

Seeing is (Sometimes) Believing

Grade Level or Special Area: 3rd Grade

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Length of Unit: Seven lessons and a Culminating Activity (approximately eight days, one day=one hour)

I. ABSTRACT

This unit focuses on vision and light as described in the *Core Knowledge Sequence*. This unit examines the parts of the eye and how they work. It uses a hands-on, discovery approach to learning the facts and concepts surrounding light. Students will be engaged in daily experiments while they discover how light works and changes.

II. OVERVIEW

- A. Concept Objectives
 - 1. Students will understand the workings of the human eye.
 - 2. Students will understand how light can be changed and manipulated for a variety of purposes.
- B. Content from the *Core Knowledge Sequence*
 - 1. Parts of the eye: cornea, iris and pupil, lens and retina (p. 82)
 - 2. Optic nerve (p. 82)
 - 3. Farsighted and nearsighted (p. 82)
 - 4. The speed of light: light travels at an amazingly high speed (p. 82)
 - 5. Light travels in straight lines (as can be demonstrated by forming shadows) (p. 82)
 - 6. Transparent and opaque objects (p. 82)
 - 7. Reflection (p. 82)
 - a. Mirrors: plane, concave, convex
 - b. Uses of mirrors in telescopes and microscopes
 - 8. The spectrum: use a prism to demonstrate that white light is made up of a spectrum of colors (p. 82)
 - 9. Lenses can be used for magnifying and bending light (as is magnifying glass, microscope, camera, telescope, binoculars) (p. 82)
- C. Skill Objectives
 - 1. Students will seek answers by making careful observations and trying things out. (Jefferson County Science Standards 2.1B)
 - 2. Students will follow written directions. (Jefferson County Science Standards 2.1D)
 - 3. Students will use charts with appropriate labels to record and organize data. (Jefferson County Science Standards 2.1F)
 - 4. Students will experience why it can be helpful to work with a team to complete a task. (Jefferson County Science Standards 2.1J)
 - 5. Student will explain procedures or ideas in a variety of ways, such as sketching, labeling and writing. (Jefferson County Science Standards 2.2A)
 - 6. Students will use tools to observe things. (Jefferson County Science Standards 3.1B)
 - 7. Students will identify and describe technology used in everyday life. (Jefferson County Science Standards 3.2C)
 - 8. Students will describe simple needs, parts and functions of the human body. (Jefferson County Science Standards 5.3A)

9. Students will identify, create and separate mixtures based on characteristics such as color. (Jefferson County Science Standards 6.1D)
10. Students will conduct a variety of experiments.

III. BACKGROUND KNOWLEDGE

- A. For Teachers
 1. *All About Light* by Melvin Berger
 2. *A New True Book: Experiments with Light* by Ray Broekel
 3. *Sound and Light* by David Glover
- B. For Students
 1. The five senses and associated body parts: Sight: eyes

IV. RESOURCES

- A. *Making Science Work: Light* by Terry Jennings (Lesson Seven)
- B. *Lenses! Take a Closer Look* by Siegfried Aust (Lesson Seven)

V. LESSONS

Lesson One: I Can See Clearly Now, My Eyes Work Well (one hour)

- A. *Daily Objectives*
 1. Concept Objective
 - a. Students will understand the workings of the human eye.
 2. Lesson Content
 - a. Parts of the eye: cornea, iris and pupil, lens, retina
 - b. Optic nerve
 3. Skill Objective
 - a. Students will describe the simple needs, parts and functions of the human body (the eye).
- B. *Materials*
 1. Appendix A: The Eye: Working Hard (one overhead and one copy for each student)
 2. Appendix B: Light and Vision Review (one copy for the teacher)
 3. Two pictures that are large enough for the class to see clearly while you hold them up
- C. *Key Vocabulary*
 1. Cornea-the clear, protective covering over the eye
 2. Pupil-the dark colored opening of the eye
 3. Iris-the colored part of the eye which surrounds the pupil
 4. Lens-the transparent part of the eye which focuses light rays that enter the eye
 5. Retina-the lining on the back of the eyeball which receive the light
 6. Optic nerve-the nerve which carries messages from the eye to the brain
- D. *Procedures/Activities*
 1. Have the class look at a picture you are holding for 15 seconds.
 2. Turn the picture around.
 3. Ask them to describe as many details about the picture as they can remember.
 4. Have them close their eyes and look at another picture you are holding.
 5. Turn the picture around and ask them to describe the details of this picture.
 6. Ask them why they can't give details about the second picture.
 7. If their only answer involves the fact that their eyes were closed, tell them another reason they could not see is because no light was entering their eye. In order to see, there must be light.

8. Ask the class to name any parts of the eye that they know. Write those words on the board. Ask the class if they know what job the parts of the eye listed on the board perform. Write any answers they give next to the part of the eye that performs that job.
 9. Tell the class to close their eyes and picture an object in their mind. Now tell them that they will imagine that they are a beam of light bouncing off that object and traveling through the eye. “Your journey into the eye begins at the eyelid and eyelashes. The eyelid and eyelashes help to keep things out of the eye by blinking. Since you are a beam of light and not a dangerous object, the eyelid opens wide to let you into the eye. The next stop is the cornea. The cornea is the security system of the eye. The cornea is a clear protective shield, which prevents dust and other harmful things from entering the eye. Since you are beams of light, you will pass right through the cornea’s security system. The doorway into the eye is the pupil. It is the opening into the depths of the eye. To get in through the pupil, the iris, or colored part of your eye will determine how big the pupil needs to be to let you in. If you are a bright beam of light, the pupil will become very small before you enter. If you are a dim beam of light, the pupil will become much larger so you can enter. Next, you must pass through the lens, which will focus you and flip you upside down. You will then appear on the retina, the colorful lining on the back of the eye. Picture your object, upside down, on the retina at the back of the eye. The image you make will be sent to the brain along the optic nerve. The brain will flip the image right side up again. Voila, there you are, just as you started out.”
 10. Put up the overhead of Appendix A: The Eye: Working Hard.
 11. Work with the class to label each part of the eye.
 12. Pass out student copies of Appendix A: The Eye: Working Hard. Have students label each part of the eye on their own.
- E. *Assessment/Evaluation*
1. Evaluate each student’s copy of Appendix A: The Eye Working Hard for accuracy.
 2. Ask questions 1-7 from Appendix B: Vision and Light Review orally.

