 Objectives—Not Applicable

The Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history, does not include the study of magnetism. In order to prepare students to meet or exceed the NGSS Grade 2 Topic Structure & Properties of Matter, this unit (as well as Grade 2 Unit 5 Simple Machines*) is critical to advance students' understanding of the physical sciences. This unit on magnetism is also important as it will help to prepare students for future learning in Grade 3 regarding the NGSS Topic Forces & Interactions, which will be explicitly addressed in Grade 3 Unit 7. To learn more about how and why the Listening & Learning Strand of CKLA approaches certain science content through read-alouds and ELA instruction, read more about the CKLA program.*

What Students Will Learn in Future Grades

Core Knowledge Sequence

Grade 4, Chemistry: Basic Terms and Concepts
Atoms
- The concept of electrical charge:
  - Positive charge (+): proton
  - Negative charge (-): electron
  - Neutral (neither positive nor negative): neutron
  - "Unlike charges attract, like charges repel" (relate to magnetic attraction and repulsion)

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Grade 2 unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Magnets

*magnetism, **force**, push, pull, **exert**, (in)visible, phenomenon, property, characteristic, material, **pole**, field, **attract**, **repel**, (un)like, same, different, interaction, **cause**, **effect**, motion, strength, strong, weak, still, unmoved, iron, lodestone, metal, filings, nickel, cobalt, natural, manmade, ...*

Orienteering

***compass**, orienteering, North Pole, South Pole, needle, north, south, east, west, Earth, direction, point, geography, map, globe, ...*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception:"Magnetism is a type of gravity."
Students of all ages may think that gravity and magnetism are related and "interchangeable" terms (AAAS, Volume 2 page 26, 2007). Teachers should be especially aware of this misconception when exploring the ideas of orienteering using compasses and the early study of earth's magnetic field.

Misconception: "Magnets don't work where there is no air."
Similar to misunderstandings about gravity, some students believe that magnetism is observable on earth, but not in space. This may

Misconception: "Forces only occur when motion is changed," or **"Only moving objects have forces acting on them."**
Students of all ages can fail to recognize that objects at rest experience forces. Activities and discussions using stationary magnets may help to demonstrate that forces exist when motion does not.

Key points for instruction:

Elementary students are usually familiar with the behavior of magnets, but they may not explain that behavior in terms of forces (i.e., they may not recognize that a magnet moving or sticking to an object is the effect of a push or pull). (AAAS,

be related to misunderstandings of gravity and magnetism as "interchangeable." (Arons, 1997; Driver et al, 1994)	Volume 2, page 26, 2007)

Potential Objectives for this Grade 2 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed.The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Identify magnetism as a force that acts on objects but cannot be seen.
- Explain how magnetism can be seen using magnets.
- Identify iron, magnets, and lodestones.
- Identify how magnets react when ends are placed near one another.
- Explain attraction and repulsion.
- Identify and label the north- and south-seeking poles of magnets

Middle

- Identify magnetic fields
- Identify strong and weak points of attraction and repulsion.
- Identify and explain the law of magnetic attraction.
- Identify temporary vs. permanent magnets.
- Identify magnets in everyday objects.
- Demonstrate how magnets in everyday objects can be used to help them function(, or as an extension, how they can cause harm).

End

- Identify the earth as a big magnet
- Explain how the earth behaves as a magnet
- Design and create a compass
- Explain how a compass uses magnetism to identify location on earth

Potential Big Guiding Questions

Essential Questions:

- **What is magnetism?**
- **What makes a compass point north?**
- **If you can't see magnetism, how do you know it exists?**
- **How can I use magnetism to help me?**

RE: Magnets

- Are larger magnets stronger than smaller ones?
- Which part(s) of a magnet exerts the greatest force?
- Can things naturally be magnetic?
- How does magnetism affect me?

RE: Orienteering

- How does a compass help me find the direction (north, south, east, west)?
- How does a compass work?
- If you don't have a compass, what other ways can you determine which way is north, south, east, or west?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example #1: (Middle of Unit 4)

{**Evaluates Student Mastery of Objectives:** Identify how magnets react when ends are placed near one another; Identify magnets in everyday objects.}

Advance Preparation:

Identifying Magnets worksheet

Variety of non-magnetic and magnetic (both temporary and permanent, optional) objects

Single magnets for each student

Note: This assessment should be completed independently, though you may require students to share materials. Set up a system with students for sharing the materials so they can reach conclusions independently, not collectively. The Identify Magnets worksheet should identify each of the objects students experiment with and have a place for them to identify whether the object is a magnet or not. As an extension, allow students to further identify if those that demonstrate magnetism are temporary or permanent magnets.

Share the Identifying Magnets worksheet with students. Remind students they have been studying magnets and tell them that they will identify magnets based on their defining characteristics--attraction and repulsion. Give students each a magnet and tell them they will use this to test the objects found on their worksheet to determine if they are magnetic or not. Have students mark an M for any objects they determine to be magnetic. After students have finished identifying, ask them to write a phrase or sentence describing how they knew if an object was magnetic or not. As an extension, invite students (on their own) to find another object in the classroom that is magnetic and draw and label it on their worksheet.

Example #2: (End of Unit 4)

{**Evaluates Student Mastery of Objectives:** Explain how a compass uses magnetism to identify

location on earth}

Advance Preparation:

Completed student compasses

Board or chart paper

Paper and writing utensils

Note: This assessment is tied to, and should immediately follow, the activity described for the end of Unit 4 below. For the writing portion, you can create a worksheet with the lede to the story in advance if you like.

After students complete the compass activity, review how they created the compass and why as a whole group. Draw models of the magnets and compass on the board, and invite students to draw representations of the magnetism on each through different parts of the process. **T - When you stroked the magnet against the needle, what happened?** (The needle became magnetized.) **T - When you placed the needle on the water, what happened and why?** (The needle pointed north, because its end had become magnetized and thereby attracted to the north end of the earth.)

