

# Chemistry: Phase Changes: Heat and Matter

Grade Level: 5

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Length of Unit: Seven lessons

## I. ABSTRACT

Roll up your sleeves and enjoy this arts integrated science unit that will take you through many changes! Activities in this unit will incorporate the arts with the natural science of chemistry. Students will create, conduct, hypothesize, experiment, test, design, shake, pop, measure, heat, write, eat, and so much more!

This unit focuses on how heat energy can cause matter to change phases by adding or removing energy. Students will develop an understanding of the three stages of matter, transferring heat energy, and the difference between heat and temperature.

## II. OVERVIEW

### A. Concept Objectives:

1. To understand that matter can be made to change phases by adding or removing energy.
2. To understand the difference between heat and temperature
3. To demonstrate an understanding of how heat is transferred through conduction, convection, and radiation.

### B. Core Knowledge Content

1. Natural Sciences
  - a. Heat and Matter
  - b. Expansion and Contraction
  - c. Measuring Heat and Temperature
  - d. Transferring Heat Energy (Conduction, convection, and radiation)

### C. Skills to be taught

1. Describe observations and data through spoken and written words, graphs, drawings, and diagrams.
2. Make inferences to form conclusions from observations.
3. Make reasonable interpretations from given or collected data.
4. Define operations by stating definitions in working terms.
5. Conduct experiments that test a hypothesis under controlled conditions.
6. Based on observations and/or data sets, formulate hypotheses that are testable.
7. Differentiate among different sources of energy one of which is heat energy.
8. Compare and contrast information on the same topic from different resources.

## III. BACKGROUND KNOWLEDGE

### A. References

1. Janice VanCleave's *Chemistry for Every Kid*.
2. *What Your 5th Grader Needs to Know*
3. *Eyewitness Science: Chemistry*

### B. Prior Knowledge

1. Review 4th grade topic on Elements

#### IV. RESOURCES

1. *Scholastic Science: How Matter Changes*
2. *What Your 5th Grader Needs To Know*
3. *Eyewitness Science: Matter*
4. *Eyewitness Science: Chemistry*

#### V. LESSONS

##### Lesson One: Natural Sciences - Chemistry

- A. Objective - The learner will develop an awareness of the science of chemistry
  1. Lesson Content:
    - a. A look at chemistry - what is it?
  2. Concept Objective:
    - a. Develop an awareness of the science of chemistry.
  3. Skill Objective
    - a. Make a list of key ideas learned about chemistry
- B. Materials
  1. *Eyewitness Science Chemistry* book
  2. Chart paper, markers, tape, transparencies, overhead projector
- C. Key Vocabulary:
  1. Chemistry
  2. Chemist
  3. Alchemist
  4. Distillation
- D. Procedure/Activities:
  1. Introduce the word chemistry to the class. Make a list of students' ideas about chemistry. Record their comments on chart paper or transparency. Also, have students think of questions they would like to have answered about chemistry. Make a list of these questions on chart paper or a transparency. Tell students to listen for answers to questions as you proceed to Activity 2.
  2. Distribute the *Eyewitness Science: Chemistry* chart to each student to make notations on as you read from it on the following topics:
    - (a) What is chemistry?
    - (b) Chemistry in nature
    - (c) Chemistry in ancient worlds
    - (d) the first chemist
  3. After reading and discussing each topic with students, check the list of questions generated by the students to see if any of their questions were answered. For any unanswered questions at the end of today's lesson, assign a small group of students to conduct further research to come up with possible answers to the questions.
  4. Evaluation/Assessment
    - a. Students will use their notes from Activity 2 to summarize the main points of today's topics on Chemistry. Summary should include points on chemistry in nature,

- chemistry in ancient worlds, the first chemist, and evidence that they understand the nature to the science of chemistry.
5. Standardized Test/State Test Connections: Summarizing main idea