Lesson Two: I Can’t See Clearly Now- Trouble on the Job (one hour)

- A. *Daily Objectives*
1. Concept Objective
 - a. Students will understand the workings of the human eye.
 2. Lesson Content
 - a. Farsighted and nearsighted
 3. Skill Objective
 - a. Students will describe simple needs, parts and functions of the human body (the eye).
- B. *Materials*
1. Appendix A: The Eye Working Hard (use overhead from Lesson One)
 2. Appendix B: Light and Vision Review (use copy from Lesson One)
 3. Appendix C: Illustration Rubric (one copy per student for teacher use)
 4. White 9” X 12” construction paper for each student
- C. *Key Vocabulary*
1. Involuntary muscle-muscles that move without conscious thought
 2. Farsighted-able to see distant objects more clearly than objects that are near
 3. Nearsighted-able to see close objects more clearly than objects that are far

D. *Procedures/Activities*

1. Put up the overhead of Appendix A: The Eye Working Hard.
2. Have students name each part of the eye and tell what it does.
3. Ask students what might happen if one part of the eye was not working correctly. For example: What would happen if the cornea was not working properly? What if the iris was not working properly?
4. Test the iris with the class. Tell them that the iris is an involuntary muscle, it works without anyone having to think about it. Pair the students and have them face their partner. Have one person in each pair close their eyes for one minute. Have the partner watch how the size of the pupil changes when they open their eyes. Have the partners switch and do the activity again. Tell them that it is actually the iris that is moving to make the pupil larger.
5. Tell the class there are two words that describe common problems the lens has when it doesn't work correctly: farsighted and nearsighted. Ask the class if they know what each word means. Determine whether the students in your class with glasses are farsighted or nearsighted based on what they can see without their glasses.
6. Tell the class that when a person is nearsighted, the image of the object they are looking at focuses just in front of the retina. This makes far away objects look blurry. When a person is farsighted, the image of the object they are looking at focuses just behind the retina. This makes objects that are near appear blurry.
7. Ask the class to list ways that we can protect our eyes. If the class is having trouble, help them categorize different kinds of protection. What do we use to protect our eyes from the sun? What do we use to protect our eyes when we use chemicals or tools? What do we use to protect our eyes from dust and insects in the air? Be sure to address the topic of how our eyelids protect our eyes by blinking and keeping things out.

E. *Assessment/Evaluation*

1. Have the students divide a piece of paper in half. Each student should choose a danger to the eye and draw it on one half of the paper. The students should then draw a picture of how to protect the eye from that danger. To complete the assessment, the student should write 1-3 complete sentences explaining how to protect the eye in the situation that they illustrated. Use Appendix C: Illustration Rubric to evaluate the papers.
2. Ask questions 8 and 9 from Appendix B: Vision and Light Review. It is also beneficial to review previous questions.

Lesson Three: Faster than a Speeding Bullet, It's a Ray of Light (one hour)

A. *Daily Objectives*

1. Concept Objective
 - a. Students will understand how light can be changed and manipulated for a variety of purposes.
2. Lesson Content
 - a. The speed of light: light travels at an amazingly high speed
 - b. Light travels in straight lines (as can be demonstrated by forming shadows)
3. Skill Objectives
 - a. Students will seek answers by making careful observations and trying things out.
 - b. Students will follow written directions.

- c. Students will explain procedures or ideas in a variety of ways, such as sketching, labeling and writing.
 - d. Students will conduct a variety of experiments.
- B. *Materials*
- 1. Appendix B: Light and Vision Review (use copy from Lesson One)
 - 2. Appendix C: Illustration Rubric (use the copies from Lesson Two)
 - 3. Appendix D: Experiment Participation Checklist (one per student for teacher use)
 - 4. Appendix E: Light: Straight and Fast (one copy with the cards cut apart)
 - 5. Three 5 inch black squares with a small circle (5 cm diameter) cut out of the center
 - 6. Three flashlights
 - 7. Six flexible drinking straws
 - 8. Two clear glasses filled with water
 - 9. Pencil (it will get wet)
 - 10. Fish tank filled $\frac{3}{4}$ full with water
 - 11. Coin
 - 12. Thick (1 inch) book
 - 13. White (12" X 18") construction paper (one piece per student)
- C. *Key Vocabulary*
- 1. Speed of light-how fast light travels (about 186,000 miles per second)
 - 2. Light ray-a very narrow beam of light
 - 3. Shadow-place of darkness created by an object blocking light
 - 4. Refraction-the way light rays bend as they pass through an object
- D. *Procedures/Activities*
- 1. Prior to the lesson, cut apart Appendix E: Light: Straight and Quick into six different cards.
 - 2. Ask children how fast they run. Tell them a marathon runner in the Olympics can run 50 yards in 5 seconds. Ask if that seems fast. Tell them a car can go one mile in a minute on the highway. An airplane can go about 33 miles in a minute. Sound can travel about 1 mile in 5 seconds. But, nothing can travel faster than light. It travels at about 186,000 miles per second. That is why we see lightning before we hear thunder.
 - 3. Tell the students that they will have a chance to conduct some experiments about light. Light moves too quickly for us to see it move, but we can see how it makes an object look as it slows down through glass and water. When light slows down it seems to bend, or refract. Tell them they will also conduct some experiments to show that light travels in a straight line. We call a beam of light a "light ray."
 - 4. Tell the class they will do many experiments over the next few days. It will be important to carefully follow the directions and conduct the experiments safely and exactly. Each student should take turns and help each other. One student will be responsible for reading the directions. Another student should try out the experiment first. If everyone works together, there will be enough time for each student to try the experiment on his or her own. It will be important to use quiet voices so that everyone can learn.
 - 5. Using Appendix E: Light: Straight and Quick, quickly demonstrate each of the experiments and space them around the room. Be sure to put each card from Appendix E: Light: Straight and Quick with its corresponding station. Divide the class into six groups and assign each group a starting station. Tell them they will have five minutes at each station. When they hear the bell, they should freeze and wait for you to direct them to their next station.