Tell students that they will now write a short story in which a character becomes trapped and has to create their own compass. Give them the lede into the story and ask them to record only the portion where the character explains how the compass is made, how they know it worked, and why it worked.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction where it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (Beginning of Unit 4)

{**Evaluates Student Mastery of Objectives:** Identify how magnets react when ends are placed near one another; Explain attraction and repulsion.}

Advance Preparation:

Magnets of the same size, with north and south poles labeled

Board or chart paper

To introduce the topic of magnetism, provide students with the opportunity to observe, explore, and experiment with magnets. Remind students that there are forces that act on objects but that we cannot see. Tell them they will learn more about one of these forces today. **T - How do we observe the changes that forces we cannot see cause?** Help students understand that like with other forces, with

this force, they will see its effects on objects based on changes that occur. Distribute the magnets. Help students recognize the two ends of the magnet, however they are identified (it is not imperative that students know "north" and "south" just now, but if that helps to identify use those terms). Have students take two magnets and bring the two south poles together. Have students describe what happens and what they feel. Then have them bring the two north poles together. Have students describe what happens and what they feel. **T - What do you think will happen when you bring together a north pole and a south pole?** This is just a prediction. Have students then bring together a north pole with a south pole. Have students describe what happens, what they feels, and how this compares with their predictions. As students are describing their predictions, encourage them to use the terms *attract* and *repel*. Explain these terms and ask them to describe situations with the magnets where they have observed and/or felt attraction and repulsion.

Example #2: (End of Unit 4)

{**Evaluates Student Mastery of Objectives:** Design and create a compass; Explain how a compass uses magnetism to identify location on earth}

Advance Preparation:

Needles or other small metal objects

Glass bowls

Water

Pieces of tissue

Small magnets

Pliers (optional)

Note: This activity is tied to, and should immediately precede, the assessment described for the end of Unit 4 above.

After reviewing how compasses work, tell students they will get a chance to put on their engineering hats and create their own compasses. Remind students that engineers design solutions to problems. Tell students their problem is that they don't have a compass, but they need to know which direction is north. Allow them to explore the objects at their desks (needle, glass bowl, water, tissue, small magnets, pliers). Ask students to consider some ways they could use the objects they have in front of them. Guide them by asking them to consider which are magnetic, and which can temporarily become magnetic, to act like a compass.

Students can magnetize the needle by stroking it with one end of the magnet (preferably the north end). **T - What is happening to the needle by doing this?** (It is becoming magnetized) **T - How do you know?** (It is attracted to/repelling the magnet, depending on the end it is facing.) Ask students how

they can get the needle to point to true north. Help them work through that the needle needs to be free to move, and that one way to do that is by letting it float on water. Students can then add water to the bowl and place a small piece of tissue on the water. Then, they can place the needle on the tissue. After a short while, the needle will point north. If you have a compass on hand you can compare it with students' compasses.

Websites & Media

Supplemental Trade Books
• •

Core Knowledge Science Program—Domain Map

Science Content

- Tools are made to perform specific jobs—for example: hammers, screwdrivers, pliers, etc.
- Simple machines help make work easier and are applied and combined in familiar tools and machines
- Specific simple machines:
  lever, pulley, wheel-and-axle
  gears—wheels with teeth and notches
  how gears work and familiar uses—for example, in bicycles
  inclined plane, wedge, screw
- Friction and ways to reduce friction—lubricants, rollers, etc.
- A biography of Elijah McCoy (invented the automatic lubricator, "The Real McCoy")

This unit contributes to meeting or exceeding the following Next Generation Science Standards:
Standards noted with an asterisk (*) are those that incorporate engineering and design

2-PS1-1**. Plan and conduct an investigation to **describe and classify different kinds of materials by their observable properties.

2-PS1-2**. Analyze data obtained from testing different materials to **determine which materials have the properties that are best suited for an intended purpose.*

2-PS1-3**. Make observations to construct an evidence-based account of how **an object made of a small set of pieces can be disassembled and made into a new object.

Note: Grade 2 Unit 1 *Cycles in Nature* directly addresses 2-PS1-4, the remaining standard from the NGSS Grade 2 Topic *Structure & Properties of Matter*, as students investigate water and the water cycle.

Rationale:

The culminating activity for this unit will take the form of an application and design challenge during which students will apply their early understandings of PS1.A (Structure & Properties of Matter) to design solutions to a problem. This unit will also offer the opportunity to explore core ideas of engineering, such as ETS1.A–C and ETS2.B. For example, students will have the opportunity to connect their learning and design experiences to the biography of Elijah McCoy, an engineer who invented an automatic lubricator for trains in the mid-19th century.

The study of tools and simple machines also offers students an excellent opportunity to discuss and apply the crosscutting concept of Structure & Function, as recommended by the NRC's *Framework for K–12 Science Education* (page 97).

Commented [1]: These guidelines are implied by the Note to Teachers for this domain in the Sequence.

Commented [2]: RE: the definition of a machine...

To physicists, "a machine is any device that can be used to transmit a force and, in doing so, can change its size [and/]or direction."
(Ultimate Visual Dictionary of Science, pg. 26)

This is an important connection to be made between this unit and the prev. Kinder Unit 6 Pushes, Pulls, etc.

Commented [3]: The Engineering is Elementary program (EiE) has a highly recommended third-party unit re: simple machines:

http://eie.org/eie-curriculum/curriculum-units/marvelous-machines-making-work-easier

Commented [4]: Potential scientist to highlight: Archimedes (c. 287–212 BC) who studied simple machines, in particular the screw thread. He can also be highlighted in Grade 4 Unit 3 Chemistry re: properties of matter (e.g., his mathematical formulas of geometric shapes and description of the upward force on objects that are floating)

Commented [5]: From the Science Bios for this grade.

Great potential for the integration of Engineering here and throughout this unit...

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
3-PS2-1*. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.*	***Rationale:*** While investigating the phenomenon of friction, students will be extending their early understanding of PS2.A (Forces & Motion), which includes the Grade 2 endpoint that students should know, "An object sliding on a surface or sitting on a slope experiences a pull due to friction on the object due to the surface that opposes the object's motion" (*Framework,* page 115). This core idea is not assessed by the NGSS until Grade 3, and so this unit will explicitly support teachers as they work to meet the vision set forth by the NRC's *Framework*.
Grade 4 Topic *Energy*, for example: ***4-PS3-4.*** *Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.**	Early study of friction also supports the core idea PS3.D (Energy in Chemical Processes & Everyday Life), which is first assessed by the NGSS in the Grade 4 Topic *Energy*. Ideas first explored during this Grade 2 unit will be reviewed and applied in upper elementary units to build additional knowledge and to apply scientific concepts such as work, energy, and change.

Commented [7]: ...such as in Grade 4 Units 3 and 7, Electricity and Energy & Waves respectively.