### **Lesson Two and Three - Heat and Matter Vocabulary Research**

- A. The learner will research the meaning of vocabulary terms related to the subject
  1. Lesson Content:
    - a. Phase Changes: Heat and Matter
  2. Concept Objective:
    - a. Understand the meaning of selected vocabulary terms related to the unit of study
  3. Skill Objective:
    - a. Define operations by stating definitions in working terms.
- B. Materials:
  - a. Vocabulary spreadsheet (Appendix A)
  - b. *What Your 5th Grader Needs to Know*
  - c. *Eyewitness Science Chemistry*
  - d. Science-related reference books
  - e. Internet connection (only if available in your school/class)
- C. Key Vocabulary
  1. See Heat and Matter Vocabulary Search spreadsheet (Appendix A)
- D. Procedures/Activities:
  1. Review the main ideas of each topic from lesson one.
  2. Invite student volunteers to read their summaries for each topic discussed in Lesson One.
  3. Introduce new words from the Vocabulary Search spreadsheet. Allow students the opportunity to state what they think the selected words mean.
  4. Distribute a copy of the *Heat and Matter Vocabulary Search* spreadsheet to each student. Inform students that this activity will involve research scientific references to find out what the selected 12.5 words mean in the context of science. Students will use at least 2 or more sources to locate the definitions of the selected words to compare and contrast. Each student will record the definition and the sources used to gather the information.
  5. At the end of Lesson 3, have students share orally some of the definitions they have found and name some of the sources of information they have used to collect their data.
  6. After students have completed a hand-written hard copy of the *Heat and Matter Vocabulary Search*, they will set up their own spreadsheet or database to present the information for teacher review and evaluation.
- E. Evaluation/Assessment
  1. Check to see students' progress at the end of Lesson 2 and Lesson 3 and allow for additional time as needed.
- F. Standardized Test/State Test Connections:
  1. Identifying word meaning/building vocabulary

### **Lesson Four - Phase Changes - Words in Action!**

- A. Objectives:
  1. Lesson Content:

- a. Phase Changes: Heat and Matter
  2. Concept Objective:
    - a. Understand that matter can be made to change phases by adding or removing energy
    - b. Understand that heat is a form of energy
  3. Skill Objective:
    - a. Summarize what happens to matter when energy is added or removed.
    - b. Make inferences to form conclusions from observations.
    - c. Based on observations, formulate hypotheses that are testable.
- B. Materials:
1. Heat and Matter Vocabulary Search Spreadsheet
  2. Ice cubes
  3. pot
  4. Hot Plate
  5. Thermometer
  6. Two clear plastic cups
  7. Water
  8. salt
  9. Refrigerator with freezer
  10. Measuring cup
  11. Tablespoon
  12. Permanent marker
  13. Notebook paper
  14. Pen
  15. Clock or watch
  16. Oven mittens
  17. Art Paper
  18. Art Supplies (markers, crayons, paints, etc.)
  19. Milk, cream, or Half & Half
  20. Vanilla extract or Chocolate syrup
  21. Sugar
  22. Ice
  23. Salt
  24. Zip lock baggies (Large and small sizes)
  25. Newspaper
- C. Key Vocabulary
1. Heat
  2. Matter
  3. Solids
  4. Liquids
  5. Gases
  6. Melting Point
  7. Freezing Point
  8. Boiling Point
  9. Joules
  10. Molecules
- D. Procedure/Activities:

1. Before conducting the activity from *Adventures with Atoms and Molecules*, pose the following questions to the class:
    - (1). What are the three phases of matter? State an example of each phase.
    - (2). What causes matter to change phases?
  2. Demonstrate to the class what happens when an ice cube in a pan is placed on a heat source. Explain the phase changes as the ice goes from ice (solid) to liquid (water), to gas (steam). Also explain to students that when the water is boiling and producing steam (gas), the water is at its boiling point. The point at which the ice turns into a liquid is the melting point and the point at which the liquid turns into a solid.
  3. Have students illustrate the process of the phase change of the ice cubes and write an explanation of what is happening at each phase change.
  4. As students are working on their assignment for activity 3, begin preparation for the extension exploration found on page 11 of *Adventures with Atoms and Molecules*. This activity challenges students to investigate if solid ice can absorb more heat than liquid salt water. (This investigation is also in *Scholastic: How Matter Changes*).
  5. Write the following question on the board: Which do you think will absorb more heat, solid ice or liquid salt water? Explain your answer.
  6. After students have had enough time to explore the question, call on volunteers to share their responses.
  7. Conduct the experiment as outlined on page 11 of *Adventures with Atoms and Molecules*. (The procedure for conducting this activity has been rewritten and included in Appendix B).
  8. Appoint students to be responsible for recording the data and reporting back to the class during the next class session.
  9. Make ice cream! Students and teacher will read and follow the directions for making ice cream to demonstrate that salt lowers the freezing point of water. State other examples of using salt to lower the freezing point of water.
  10. While the students are eating their ice cream, have them write an explanation of phase changes and the source of energy. Students will also illustrate the process of making ice cream, beginning with illustrating the materials needed and each step followed in this activity.
- E. Evaluation/Assessment
1. Evaluate students' illustrations and writings from Activity 4 for accuracy of information and process.
  2. Comprehension questions (Appendix C)
- F. Standardized Test/State Test Connections:
1. Comprehension and following written directions
  2. Sequencing information/retelling