6. Use Appendix D: Experiment Participation Checklist to monitor the groups as they conduct the experiments.
 7. When all groups have had a chance to conduct each experiment call the class back together.
 8. Give each child a piece of white construction paper. Have them fold it in half. On one half they should write, "Light travels in a straight line." On the other half they should write "Light refracts, or bends, when it passes through glass or water." Have them draw a picture of one experiment for each fact.
- E. *Assessment/Evaluation*
1. Use Appendix C: Illustration Rubric to assess pictures for scientific accuracy. The picture accompanying "Light travels in a straight line" should show light traveling in a straight line. The picture accompanying "Light refracts, or bends, when it passes through glass or water" should show how the shape of an object looks different through glass or water.
 2. Orally review with Appendix B: Light and Vision Review. Use any of the questions from 1-13.

Lesson Four: Now You See It, Now You Don't: Transparent, Translucent, Opaque (one hour)

- A. *Daily Objectives*
1. Concept Objective
 - a. Students will understand how light can be changed and manipulated for a variety of purposes.
 2. Lesson Content
 - a. Transparent and opaque objects
 3. Skill Objectives
 - a. Students will seek answers by making careful observations and trying things out.
 - b. Students will use charts and tables with appropriate labels to record and organize data.
 - c. Students will experience why it can be helpful to work with a team to complete a task.
- B. *Materials*
1. Appendix B: Light and Vision Review (use copy from Lesson One)
 2. Appendix C: Illustration Rubric (use copies from Lesson Two)
 3. Appendix D: Experiment Participation Checklist (use copies from Lesson Three)
 4. Six flashlights
 5. White (12" X 18") construction paper for each student
- C. *Key Vocabulary*
1. Transparent-all or most light is able to pass through
 2. Translucent-some light is able to pass through
 3. Opaque-little or no light is able to pass through
- D. *Procedures/Activities*
1. Review yesterday's experiments with refraction. Discuss how light slowed down and bent when it traveled through water or glass. Discuss that all of the light did pass through the water and glass. Discuss transparent, translucent and opaque with the class. Write each of the words on the board with their definition underneath them. Give two or three examples of each.
 2. Divide the class into six groups. Give each group of students a flashlight. Tell them that they will use the flashlight to find at least six objects for each category in the classroom or on the playground. Remind them about working quietly and

responsibly in their groups. Tell the class that you will spend 10 minutes in the classroom and ten minutes on the playground. When they hear the first bell, they should line up silently to go outside. When they hear the second bell, they should line up quietly to go back into the classroom.

3. Use Appendix D to monitor the groups as they go through the classroom finding objects. After ten minutes, ring the bell and take them outside.
4. Use Appendix D to monitor the groups as they find objects on the playground for each category. After ten minutes ring the bell and bring the class inside.
5. Give each student a piece of white construction paper. Have them fold the paper into thirds. Each third should be labeled with one of the vocabulary words and its definition. The students should draw or list at least six objects for each category.

E. *Assessment/Evaluation*

1. Evaluate the accuracy of the objects listed in the exercise described above using Appendix C.
2. Use questions 1-16 from Appendix B: Vision and Light Review to check knowledge.

Lesson Five: Reflecting Light is Bouncing All Around (one hour)

A. *Daily Objectives*

1. Concept Objective
 - a. Students will understand how light can be changed and manipulated for a variety of purposes.
2. Lesson Content
 - a. Reflection
 - i. Mirrors: plane, concave, convex
 - ii. Uses of mirrors in telescopes and some microscopes
3. Skill Objectives
 - a. Students will seek answers by making careful observations and trying things out.
 - b. Students will follow written directions.
 - c. Students will explain procedures or ideas in a variety of ways, such as sketching, labeling and writing.
 - d. Students will conduct a variety of experiments.

B. *Materials*

1. Appendix B: Light and Vision Review (from Lesson One)
2. Appendix C: Illustration Rubric (from Lesson Two)
3. Appendix D: Experiment Participation Checklist (from Lesson Three)
4. Appendix F: Reflecting Light is Bouncing All Around (one copy with activities cut apart)
5. Six spoons
6. One flashlight
7. Six plane (flat) mirrors
8. A variety of reflective objects (pan, metal spatula, etc.)
9. A variety of non-reflective objects
10. One 3 inch pencil
11. One small piece of wrapped candy
12. One photograph
13. White (12" X 18") construction paper for each student