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. *(2-PS1-2)*

MP.4 Model with mathematics. *(2-PS1-1 and 2-PS1-2)*

MP.5 Use appropriate tools strategically. *(2-PS1-2)*

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with

up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. *(2-PS1-1 and 2-PS1-2)*

POTENTIAL CCSS ELA Connections

RI.2.8 Describe how reasons support specific points the author makes in a text. *(2-PS1-2)*

W.2.7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). *(2-PS1-1, 2-PS1-2, and 2-PS1-3)*

W.2.8 Recall information from experiences or gather information from provided sources to answer a question. *(2-PS1-1, 2-PS1-2, and 2-PS1-3)*

POTENTIAL Cross-Curricular Connections within the *CK Sequence*

Potential Links:
Mathematics: Measurement—linear measurement (e.g., make linear measurements in feet and inches, and in centimeters; know that one foot = 12 inches; know abbreviations: ft., in.) and weight (e.g., compare weights of objects using a balance scale; estimate and measure weight in pounds, and know abbreviation: lb.)

Prior Knowledge

Core Knowledge Sequence
Kindergarten
Introduction to Magnetism

- Identify familiar everyday uses of magnets (for example, in toys, in cabinet locks in "refrigerator magnets," etc.)
- Classify materials according to whether they are or are not attracted by a magnet

Taking Care of the Earth

- Some materials can be recycled (for example, aluminum, glass, paper)

Science Biographies

- Wilbur and Orville Wright

Grade 1
Matter & Properties of Matter

- Names and common examples of three states of matter:
  solid (for example, wood, rocks)
  liquid (for example, water)
  gas (for example, air, steam)
- Units of measurement:

Length: centimeter, inch, foot
Volume: gallon, quart
- Temperature: degrees Fahrenheit

Grade 1, continued
Introduction to Electricity
- Basic parts of simple electric circuits (for example, batteries, wire, bulb or buzzer, switch)
- Conductive and nonconductive materials
- Safety rules for electricity

Science Biographies
- Thomas Edison (Grade 1)

Core Knowledge Science (Previously taught units)
Kindergarten
Taking Care of the Earth (Unit 5)
- Identify everyday objects that are made from natural resources
- Describe how humans use the earth's natural resources (K-ESS3-1)
- Identify common resources that are limited and nonrenewable
- Classify resources as renewable or nonrenewable
- Describe how humans have changed the environment around them in order to meet their needs (K-ESS3-2)
- Identify items that can be used over and over again
- Identify materials that can be recycled (2-PS1-1)
- Classify objects as recyclable or as garbage
- Develop solutions that can protect the earth's natural resources (K-ESS3-3)

Pushes, Pulls, and an Introduction to Magnets (Unit 6)
- Predict how pushes and pulls affect objects.
- Describe what happens when objects touch.
- Identify whether the force between two objects is a push or a pull.
- Describe the direction of a push or pull.
- Apply your knowledge of forces to balance a lever.
- Compare the strength of force applied to reach different distances.
- Describe the term 'motion.'
- Identify what causes a change in motion.
- Predict what will happen when two objects collide and push on each other.
- Describe different ways magnets are used in everyday life.
- Describe the term 'attract.'
- Classify materials according to whether they are or are not attracted by a magnet.
- Describe the term 'repel.'

- Apply your knowledge of forces and magnets to solve a problem.

Grade 1

Matter & Its Properties (Unit 5)

- Describe characteristics of matter
- Identify common features found among solids (2-ESS2-3)
- Describe characteristics of liquids (2-PS1-4 and 2-ESS2-3)
- Describe water vapor (2-PS1-4 and 2-ESS2-3)
- Develop a method by which we can classify matter (2-PS1-1)
- Classify different kinds of matter by their observable properties (2-PS1-1)
- Describe how physical properties of matter can be measured
- Measure objects using nonstandard units
- Determine when objects should be measured in inches or feet
- Compare the volume of pints, quarts, and gallons
- Describe how measuring the temperature helps us in our everyday lives

Introduction to Electricity (Unit 6)

- Describe how electricity impacts our everyday life
- Identify actions that keep us safe around electricity
- Compare and contrast open and closed circuits
- Classify objects as insulators or conductors
- Describe characteristics of materials that act as conductors and materials that act as insulators
- Describe how Thomas Edison's inventions are used today
- Identify problems that could be solved with new or improved tools
- Develop a tool (model or illustration) that can be used to solve an identified problem
- Describe how a tool can be used to solve an identified problem

Grade 2

Magnetism (Unit 4)

- [objectives TBD for this unit]

CKLA Grade 2 Objectives—Not Applicable

The Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history, does not include the study of tools or simple machines. In order to prepare students to meet or exceed the NGSS Grade 2 Topic Structure & Properties of Matter, this unit is critical to advance students' understanding of the physical sciences. To learn more about how and why the Listening & Learning Strand of CKLA approaches certain science content through read-alouds and ELA instruction, read more about the CKLA program.

What Students Will Learn in Future Grades

Future CK Science Units

- Grade 3 Unit 7 *Forces & Interactions*

- Grade 4 Unit 3 *Electricity*
- *Grade 4 Unit 7 Energy & Waves*

Core Knowledge Sequence

VII. Science Biographies (Grade 3)

- Biography of Alexander Graham Bell

III. Electricity (Grade 4), for example:

- Electric circuits, and experiments with simple circuits (battery, wire, light bulb, filament, switch, fuse)
- Closed circuit, open circuit, short circuit
- Conductors and insulators
- Electromagnets: how they work and common uses

IV. Energy, Heat, and Energy Transfer (Grade 6), for example:

- Forms of energy: mechanical, heat, electrical, wave, chemical, nuclear
- The many forms of energy are interchangeable, for example, gasoline in a car, windmills, hydroelectric plants.
- Sources of energy: for example, heat (coal, natural gas, solar, atomic, geothermal, and thermonuclear), mechanical motion (such as falling water, wind)

I. Physics (Grade 8)

A. Motion, for example:

- Velocity, speed, and average speed
- Familiar units for measuring speed: miles or kilometers per hour

B. Forces

- The concept of force: force as a push or pull on an object
- Examples of familiar forces (such as gravity, magnetic force)
- A force has both direction and magnitude
- Measuring force: expressed in units of mass, pounds in English system, newtons in metric system
- Unbalanced forces cause changes in velocity
- If an object is subject to two or more forces at once, the effect is the net effect of all forces
- The motion of an object does not change if all the forces on it are in balance, having net effect of zero
- The motion of an object changes in speed or direction if the forces on it are unbalanced, having net effect other than zero
- To achieve a given change in the motion of an object, the greater the mass of the object, the greater the force required