**Lesson Five - Words in Action!**

1. Lesson Content:
  - a. Phase Changes: Heat and Matter
  - b. Expansion and Contraction
2. Concept Objectives:
  - a. Understand that matter can be made to change phases by adding or removing energy

- b. Understand that heat can cause matter to expand or contract
- 3. Skill Objective:
  - a. Describe observations and data through spoken and written words and drawings.
  - b. Conduct experiments that test a hypothesis under controlled conditions.
  - c. Make measurement of mass
- B. Materials
  - 1. *Heat and Matter Vocabulary Search* spreadsheet
  - 2. Unpopped bag of microwave popcorn
  - 3. microwave (If microwave not available, use a hot plate and Jiffy Pop popcorn)
  - 4. Scales
  - 5. 2 cups
  - 6. Water
  - 7. Ice
  - 8. *What Your 5th Grader Needs To Know*
- C. Key Vocabulary
  - 1. Expansion
  - 2. Contraction
  - 3. Calorie
- D. Procedures/Activities:
  - 1. Review and discuss Lesson 4 paying particular attention to the Key Vocabulary and Concept Objectives.
  - 2. Review the investigation question from Lesson 4 (See Activity 5). Ask children if they want to change their original hypothesis before the Research Team shares the results of their investigation.
  - 3. Research Team presents findings to the class
  - 4. Inform students that they will continue to explore the chemistry of heat and matter by learning about Expansion and Contraction. Ask the following questions to stimulate thinking and discussion:
    - (1) What are the meaning of the terms expansion and contraction?
    - (2) Explain how heat causes matter to expand and what happens when the matter begins to lose heat.
  - 5. Have students to work in teams to write their explanation to question two above. Students will refer to their explanation as the class participates in the following activities:
  - 6. Show the students an unpopped bag of microwave popcorn. Have them write down all the characteristics of the bag. Make a list of the characteristics. Next ask students to work with their Research Teammates to explain in sequential order what happens when you place the unpopped bag of microwave popcorn in the microwave oven.
  - 7. Weigh the unpopped bag popcorn before placing in the microwave oven. Have the students record the weight of the popcorn.
  - 8. Ask students to hypothesize what will happen to the weight of the popcorn and explain why. Students are to record their hypotheses in their Science Journals.

9. Take the popcorn out of the microwave oven. Weigh the popcorn. Have students record the weight and to write their observations of the popped popcorn.
  10. After about 5 minutes of allowing students to share their observations, hold up the cooled bag of microwave popcorn. Ask students to list any differences they observe. Weigh the popcorn. Have students to record the weight of the cooled bag of popcorn.
  11. Ask students to explain what just happened and tell why.
  12. Read pages 367-368 of *What Your 5th Grader Needs to Know* to further explain the concepts of Expansion and Contraction.
  13. Direct students to think of other examples of matter that expands when it is heated and contracts or takes up less space when cooled.
  14. As students are working, pop more popcorn for them to enjoy!
- E. Evaluation/Assessment
1. Evaluate students' list of examples from Activity 13 to determine whether or not they understand the concept of expansion and contraction.
- F. Standardized Test/State Test Connections:
1. Reading comprehension - Sequencing information

### **Lesson Six and Seven: Transferring Heat Energy**

1. Lesson Content
    - a. Transferring Heat Energy: Conduction, Convection, and Radiation
  2. Concept Objective:
    - a. Understand the meaning of conduction, convection, and radiation
    - b. Understand that heat travels from one place or object to another in three ways.
  3. Skill Objective:
    - a. Describe observations and data through spoken and written words and drawings.
    - b. Make inferences to form conclusions from observations.
    - c. Define operations by stating definitions in working terms.
    - d. Based on observations, formulate hypotheses that are testable.
- B. Materials
1. Hot Plate
  2. Pyrex skillet (see-through pan)
  3. Thermometer
  4. Plastic Spoons, Metal Spoons, Wooden Spoons
  5. Thermos
  6. Straws
  7. Food Coloring
  8. Scissors
  9. Construction Paper
  10. Thread/String
  11. Masking tape
  12. *More Science In Action: The Marshall Cavendish Guide to Projects and Experiments*
  13. *What Your 5th Grader Needs To Know*
- C. Key Vocabulary
1. Convection