C. *Key Vocabulary*

1. Reflection-when light is bounced back from a surface

2. Concave-curved inward like the inside of a bowl
 3. Convex-curved like a ball
 4. Plane-flat
- D. *Procedures/Activities*
1. Before class cut apart each of the experiment cards from Appendix F: Reflecting Light is Bouncing All Around.
 2. Review yesterday's light facts. Light travels quickly in a straight line. When light travels through water or glass it bends or refracts.
 3. Ask the class what the word reflection means. Discuss a reflection in a mirror, light reflecting off of a window and any other types of reflection the students mention.
 4. Tell the class that there are three main types of mirrors: plane, concave and convex. Explain that plane, or flat mirrors are the most common. Ask if they have any plane mirrors in their home. Explain that convex mirrors are curved like the inside of a spoon. Explain that concave mirrors are curved like the curve of a ball. Tell them that they will have the chance to use all three types of mirrors in today's experiments.
 5. Using Appendix F: Reflecting Light is Bouncing All Around, quickly demonstrate each of the experiments and spread them around the room. Be sure to put each card from Appendix F: Reflecting Light is Bouncing All Around with its corresponding station. Divide the class into six groups and assign each group a starting station. Tell them they will have five minutes at each station. When they hear the bell, they should freeze and wait for you to direct them to their next station.
 6. Use Appendix D to monitor the groups as they conduct the experiments.
 7. When all groups have had a chance to conduct each experiment call the class back together.
 8. Give each child a piece of white construction paper. Have them write the word "reflection" and its definition on their paper. They should draw one of the experiments that demonstrated reflection on their paper.
- E. *Assessment/Evaluation*
1. Use Appendix C to evaluate their drawing. Does their picture accurately show light reflecting off of something?
 2. Review with some of the questions (1-18) from Appendix B: Vision and Light Review.

Lesson Six: The Spectrum Colors My World (one hour)

- A. *Daily Objectives*
1. Concept Objective
 - a. Students will understand how light can be changed and manipulated for a variety of purposes.
 2. Lesson Content
 - a. The spectrum: use a prism to demonstrate that white light is made up of a spectrum of colors
 3. Skill Objectives
 - a. Students will seek answers by making careful observation and trying things out.
 - b. Students will follow written directions.
 - c. Students will explain ideas in a variety of ways, such as sketching, labeling and writing.
 - d. Students will conduct a variety of experiments.

B. *Materials*

1. Appendix B: Vision and Light Review (from Lesson One)
2. Appendix C: Illustration Rubric (from Lesson Two)
3. Appendix D: Experiment Participation Checklist (from Lesson Three)
4. Appendix G: Color My World (one copy with the activity cards cut apart)
5. Three flashlights covered with cellophane (one red, one green, one blue)
6. A pitcher filled with water
7. Thirty-six small cups
8. Cellophane (one piece each: red, blue, green, yellow)
9. Colorful objects (you can use crayons or markers here)
10. Coffee filters cut into strips
11. Orange marker
12. Purple marker
13. Green marker
14. Glass filled $\frac{3}{4}$ with water
15. Prism
16. Water tight jar filled with water
17. White cardboard
18. Cake pan filled with water
19. Plane mirror
20. White (12" X 18") construction paper for each student

C. *Key Vocabulary*

1. Prism-a transparent wedge, usually of glass, used to split white light into the colors of the rainbow
2. Spectrum-the band of colors that make up white light

D. *Procedures/Activities*

1. Cut apart the experiment cards from Appendix G: Color My World ahead of time.
2. Ask the class to list the colors of the rainbow. If they are unfamiliar with the acronym Roy G. Biv (red, orange, yellow, green, blue, indigo, violet), introduce it to them at this time.
3. Ask the class what the primary colors are. They should tell you red, blue and yellow. Ask them how you make orange, purple and green. Teach them that when you see a green leaf, the green light from the sun is being reflected and all the other colors are being absorbed. When you see a red flower, the red light from the sun is being reflected and all the other colors are being absorbed. When you see a black object, all the colors of the light are being absorbed. When you see a white object, all the colors are being reflected.
4. Tell the class that the primary colors of light are red, blue and green. To make colored light, you mix these three colors.
5. Tell the class that some things can be used to break the white light into different colors. Ask them if they can think of any objects that are used for this. Be sure that you talk about prisms, raindrops and water in general.
6. Using Appendix G: Color My World , quickly demonstrate each of the experiments and spread them around the room. Be sure to put each card from Appendix G: Color My World with its corresponding station. Divide the class into six groups and assign each group a starting station. Tell them they will have five minutes at each station. When they hear the bell, they should freeze and wait for you to direct them to their next station.
7. Use Appendix D to monitor the groups as they conduct the experiments.

8. When all groups have had a chance to conduct each experiment call the class back together.
 9. Give each child a piece of white construction paper. Have them fold their paper in half and write “Mixing Colors” on one half and “Separating Colors” on the other half. Have them draw a picture from one of the corresponding experiments on each half.
- E. *Assessment/Evaluation*
1. Use Appendix C to evaluate the accuracy of their work from the assignment mentioned above.
 2. Orally review questions 1-20 from Appendix B: Vision and Light Review.

Lesson Seven: Lenses Make it Clearer (one hour)

- A. *Daily Objectives*
1. Concept Objectives
 - a. Students will understand the workings of the human eye.
 - b. Students will understand how light can be changed and manipulated for a variety of purposes.
 2. Lesson Content
 - a. Lenses can be used for magnifying and bending light (as in magnifying glass, microscope, camera, telescope, binoculars)
 3. Skill Objectives
 - a. Students will seek answers by making careful observations and trying things out.
 - b. Students will follow written directions.
 - c. Students will explain ideas in a variety of ways, such as sketching, labeling and writing.
 - d. Students will use tools to observe things.
 - e. Students will identify and describe technology used in everyday life.
 - f. Students will describe simple needs, parts, and functions of the human body (the eye).
- B. *Materials*
1. Appendix B: Vision and Light Review (from Lesson One)
 2. Appendix C: Illustration Rubric (from Lesson Two)
 3. Appendix D: Experiment Participation Checklist (from Lesson Three)
 4. Appendix H: Lenses Make it Clearer
 5. Six 3 inch squares of cardstock with a hole cut in the center (the holes will be covered with tape)
 6. Glass filled $\frac{3}{4}$ with water
 7. Convex lens (use lens from reading glasses)
 8. One sheet of white paper
 9. Two magnifying glasses
 10. Lens from a pair of glasses for a nearsighted person
 11. Cup with four or five small objects placed inside and covered with plastic wrap.
 12. Microscope
 13. Prepared slides
 14. White (12” X 18”) construction paper for each student
- C. *Key Vocabulary*
1. Magnify-make larger
 2. Lens-a curved piece of glass or plastic to make things larger or clearer
- D. *Procedures/Activities*
1. Cut apart the activity cards from Appendix H: Lenses Make it Clearer.