C. Density & Buoyancy, for example:

- When immersed in a fluid (i.e. liquid or gas), all objects experience a buoyant force

Commented [9]: Also consider how knowledge from this Tools & Simple Machines unit might be applied in future units re: more complex devices that help us (e.g., predict weather and/or G4 U6 Biography of Benjamin Banneker who, among his other notable achievements, invented his own wooden clock): https://www.loc.gov/item/today-in-history/november-09/

and

http://www.americaslibrary.gov/es/md/es_md_banneker_1.html

- Predict whether an object will float or sink

D. Work

- In physics, work is a relation between force and distance: work is done when force is exerted over a distance. [Also see ***E. Energy*** below]
- Equation: Work equals Force x Distance (W = F x D)
- Common units for measuring work: foot-pounds (in English system), joules (in metric system; 1 joule = 1 newton of force x 1 meter of distance)

E. Energy

- In physics, energy is defined as the ability to do work
- Energy as distinguished from work
- To have energy, a thing does not have to move
- Work is the transfer of energy
- Two main types of energy: kinetic and potential
  Some types of potential energy: gravitational, chemical, elastic, electromagnetic
  Some types of kinetic energy: moving objects, heat, sound and other waves
- Energy is conserved in a system

F. Power

- In physics, power is a relation between work and time: a measure of work done (or energy expended) and the time it takes to do it
- Equation: Power equals Work divided by Time (P = W/T), or Power = Energy/Time
- Common units of measuring power: foot-pounds per second, horsepower (in English system); watts, kilowatts (in metric system)

Core Vocabulary

*The following list contains the core vocabulary words suggested for purposeful integration across this Grade 2 unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Tools & Work	Simple Machines
force, *work, push, pull, press, touch, exert,* ***machine***, *tool,* ***effort***, *power, energy, load, problem, task, job, help, aid, easier, harder, hammer, screwdriver, plier, ax, [other examples*	*tool, device, machine,* ***instrument***, *equipment,* ***simple***, *single, individual,* ***complex***, ***series***, *combine, set, group,* ***system***, *inclined plane, ramp, slant, wedge, pry, rod, screw, spiral,* ***lever***, *fulcrum,*

Commented [10]: potential here for multiple meaning word work... going to work today, how does that work (that doesn't work), physicist's def'n of work, homework...

See the Visual Thesaurus for more ideas: http://www.visualthesaurus.com/app/view

Could also apply to POWER

*of common tools], **interaction**, weight, **cause**, **effect**, change, size, strength, strong, weak, more, less, direction, way, left, right, up, down, sideways, angle, **motion**, movement, slide, roll, move, fall, slip, at rest, motionless, still, unmoved, balance, (in)direct* **Elijah McCoy** *train, **locomotive**, engine, steam engine, **friction**, touch, press, slide, heat, smooth, slick, slippery, rough, coarse, limit, unwanted, damage, break, broken, **lubricant**, oil, **automatic**, engineer, inventor, design, invention, test, model, **criteria**, success, failure, error, data, **evidence***	*point, fixed, pivot, seesaw, load, lift, carry, **pulley**, rope, wheel, axle, **gear**, bicycle, pedal, chain, crank, chainwheel, frame, swivel, swing*

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "Forces only occur when motion is changed," or **"Only moving objects have forces acting on them."** Students of all ages can fail to recognize that objects at rest experience forces. Activities and discussions using a leveled balance or lever can help to demonstrate that forces exist when motion does not. **Misconception: "Objects in motion within a curved tube/path will continue to curve when the object exits the tube/path."** Students of all ages may believe that a track or path will influence an object's motion even after	**Key points for instruction:** Children need to develop the language tools to describe motion appropriately prior to developing an understanding of the principals of motion (Driver, Squires, Rushworth, and Wood-Robinson, 1994). It is highly recommended that teachers scaffold and promote vocabulary development during this unit, using strategies such as Word Walls (Keely, 2013). Common usage of the terms *material* and *stuff* may surface during discussions with students about matter and what things are made of. "Although the word *stuff* may not be accepted as a scientific word, it has tangible connotations for students and

the track ends (Mayer, 2007; McClosky, Caramaza, & Green,1980). When an object exits the curved path, the force exerted by the path is removed, so the object will actually continue in a *straight line*. To explore this concept with early elementary students, Page Keeley offers a formative assessment probe, the "Marble Roll," in her book *Uncovering Student Ideas in Primary Science* (page 71, 2013).

Misconception: "Friction occurs only when objects are moving passed or rubbing against each other."
Traditional instruction about friction often includes having students feel its effects when rubbing their hands together or observing objects slide down or passed one another. These are good starting points, but instruction should be purposefully extended to include discussions of objects that are at rest to avoid the misconception above. Objects that are at rest and stationary on a slide or ramp can prompt students to think about friction.

Misconception: "Friction only occurs between to two solids."
Air resistance (i.e., friction drag) is an interesting phenomenon to discuss and explore with students in order to reveal their ideas about friction, as well as their working concept of matter in general. Examples of gases and liquids that experience friction should be purposefully integrated into instruction so that this misconception is not reinforced by omission.

therefore is useful for developing the idea that there are different kinds of 'stuff' with different properties" (Keeley, 2013). Students may also use the term *material* to mean the component pieces of an object—for example, fabrics are made of smaller material (Driver, et. al., 1994).

Key points for instruction, continued:

Students may classify only things that they can feel (i.e., that have "felt weight") as being matter. Many students may believe that gases are not matter because they cannot feel their weight and/or describe and classify matter based upon the weight of the samples at hand.

Consider reading more about common misconceptions and key points for instruction offered by Ohio State University's College of Education and Human Ecology: Common Misconceptions about States and Changes of Matter. The OSU project, *Beyond Penguins and Polar Bears*, is an excellent resource for teachers to learn more about misconceptions and broader implications for learning about a variety of scientific topics.