2. Conduction
  3. Radiation
- D. Procedures/Activities:
1. Pose the following (or similar) questions to the class after you have placed a plastic, wooden, and metal utensil in a cup of very hot water:
    - (a) What do you think will happen to each utensil in the cups of hot water?
    - (b) If you think the water will heat the utensils, explain why you think that and tell which utensil will get the hottest.
    - (c) Will each part of the utensil in the hot water feel the same? Will one part of the utensil feel hotter than the other part? Explain why.
    - (d) Which science vocabulary word explains what is happening in this process?
  2. Test students' hypotheses. Allow volunteers to come up and feel each utensil and report to the class their observations through touch.
  3. Ask volunteers to read their definitions of convection. Ask students where convection occurs.
  4. Demonstrate for students how conduction and convection can take place at the same time. Heat a pot of water on a hot plate. Ask volunteers to tell what is acting as the conductor of heat and to tell how convection is occurring in the pot of water as it is heating.
  5. To further demonstrate this process, follow the activity as outline in *What Your 5th Grader Needs to Know*, that uses a straw, food coloring, hot plate, and glass beaker. This activity demonstrates again how convection takes place in liquids.
  6. Refer to *More Science In Action The Marshall Cavendish Guide to Projects and Experiments-Forces Of Nature* page 17 for an activity on convection. Follow this activity as directed with the children. Have students to record in their Science Journals what is happening to make the twirler turn. Hang the twirlers in different parts of the classroom (some over the heat source and some away from the heat source). Ask students to record any and all observations.
  7. Pour a cup of liquid from a thermos bottle that has been in the thermos for several hours.
  8. Ask students to observe the liquid and determine if they see steam (gas) coming from the liquid. If so, ask students what does the presence of steam indicate (the liquid is still very hot).
  9. Ask volunteers to hypothesize why they think the liquid is still hot.
  10. After the discussion, disassemble a thermos so that students can see the inside of the thermos. Explain to students that the heat transference process of radiation is what keeps the liquid hot. Explain that a thermos is also designed to keep liquids cold as well.
  11. Read the section on "Transferring Heat Energy" in the 5th grade Core Knowledge book.
  12. Direct students to work in small groups of no more than three students to come up with a poem, rap, or song to a nursery rhyme tune that will help

them and their classmates remember the most important details about conduction, convection, and radiation.

13. Record in Science Journal the main idea of each day's lesson. Students may use illustrations in their summary if necessary.

D. Evaluation/Assessment:

1. Students refer to QAR (question, answer, relationship, Appendix D) method to develop and write four questions for their classmates to answer about convection, conduction, and radiation.
2. Cooperative groups will share their poem, rap, or song that demonstrates their understanding of transferring heat.

E. Standardized Test/State Test Connections:

1. Make inferences to form conclusion
2. Construct meaning from informational text.

#### IV. CULMINATING ACTIVITY

To culminate this unit of study, begin by having students share orally some of the entries in their Science Journals as a means of review. Clear up any questions or misconceptions students may have. Review the text from the Core Knowledge manual after students have shared. During this time, students can share their poems, skits, songs, raps, and artwork they have constructed to demonstrate their understanding of heat and matter.

Finally, to evaluate students' mastery of the content of the unit, direct students to complete the unit test (Appendix E). Students may use their notes, textbooks, and any other reference material in the classroom.

#### VII. HANDOUTS/WORKSHEETS

1. Appendix A: Heat and Matter Vocabulary Spreadsheet
2. Appendix B: Can Solid Ice Absorb More Heat than Liquid Salt Water
3. Appendix C: Comprehension test questions on Phases Changes
4. Appendix D: Question-Answer Relationship
5. Appendix E: Unit Test
6. Appendix F: Let's Make Ice Cream!

#### VIII. BIBLIOGRAPHY

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