2. Review what farsighted and nearsighted people experience.
 3. Read pp. 8-11, 14, 15, 18, and 19 in *Lenses! Take a Closer Look* by Siegfried Aust.
 4. Look at the pictures on pp. 15, 22, 25, and 26 in *Lenses! Take a Closer Look* by Siegfried Aust to see how lenses and mirrors are used in various instruments. You can also look at pp. 18, 25, and 29 in *Making Science Work: Light* by Terry Jennings.
 5. Using Appendix H: Lenses Make it Clearer, quickly demonstrate each of the experiments and space them around the room. Be sure to put each card from Appendix H: Lenses Make it Clearer with its corresponding station. Divide the class into six groups and assign each group a starting station. Tell them they will have five minutes at each station. When they hear the bell, they should freeze and wait for you to direct them to their next station.
 6. Use Appendix D to monitor the groups as they conduct the experiments.
 7. When all groups have had a chance to conduct each experiment call the class back together.
 8. Give each child a piece of white construction paper. Have them write "Lenses make things clearer" on the paper. Then they will draw a picture of one of the experiments showing how lenses make things clearer.
- E. *Assessment/Evaluation*
1. Use Appendix C to evaluate the drawings.
 2. Ask all of the review questions from Appendix B: Light and Vision Review.

VI. CULMINATING ACTIVITY

- A. Appendix I: Vision, Light and Optics Test
- B. Optic Fun: Bring in optical illusions and 3-D Eye books for the class to enjoy.

VII. HANDOUTS/WORKSHEETS

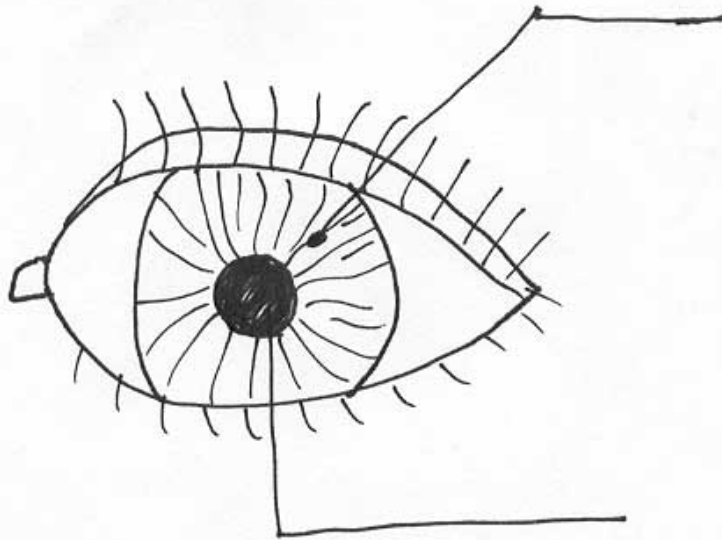
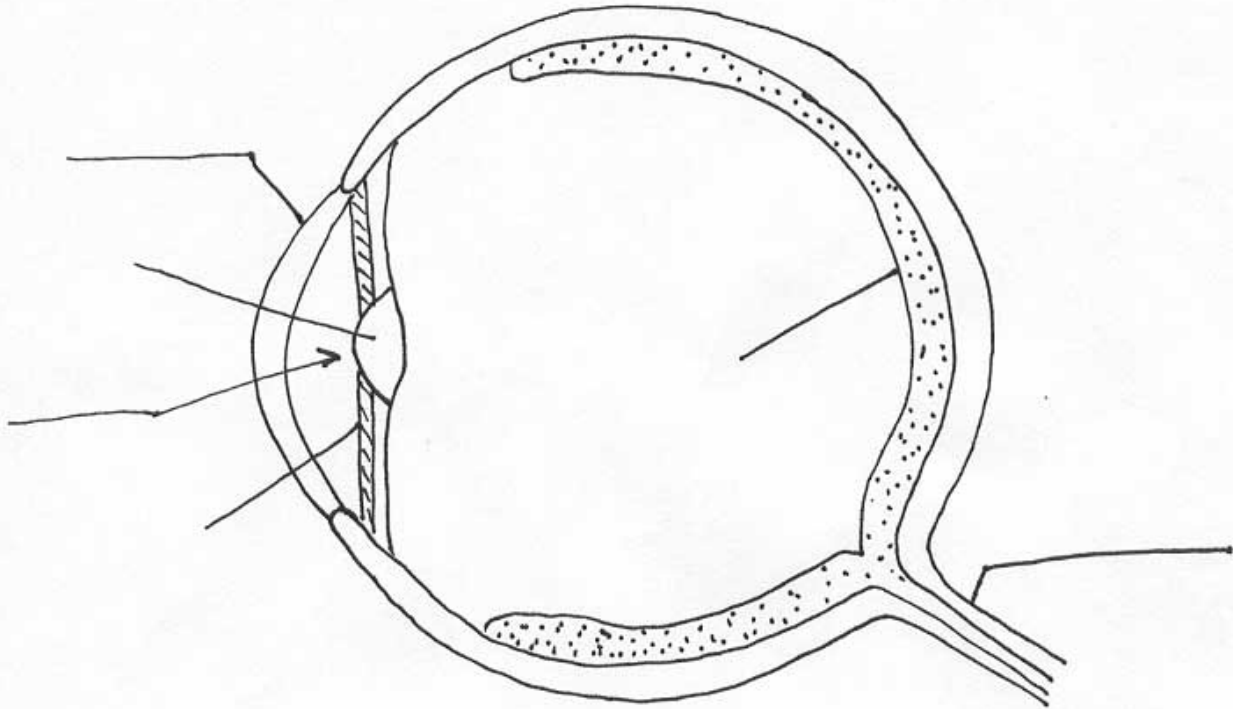
- A. Appendix A: The Eye: Working Hard
- B. Appendix B: Vision and Light Review
- C. Appendix C: Illustration Rubric
- D. Appendix D: Experiment Participation Checklist
- E. Appendix E: Light: Straight and Fast
- F. Appendix F: Reflecting Light is Bouncing All Around
- G. Appendix G: Color My World
- H. Appendix H: Lenses Make it Clearer
- I. Appendix I: Vision, Light and Optics Test
- J. Appendix J: Vision, Light and Optics Test Key