Potential Objectives for this Grade 2 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed. The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Describe how tools can be used to make work easier
- Describe the jobs of common tools (e.g., a hammer, screwdriver, pliers)
- Organize materials based on their properties and uses
- Describe features of tools that help make work safer
- Describe how a tool's properties make it well suited for its intended use

Middle

- Describe force in scientific terms
- Identify examples of simple machines (e.g., levers, pulleys, inclined planes, screws, wedges, and wheels and axles)
- Describe how simple machines (e.g., lever, pulley, inclined plane, screw, wedge, wheel and axle) can be used to make work easier
- Classify simple machines by their observable properties
- Compare and contrast the effects of machines that reduce friction
- Describe how simple machines can combine to form more complex machines
- Describe how a machine created by Elijah McCoy reduced friction
- Describe how Elijah McCoy used his scientific knowledge to solve a problem
- Describe how engineers can design machines that can be used to solve problems

End

- Using your knowledge of simple machines, plan ways to make work easier for a specific task
- Design and use a simple machine to help make a task (work) easier
- Explain how a simple machine, or a machine made up of simple machines, can make work easier

Potential Big Guiding Questions

Essential Questions:

- **What are tools?**
- **What is the difference between a simple and a complex machine?**
- **What simple machines can I use to help me in everyday life?**

RE: Tools

- Who designs tools and why?
- How can a tool make the job of digging a hole easier?
- How can tools make the job of nailing or screwing something together safer?
- How do the characteristics of tools make them uniquely suited for the work they help to do?

RE: Simple Machines

Commented [13]: structure & function... see K-2 endpoint re: this concept: "For example, children explore how shape and stability are related for a variety of structures (e.g., a bridge's diagonal brace) or purposes (e.g., different animals get their food using different parts of their bodies). As children move through the elementary grades, they progress to understanding the relationships of structure and mechanical function (e.g., wheels and axles, gears)." (Framework, pg. 97)

- How do levers make work easier?
- How do pulleys change the direction of force?
- How do inclined planes make work easier?
- How can wedges be applied to accomplish a task?
- How do wheels and axles make work easier?
- What machine did Elijah McCoy invent, and what problem did it solve?
- How do engineers solve problems?

RE: A Design Challenge

- What problem am I trying to solve?
- What tools or machines would help solve this problem?
- Can tools or machines be combined to solve this problem? How so?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Example #1 (Middle of Unit 4)

{**Evaluates Student Mastery of Objectives:** Compare and contrast the effects of machines that reduce friction.}

Note: This is an informal assessment conducted by the teacher in a large group setting. This assessment assumes that students have been able to investigate the effects of using different materials to reduce friction while they accomplish a task. For example, observing the effects of using rollers, lubricants, or other materials while designing a

Advance Preparation:

- Chart paper and marker(s) to create a line graph
- Images of different methods of reducing friction (e.g., lubricants, rollers, etc.)

Assessment Task: After students have observed and experimented with different methods and machines for reducing friction, lead them through a discussion of their findings. On chart paper, create a comparative chart with a line graph labeled "Amount of Friction Reduced." Label one end of the spectrum "Most" and label the other end "Least." Show students image representations of the different ways to reduce friction discussed in this unit and ask them to assess how much the item aided in reducing friction. Ask a student to place the image on the line graph in the appropriate location (relative to their answer; i.e., if students agree that the object/substance reduced friction a great deal, direct the student to place the image closer to the "Most" section of the graph). After the first image, ask students where the next would fall relative to the one they just placed. Continue this line of questioning until all

images have been placed on the comparative graph. Have students discuss which methods or materials work best for reducing friction in different circumstances. You may wish to update the graph based on students' responses. Keep the graph posted for students to reference through the next several lessons.

Commented [20]: ...which will include the summary design challenge at the end of this unit and described as Example #2 below.

Example #2: (End of Unit 4)

{**Evaluates Student Mastery of Objectives:** Using your knowledge of simple machines, plan ways to make work easier for a specific task; Design and use a simple machine to help make a task (work) easier.}

Note: This assessment requires several days for design, execution/redesign, and debriefing.

Advance Preparation:

- Several of the following:
  - Small, heavy boxes
  - Objects to place in a hole
  - Balls (lightweight)
  - Boxes (lightweight)
- Create activity pages for the following steps:
  - Planning
  - Design (and redesign/revision)
  - Explanation
- For each student, supply a set of materials and/or images representing simple machines (i.e., for brainstorming their designs and helping them to prototype their solutions)
- Glue/tape/means of affixing materials together (optional)

Assessment Task: Students will work individually (but collaboration is welcome) on this performance assessment to design a machine to accomplish a task. Tell students they will be engineers for this activity. They will be presented with a problem and asked to design a machine to help them solve the problem. They will be asked to explain how their machine makes work easier. Remind students that they should be ready to describe how and provide evidence that their machines change the direction and/or amount of force being applied to accomplish the task.

Offer students one of the following scenarios (or give different groups each a different scenario) as the problem for which they will be asked to design a solution.

1. You need to move a heavy box from one end of the [student's] desk to another. What machine can you build to help make it easier to do so?
2. You need to place an object in a hole without touching it. What machine can you build to make it easier to do so?
3. You need to toss a ball across the room without touching it. What machine can you build to make it easier to do so?
4. You need to lift a heavy box from the floor onto your desk. What machine can you build to make it easier to do so?

Have student plan their designs. Ask students what they need to do (e.g., move the object

vertically/horizontally) and how that work can be made easier (e.g., using more or less force; changing the direction of force). Encourage them to identify each of the simple machines used from their sets of materials, and identify which would be helpful in moving their object as needed. [As a challenge, encourage students to think of ways to combine these simple machines in ways to move their objects with further ease. Allow students to experiment with their set of materials. Have tape or another way of affixing machines together available for students.]

After giving students time to experiment with the simple machines and think about how to potentially and/or combine them to make the task easier, have them draw the design they want to build using an activity page. As students are drawing, ask them to describe their designs. **T - How does this [some aspect of their design] help with the task?** Encourage students to apply their understanding of simple machines to help with the work they want to accomplish. **T - What other machines could you use to accomplish this same task?** (Student answers will vary.)

After students have finished designing their machines, have them build prototypes of their machines. Encourage students to test and allow students to modify their designs as they build. As students test and modify, check in with students. **T - So your lever works to lift the ball, but how are you going to make sure it goes into the hole? What can you do to modify your design to accomplish this task?** (apply a different force using another machine, etc.) **T - If you move the fulcrum closer to the ball, what happens? What happens when you move the fulcrum further from the ball?** (the distance changes regarding how high the ball is lifted and how far the force must be applied on the other end) **T - Can you think of any other ways to push or pull the ball into the hole?** (Encourage imaginative ideas, as long as they incorporate simple machines. e.g., A giant inclined plane could be used to roll the ball to the other side of the room.)

As students settle on a final design, set up groups of students who participated in the same design challenge and allow them to discuss each other's designs. If time allows, have them use their prototype designs to test how well each machine accomplishes the task. Ask students about the amount of force applied and changes in the direction, and encourage students to share what worked and what didn't in their design process.

Note: You may wish to have students travel to other groups' stations during the design process as well, to "assess" the designs according to predetermined criteria (e.g., moved the furthest, required least force, etc.). As a check for understanding, you could ask students which required the most force to be applied.

Once students have completed their projects and shared with the class, have them write a summary of their design process and what they learned along the way. Ask students to include their original designs, and "red line" any changes they made to it for the final version, so it is visible what changed. This will help guide them in writing about the changes the came up with along the way and why they were made. Have several students share and discuss their findings. Collect the summaries and students' final designs to serve as work products for the culminating assessment.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction where it would be delivered. Aligned NGSS are noted in parentheses.

Example #1: (Middle of Unit 4)

{**Evaluates Student Mastery of Objectives:** Describe how simple machines can be used to make work easier.}

Note: The procedures for this activity pertaining to levers can be applied to other simple machines, adjusting for each machine's specific characteristics and applications for engineering and aiding work.

Advance Preparation:

- Lever and fulcrum for each student or each table grouping
- Pebbles, small rocks, or other small objects
- Observations worksheet (You can combine the worksheets for each simple machine into a record book for students to reference later.)

Activity:

Tell students they will learn about and observe a simple machine that people have created to solve problems. Introduce one such problem by telling students about a person who wanted to build a wall out of heavy rocks. She needed to lift each of these rocks and stack them into a pile of rocks forming a wall. **T - What exactly is the problem in this scenario?** (The woman needs to lift several very heavy objects. They are too heavy for her to lift so she needs a tool to help her.) **T - What might you do in this situation?** (Answers will vary, but may include that students would use something or someone to help them.) Tell students that people invented a way of helping to complete tasks such as this using a lever.

Distribute small levers and fulcrums to each student (or each table grouping) to observe and manipulate as you explain how levers work. Tell students that a simple lever is designed to lift and maneuver objects. Demonstrate this and/or show students a video of levers in action. **T - How does the lever help with the problem of lifting the object?** (It makes it easier to apply some force to the tool and push it to move the object.) **T - Does this result in a change in effort or a change in direction of the force?** If students struggle with this concept, ask students to explain their reasoning. Remind students to be as specific as they can be about the relative amount of force and the direction it is being applied. Ask students if the object moved. Continue to guide them until they understand that levers such as this change the direction of force being applied (i.e., the woman pushes down on one side so that the other side lifts the heavy load). The same goal was achieved, just in a different direction, and the lever helped to lift the rock up.

Ask students to experiment with their lever and fulcrum to move small objects. Using an activity page, have students record what happens in different situations, such as with the fulcrum in the middle of the lever vs. further to one side or another. Debrief by having students share their findings with each other and as a whole group. **T - What did you notice regarding the amount of force required to move the object when the fulcrum is in the middle versus nearer to the placement of the object on the lever?** (Less force is required to move the object when the fulcrum is closer to it on the lever.) **T - How**

does it change when the fulcrum is further from the placement of the object on the lever? (More force is required.) **T - In which situation did you press on the lever over a longer distance?** (When the fulcrum is closest to the object on the lever.) **T - What does this tell you about how this simple machine helps to do work?** (Students answers will vary; the point here is to expose students to the idea that different amounts of force and distance can result in the same amount of work being done.) **T - How does the design of this simple machine help make the task we started with easier?** (Levers can help to change the direction of force; challenge-level expectation: levers can also help by changing the required distance over which the force is applied)

Example #2: (End of Unit 4)

{**Evaluates Student Mastery of Objectives:** Identify levers, pulleys, inclined planes, screws, wedges, and wheels and axles as simple machines}

Advance Preparation:

- Identify several simple machines in your classroom or school building
- Pen and activity pages to write down what students find
- Chart paper and marker to record students' recollections upon return

Activity:

As a review activity at the end of the unit, lead students on an exploratory walk through your classroom or the school building to find simple machines. Have students recall the six simple machines they learned about in this unit: levers, pulleys, inclined planes, screws, wedges, and wheels and axles. Tell students they use simple machines every day to help them accomplish different tasks more easily. Let students search for instances of simple machines in the classroom. Have students raise their hands when they have found one. Ask students some questions about the item. **T - Describe the item to me. What kind of simple machine is it?** (e.g., The blinds have a pulley on them.) **T - What problem does it help solve?** (It helps to pull the blinds up and down. Without the pulley, you would have to do it by hand.)

Continue until students have found a good number of items. Then return to a central location in the classroom and using chart paper, create a list of the items in their classroom that act as simple machines (that students found during their walk). **T - How do these items help us in everyday life?** Beside each item, record what kind of simple machine each was and how it helps to solve a problem. You may wish to add to the list from your own list prepared in advance.

Websites & Media

Museum of Science and Industry Chicago—Simple Machines Game:
https://www.msichicago.org/play/simplemachines/

This four-stage game challenges children to use digital representations of simple machines to accomplish tasks. Students select between different objects and different configurations to examine the effects of various amounts of force and distance. After accomplishing a task, the game also points out where these four simple machines might be found in the real world.

PBS Kids Design Studio—Design Challenges Using Simple Machines:
http://pbskids.org/designsquad/parentseducators/resources/index.html

Looking for more design projects that can be done in the classroom or at home? Check out this website for ideas and support. The PBS Design Studio also offers free lesson plans and instructional videos to help introduce and guide students through projects.

Smithsonian National Air and Space Museum—Air is Stuff:
http://howthingsfly.si.edu/gravity-air/air-stuff

Build your background knowledge by exploring this online resource from the National Air and Space Museum. With an accurate understanding of the atmosphere, air resistance, and drag, you will be able to effectively foreshadow future learning of friction and matter that comes in the later grades, such as in Grade 4 Unit 5 *Meteorology*.