VIII. BIBLIOGRAPHY

- A. Ardley, Neil. *The Science Book of Light*. New York: Gulliver Books, 1991. 0-15-200577-3.
- B. Aust, Siegfried. *Lenses! Take a Closer Look*. Minneapolis, Minnesota: Lerner Publications Company, 1987. 0-8225-9732-2.
- C. Berger, Melvin. *All About Light*. New York: Scholastic Inc., 1995. 0-590-48076-6.
- D. Broekel, Ray. *A New True Book: Experiments With Light*. Chicago: Children's Press, 1986. 0-516-01278-9.
- E. Glover, David. *Sound and Light*. New York: Kingfisher Books, 1993. 1-85697-935-0.
- F. Jennings, Terry. *Making Science Work: Light*. Austin, Texas: Raintree Steck-Vaughn Publishers, 1996. 0-8172-4253-8.

- G. Siepak, Karen Lee. *Light and Color*. Greensboro, North Carolina: Carson-Dellosa Publishing Company, Inc., 1994. (no ISBN number available).

Appendix A
The Eye: Working Hard



Appendix B Vision and Light Review

1. What is the protective covering over your eye? (cornea)
2. What is the hole that lets light into the eye? (pupil)
3. What is the muscle that opens and closes the pupil? (iris)
4. What is the colored part of your eye? (iris)
5. What is the part of your eye that helps you focus? (lens)
6. What is the back of your eye called? (retina)
7. What sends messages from the eye to the brain? (optic nerve)
8. If a person can see things clearly when they are near, but has some difficulty seeing things that are far away, are they farsighted or nearsighted?
(nearsighted)
9. If a person can see things clearly when they are far, but has some difficulty seeing things that are near, are they farsighted or nearsighted? (far sighted)
10. What do we call it when light slows down and bends? (refraction)
11. Does light travel slowly or quickly? (quickly)
12. How fast does light travel? (186,000 miles per second)
13. Does light travel in a crooked line or a straight line? (straight line)
14. When all light passes through an object, what word do we use to describe the object? (transparent)
15. When some light passes through an object, what word do we use to describe the object? (translucent)
16. When no light passes through an object, what word do we use to describe the object? (opaque)
17. What do we call it when light bounces off an object? (reflection)
18. Which is faster, light or sound? (light)
19. Describe a plane mirror.
20. Describe a convex mirror.
21. Describe a concave mirror.
22. What is it called when white light is broken into all the visible colors?
(spectrum or rainbow)
23. What can be used to break up white light into the spectrum? (prism or raindrop)
24. What can help us see by magnifying an object? (lens)
25. Name some things that contain a lens.
26. Name some things that contain a mirror.

Appendix C Illustration Rubric

Name: _____

This chart explains how your child's work was evaluated.

	Unsatisfactory	Partially Proficient	Proficient	Advanced
Drawing	Drawing has no detail and the concept is unknown. (0 points)	Drawing does not have enough detail, so the concept is not clear. (2 points)	Drawing shows enough detail to make the concept clear. (3 points)	Drawing shows extra detail making the science concept clear. (4 points)
Writing	There is very little or no writing. (0 points)	Some information is missing. (2 points)	Writing is complete and clear. (3 points)	Extra information is added to explain the concept. (4 points)
Quality	The work is sloppy. (0 points)	Work is not as neat and clear as it could be. (2 points)	Work is neat and clear. (3 points)	Work includes attractive detail. (4 points)

This chart will show your child's marks for each project.

	Drawing	Writing	Quality	Total
Eye Protection				
Straight Line/ Refraction				
Translucent, Transparent and Opaque				
Reflecting Light				
The Spectrum				
Lenses				
Total for all projects				

Appendix D Experiment Participation Checklist

Name: _____

Each day during our light unit, your child participated in a variety of experiments. The following observations were made regarding his/her participation.

	Excellent	Good	Fair	Poor
*Light travels in a straight line				
Took turns	_____	_____	_____	_____
Used materials properly	_____	_____	_____	_____
Stayed on task	_____	_____	_____	_____
Worked with others	_____	_____	_____	_____
*Translucent, Transparent and Opaque				
Took turns	_____	_____	_____	_____
Used materials properly	_____	_____	_____	_____
Stayed on task	_____	_____	_____	_____
Worked with others	_____	_____	_____	_____
*Reflecting Light				
Took turns	_____	_____	_____	_____
Used materials properly	_____	_____	_____	_____
Stayed on task	_____	_____	_____	_____
Worked with others	_____	_____	_____	_____
*The Spectrum				
Took turns	_____	_____	_____	_____
Used materials properly	_____	_____	_____	_____
Stayed on task	_____	_____	_____	_____
Worked with others	_____	_____	_____	_____
*Lenses				
Took turns	_____	_____	_____	_____
Used materials properly	_____	_____	_____	_____
Stayed on task	_____	_____	_____	_____
Worked with others	_____	_____	_____	_____

Comments:

Appendix E
Light: Straight and Fast

Teacher preparation:

- Cut holes with a 5 cm diameter into the center of three 5" black squares
- Fill a glass with water
- Fill a fish tank with water
- Put a coin in a glass and fill the glass with water

<p>Hold the squares with so that the holes line up with each other. Shine a flashlight through the holes. Move one square. What happens to the light? Light moves in a straight line. If something dark blocks the light ray, it will stop.</p>	<p>Look at a pencil. Put the pencil in the glass with water. Look at how the shape of the pencil seems to have changed where the pencil meets the water. This is called refraction. Refraction is the way light rays bend when they pass around an object.</p>
<p>Take a flashlight and shine it on the wall. Put your hand in front of the light ray and what happens? Make different shapes in front of the light ray. Light travels in a straight line. The rays that pass around your hand shine on the wall. The rays that are blocked by your hand create a shadow on the wall.</p>	<p>Shine a flashlight straight into the fish tank. Notice that the beam of light shines straight through the water. Now shine the light into the tank at an angle. Notice how the beam of light seems to bend. This is called refraction. Light bends when it passes through glass and water.</p>
<p>Look through a straw that is straight. Bend the straw. What happens to the light in the straw? Light rays travel in a straight line. They cannot travel around corners.</p>	<p>Look at the coin in the glass of water. Put a book in front of the glass. Get your eyes level with the book. What has happened to the coin? When light hits water, it refracts or bends and changes how you see the object.</p>

Adapted from: *Sound and Light* by David Glover and *All About Light* by Melvin Berger.

Appendix F

Reflecting Light is Bouncing All Around

Teacher preparation:

- Collect a variety of objects, some shiny, some not.
- Make sure you have a pencil that is about 3 inches long.

<p>Look into the inside of the spoon. What does your reflection look like? This is a concave mirror. Look at your reflection on the back of the spoon. What does your reflection look like? This is a convex mirror.</p>	<p>Use two flat mirrors and put them together to form an angle (\wedge). Put a small pencil touching each edge. Can you make a pencil triangle using the reflection? Can you make a square? What other shapes can you make with two mirrors and one pencil?</p>
<p>Take the flashlight and shine it straight down onto the mirror. Where does the reflection of the light go? Take the flashlight and shine it on the mirror at an angle. Where does the reflected light go? Light will bounce off a mirror at the same angle, in the opposite direction that it hits the mirror.</p>	<p>Use two flat mirrors and put them together to form an angle (\wedge). Put a small piece of candy in the opening between the mirrors. Make the opening smaller and larger. How many objects do you see reflected when the opening is small? How many objects do you see when the opening is large?</p>
<p>Look at the objects you have. Which of them show some reflection? Do any of them show an upside down reflection? Which objects show the clearest reflections?</p>	<p>Use a mirror to make monster faces. Hold a mirror in the exact center of a photograph of a person. What happens when you move it a little off center? Can you make a huge nose? What about a face without a nose?</p>

Adapted from: *Sound and Light* by David Glover and *All About Light* by Melvin Berger

Appendix G Color My World

Teacher preparation:

- Cover three flashlights with cellophane: one red, one green one blue
- Fill a pitcher, a glass, a jar and a cake pan with water
- Cut coffee filter into strips

<p>Use the flashlights covered with cellophane to mix the following colors:</p> <p>Red and green Red and blue Green and blue All three (Where all three meet you should see white)</p>	<p>Make an orange line on a coffee filter strip. Make a green line on another strip. Make a purple line on a third strip. Put the edges of the strips in water. Wait to see what happens to the lines you drew. (You may have to let it continue to change on your desk while you work at other stations).</p>
<p>Pour a small amount of water into the small cups. Use food coloring to try and make the following colors:</p> <p>Red Orange Yellow Green Blue Purple</p> <p>Only use one or two drops of each color of food coloring per cup.</p>	<p>Hold a prism so that it catches some light. Do you see the spectrum? Try hitting it with light from different angles. Hold up a jar filled with water so that it catches light. Can you see the spectrum?</p>
<p>Put the pieces of cellophane over different objects. How does the color change? How do red objects look under green cellophane? What about blue objects under red cellophane? Try as many combinations as you can.</p>	<p>Put the cardboard between the pan of water and the window. Make sure the sun can shine into the pan of water. Put the mirror into the water and tilt it until it reflects the sunlight onto the white cardboard, showing the rainbow.</p>

Adapted from: *Sound and Light* by David Glover and *Light and Color* by Karen Lee Siepak.

Appendix H Lenses Make it Clearer

Teacher preparation:

- Laminate or cover newspaper comics or articles with contact paper to use with water magnifiers
- Cut holes in six squares of cardstock. Cover the holes with clear tape.
- Fill a cup with water
- Put four or five small objects in a cup. Cover the cup with plastic wrap. Pour a small amount of water onto the plastic wrap.