Supplemental Trade Books

- *Experiments with Simple Machines (A True Book)* by Salvatore Tocci (Children's Press, 2003) ISBN 0516226045
- *How Do You Lift A Lion?* by Robert E. Wells (Albert Whitman & Company, 1996) ISBN: 0807534218
- *Levers (Early Bird Physics)* by Sally M. Walker and Roseann Feldmann (Lerner Publications, 2001) ISBN 0822522187
- *Levers (Understanding Simple Machines)* by Anne Welsbacher (Capstone Press, 2000) ISBN 0736806113
- *Machines We Use (It's Science!)* by Sally Hewitt (Children's Press, 1998) ISBN 0516263927
- *Pull, Lift, and Lower: A Book About Pulleys* (Amazing Science: Simple Machines) by Michael Dahl (Picture Window Books, 2006) ISBN: 1404819088
- *Science Experiments with Simple Machines* by Sally Nankivell-Aston and Dorothy Jackson (Children's Press, 2000) ISBN 0531154459
- *Simple Machines (Rookie Read-About Science)* by Allan Fowler (Children's Book Press, 2001) ISBN 0516273108
- Teacher Resource: *The Way Things Work Now* by David Macaulay (HMH Books for Young Readers, Rev. 2016) ISBN 0544824385

Recommended by the National Science Teachers Association

- *Michael's Racing Machine (I Wonder Why)* by Lawrence F. Lowery (NSTA Kids, 2014) ISBN 9781941316054
- Teacher Resource: *Energy—Stop Faking It! Finally Understanding Science So You Can Teach It* by William C. Robertson (NSTA Press, 2002) ISBN 9780873552141

Commented [26]: https://www.amazon.com/Lift-Lion-Wells-Knowledge-Science/dp/0807534218

Commented [27]: TH also notes that this series includes 4 other books on Inclined Planes and Wedges, Pulleys, Screws, and Wheels and Axles...

Commented [28]: TH also notes that this series has 5 other books on Inclined Planes, Pulleys, Screws, Wedges, and Wheels and Axles...

Commented [29]: https://www.amazon.com/Pull-Lift-Lower-Pulleys-Machines/dp/1404819088

Commented [30]: Also recommended by NSTA in "Teaching through Trade Books" column by Christine Anne Royce (Science & Children, Dec. 2011, pgs. 22–24)

Commented [31]: One chapter includes information on simple machines.

Core Knowledge Science Program—Domain Map

Science Content

• There are many different kinds of living things in any area, and they exist in different places on land and in water.
• Different plants survive better in different settings because they have varied needs for water, minerals, and sunlight.
• Review and application from Grade 1 Unit 4 *Living Things and Their Environments*
  ○ Living things live in environments to which they are particularly suited.
  ○ Specific habitats and what lives there, for example:
  ■ Forest [oak trees, squirrels, raccoons, snails, mice]
  ■ Meadow and prairie [wildflowers, grasses, prairie dogs]
  ■ Underground [fungi, moles, worms]
  ■ Desert [cactus, lizard, scorpion]
  ■ Water [fish, oysters, starfish]
  ○ Food chains and food webs: a way of picturing the relationships between living things
  ■ Animals: big animals eat little ones, big animals die and are eaten by little ones.
  ■ Plants: nutrients, water, soil, air, sunlight

This unit contributes to meeting or exceeding the following Next Generation Science Standards:	
Grade 2 Topic Interdependent Relationships in Ecosystems**, for example:* ***2-LS4-1.** Make observations of plants and animals to **compare the diversity of life in different habitats.	***Rationale:*** This unit will provide students with the opportunity to strengthen their understanding of the core ideas LS4.D (Biodiversity) and LS2.A (Interdependent Relationships in Ecosystems). It will also provide an opportunity for students to extend their understanding of habitats (started in Grade 1 Unit 4) and dive deeper into ways that scientists map and model the relationships between organisms, for example using food webs.

This unit offers the opportunity to foreshadow learning that will support the following Next Generation Science Standards:	
Grade 3 Topic Interdependent Relationships in Ecosystems: Environmental Impacts on Organisms**, for example:* ***3-LS4-1.** Analyze and interpret data from fossils to **provide evidence of the	

organisms and the environments in which they lived long ago.	

Potential Skills & Cross-Curricular Integrations

The connections listed below are intended as ideas for possible integration across this unit. Finding connections in math, in language arts, and in works of poetry, art, and music, may help you as you create meaningful learning experiences for your students. Connections such as these can help your students make links between various disciplines and deepen their understanding of this domain.

POTENTIAL CCSS Math Connections

MP.2 Reason abstractly and quantitatively. *(2-LS4-1)*

MP.4 Model with mathematics. *(2-LS4-1)*

MP.5 Use appropriate tools strategically. *(2-ESS2-1)*

2.NBT.A Understand place value. *(2-ESS1-1)*

2.MD.B.5 Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units, e.g., by using drawings (such as drawings of rulers) and equations with a symbol for the unknown number to represent the problem. *(2-ESS2-1)*

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. *(2-LS4-1)*

POTENTIAL CCSS ELA Connections

RI.2.1 Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text. *(2-ESS1-1)*

RI.2.3 Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text. *(2-ESS1-1 and 2-ESS2-1)*

RI.2.9 Compare and contrast the most important points presented by two texts on the same topic. *(2-ESS2-1)*

W.2.6 With guidance and support from adults, use a variety of digital tools to produce and publish writing, including in collaboration with peers. *(2-ESS1-1)*

W.2.7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). *(2-ESS1-1 and 2-LS4-1)*

W.2.8 Recall information from experiences or gather information from provided sources to answer a question. *(2- ESS1-1 and 2-LS4-1)*

SL.2.2 Recount or describe key ideas or details from a text read aloud or information presented orally

or through other media. *(2-ESS1-1)*

POTENTIAL Cross-Curricular Connections

Prior Knowledge

Core Knowledge Sequence

I. Living Things and Their Environments

A. HABITATS

- Living things live in environments to which they are particularly suited. • Specific habitats and what lives there, for example:
  - Forest [oak trees, squirrels, raccoons, snails, mice]
  - Meadow and prairie [wildflowers, grasses, prairie dogs] Underground [fungi, moles, worms]
  - Desert [cactus, lizard, scorpion]
  - Water [fish, oysters, starfish]
- The food chain or food web: a way of picturing the relationships between living thing
  - Animals: big animals eat little ones, big animals die and are eaten by little ones.
  - Plants: nutrients, water, soil, air, sunlight

B. OCEANS AND UNDERSEA LIFE

- Most of the earth is covered with water.
- Locate oceans: Pacific, Atlantic, Indian, Arctic.
- Oceans are salt water (unlike fresh water rivers and lakes).
- Coast, shore, waves, tides (high and low)
- Currents, the Gulf Stream
- Landscape of the ocean floor: mountain peaks and deep valleys (trenches)
- Diversity of ocean life: from organisms too small for the eye to see (plankton), to giant whales
- Dangers to ocean life (for example, overfishing, pollution, oil spills)