<p>Put a drop of water onto the tape that covers the hole in the cardstock. Use your mini magnifier to look at the comics. What happens to the size of the print?</p>	<p>Take the old lens from a pair of glasses for nearsighted people. Put the lens on a book. What happens to the size of the print? Flip the lens and what happens to the size of the print?</p>
<p>Use the convex lens from an old pair of reading glasses. Face a sunny window and hold the white paper between the lens and the window. Move the lens until you see the image of the window and what is outside on the white paper. The image is upside down, similar to how your retina "sees" objects.</p>	<p>Look through the water into the cup. How have the objects in the cup changed because of the water? Water acts like a lens by magnifying the objects inside the cup.</p>
<p>Use two magnifying glasses to make a simple telescope. Hold one magnifying glass close to your face. Hold the other magnifying glass an arm's length away. Look at a distant object.</p>	<p>Look through the microscope to see the image magnified. Gently turn the focus knob to see it become more or less clear. Be sure to focus it clearly when your turn is finished.</p>

Adapted from: *Sound and Light* by David Glover, *Light and Color* by Karen Lee Siepak, *Making Science Work: Light* by Terry Jennings and *The Science Book of Light* by Neil Ardley.

Appendix I
Vision, Light and Optics Test

Name: _____

Fill in the blanks with the following words:

transparent

translucent

opaque

nearsighted

spectrum

farsighted

1. When no light passes through an object, the object is _____.
2. When some, but not all light passes through an object the object is _____.
3. When all (or most) of the light passes through an object the object is _____.
4. All of the colors that make up white light are called the _____.
5. When an object focuses in front of the retina and a person can only see things that are near they are considered _____.
6. When an object focuses behind the retina and a person can only see things that are far they are considered _____.

Appendix I, page 2
Vision, Light and Optics Test

Label each of the following:

cornea

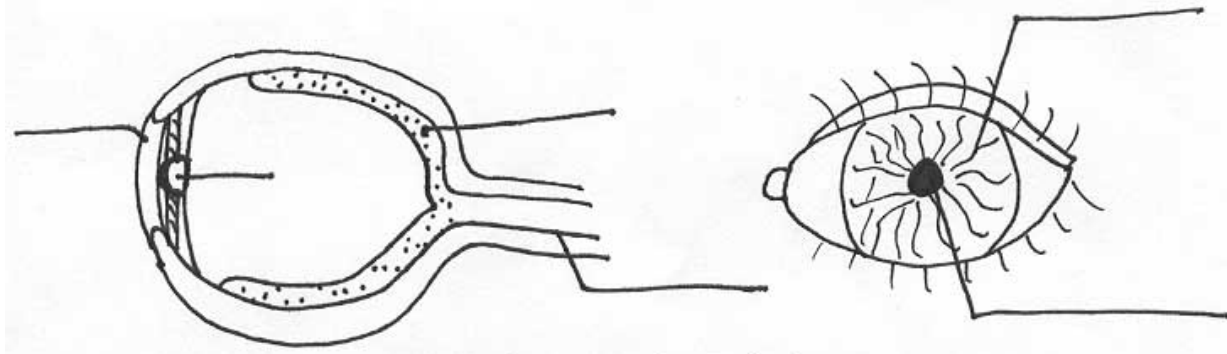
iris

pupil

lens

retina

optic nerve



Draw a picture showing what happens when light hits a mirror.
What is this called?

Draw a picture showing what happens when light slows down as it passes
through an object. What is this called?

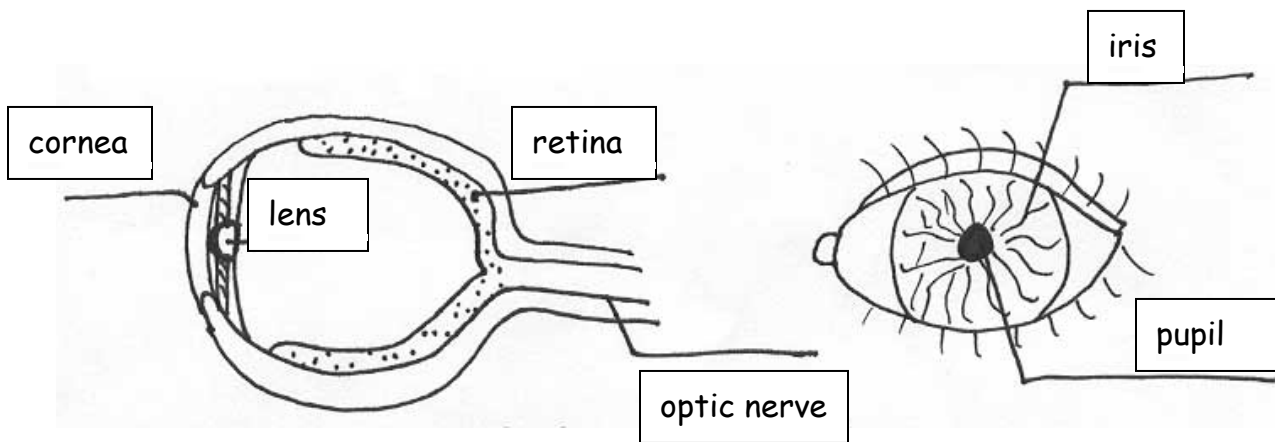
Draw a picture showing one way white light can be broken apart in different
colors.

Draw a picture showing how lenses change the way we see an object.

Appendix J Vision, Light and Optics Test Key

1. opaque
2. translucent
3. transparent
4. spectrum
5. nearsighted
6. farsighted

Labeling the eye



Appendix J

Vision, Light and Optics Test Key

The drawing of light hitting a mirror should show the beam of light hitting a mirror and bouncing off in the opposite direction at the same angle. This is called reflection.

The picture of light slowing down should show the beam of light, or an object in water looking like it is split where the light or object enters the water. This is called refraction.

The picture of light broken apart should show water or a prism breaking the white light apart into the colors of the spectrum in order: red, orange, yellow, green, blue, purple.

The picture of the lens changing the way we see an object should show an object looking bigger or clearer through a lens.