C. ENVIRONMENTAL CHANGE AND HABITAT DESTRUCTION

- Environments are constantly changing, and this can sometimes pose dangers to specific habitats, for example:
  - Effects of population and development
  - Rainforest clearing, pollution, litter

VII. The Earth

A. GEOGRAPHICAL FEATURES OF THE EARTH'S SURFACE

- The shape of the earth, the horizon
- Oceans and continents
- North Pole and South Pole, Equator

B. WHAT'S INSIDE THE EARTH

- Inside the earth

    - Layers: crust, mantle, core
    - High temperatures
- Volcanoes and geysers
- Rocks and minerals
    - Formation and characteristics of different kinds of rocks: metamorphic, igneous, sedimentary
    - Important minerals in the earth (such as quartz, gold, sulfur, coal, diamond, iron ore)

Core Knowledge Language Arts (CKLA)
Domain Anthology, *The History of the Earth*

- Identify geographical features of the earth's surface: oceans and continents
- Locate the North Pole, the South Pole, and the equator on a globe
- Describe the shape of the earth
- Explain that much of our knowledge of the earth and its history is the result of the work of many scientists
- Identify the layers of the earth: crust, mantle, and core (outer and inner)
- Describe the crust
- Describe the mantle and core inside the earth
- Describe volcanoes and geysers
- Describe how heat, pressure, and time cause many changes inside the earth
- Identify common minerals in the earth
- Explain how minerals are used by people
- Identify the three types of rocks: igneous, sedimentary, and metamorphic
- Describe how heat, pressure, and time cause the formation of igneous, sedimentary, and metamorphic rocks
- Describe fossils
- Explain how fossils provide information about the history of the earth
- Explain how we know about dinosaurs
- Describe various dinosaurs

Core Knowledge Science (Previously taught Kindergarten units)

CKLA Grade 2 Objectives

The following objectives are addressed through the Core Knowledge Language Arts program (CKLA), which builds students' background knowledge in certain domains of literature, science, and history. To learn more about how and why the Listening & Learning Strand of CKLA approaches science content through read-alouds and ELA instruction, read more about the CKLA program.

N/A

What Students Will Learn in Future Grades

Core Knowledge Sequence

Grade 4 Geology: The Earth and Its Changes

Earth's Layers
- Crust, mantle, core (outer core and inner core)
- Movement of crustal plates
- Earthquakes:
  Faults, San Andreas fault
  Measuring intensity: seismograph and Richter scale
  Tsunamis
- Volcanoes:
  Magma
  Lava and lava flow
  Active, dormant, or extinct
  Famous volcanoes: Vesuvius, Krakatoa, Mount St. Helens
- Hot springs and geysers: Old Faithful (in Yellowstone National Park)
- Theories of how the continents and oceans were formed: Pangaea and continental drift

How Mountains are Formed
- Volcanic mountains, folded mountains, fault-block mountains, dome-shaped mountains
- Undersea mountain peaks and trenches (Mariana Trench)
- Major mountain ranges on different continents:
  South America: Andes
  North America: Rockies and Appalachians
  Asia: Himalayas and Urals
  Africa: Atlas Mountains
  Europe: Alps
- High mountains of the world:
  Asia: Everest
  North America: McKinley
  South America: Aconcagua
  Europe: Mont Blanc
  Africa: Kilimanjaro

Rocks
- Formation and characteristics of metamorphic, igneous, and sedimentary rocks

Weathering and Erosion
- Physical and chemical weathering
- Weathering and erosion by water, wind, and glaciers
- The formation of soil: topsoil, subsoil, bedrock

Core Vocabulary

The following list contains the core vocabulary words suggested for purposeful integration across this

*Grade 2 unit. **Boldfaced** terms could be introduced and/or reviewed with students using a Word Work activity, as modeled by the Core Knowledge Language Arts program (CKLA). The inclusion of the words on this list does not mean that students are immediately expected to be able to use all of these words on their own. However, through repeated exposure across the lessons, students should acquire a good understanding of most of these words and begin to use some in conversation.*

Subtopic	Subtopic

Potential Misconceptions

Students have been shown to learn significantly more science when their teachers demonstrate strong knowledge of potential student errors, and when the teacher plans accordingly (Sadler & Sonnert, 2016). The following incorrect statements serve as a sampling of the "intuitive theories" or "alternative conceptions" that students and teachers may actively use to describe their thinking, and which might interfere with the process of learning. The details following each statement are not intended to imply the scope of instruction for this grade, but instead provide a clearer sense of what students (of all ages) often misunderstand and/or overgeneralize when investigating and describing scientific ideas.

Misconception: "	Key points for instruction:

Potential Objectives for this Grade 2 Unit

The organization of the following objectives reflects the order in which they are expected to be addressed.The proposed timing within the unit ("beginning," "middle," or "end") and aligned NGSS are also noted. In addition to daily lessons focused on each objective, days have been built into the unit for review and assessment.

Beginning

- Identify Earth events that occur quickly
- Identify Earth events that occur slowly
- Provide evidence demonstrating quick and slow Earth events
- Explain that Earth events can occur quickly or slowly

Middle

- Identify how wind can affect the shape of land over time
- Identify how water can affect the shape of land over time
- Explain how wind and water can affect the shape of land over time

End

- Design a solution for slowing or preventing wind/water from changing the shape of land

Potential Big Guiding Questions

Essential Questions:

- **How does Earth change over time?**
- **What factors affect how Earth changes over time?**
- **How can we prevent affects to the shape of land?**

RE: Earth events

- What Earth events occur quickly? Slowly?
- How do we know an Earth event is happening or has happened?

RE: Shape of Land

- How does wind affect the land?
- How does water affect the land?
- Why would we want to prevent wind or water from affecting the shape of the land?

Potential Assessment Opportunities

The following assessment tasks serve as a sampling of how students can demonstrate mastery of lesson objectives. Each aligned objective and NGSS is noted in parentheses. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point in time the assessment would take place.

Potential Activities & Procedures

The following activities or procedures serve as a sampling of what instruction could look like in this unit. Each example was specifically designed to contribute to one or more of the aforementioned objectives. In addition, the proposed timing ("beginning," "middle," or "end") is noted in order to indicate the approximate point of instruction where it would be delivered. Aligned NGSS are noted in parentheses.

Websites & Media

Supplemental Trade Books

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