K-2: Seeing the Light

Curriculum Connections

Life Sciences
The 5 Senses
- Students use their sense of sight to investigate color

Physical Science
Properties of Light
- Light travels in a straight line until it hits and object
- Light can be reflected off certain objects
- There is color in light---Rainbows
- Investigating shadows

** Based on the New York State Elementary Science Core Curriculum and the New York City New Standards™*

National Standards

Content Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Content Standard B: Physical Science
- Properties of objects and materials
- Position and motion of objects
- Light, heat, electricity and magnetism

Content Standard C: Life Science
- The characteristics of organisms

K-2 Exhibits List

Anti-Gravity Mirror
Aurora
Bridge Light
Christmas Tree Balls
Color Removal
Colored Shadows
Convection Current
Corner Reflector
Cow's Eye Dissection Demonstration
Critical Angle
Diffraction
Diffraction Grating
Distorted Room
Duck into Kaleidoscope
Everyone is You and Me
Laser and Optics Demonstration
Lens Table
Light Island
Light Palette
Long Path Diffraction
Look into Infinity
Magic Wand

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Mirrorly a Window
Motion Detector
Peripheral Vision
Piano Strobe
Pipes of Pan
Prism Tree
Pupil
Resonator
Resonant Pendulum
Resonant Rings
Shadow Kaleidoscope
Soap Bubbles
Soap Film Painting
Soap Films
Sophisticated Shadows
Touch the Spring
Vibrating String
Visible Effects of the Invisible
Violin Patterns

Guide Theme

The theme of these guides are based on popular crime and detective show investigations on TV; a mystery unfolds, questions are asked, evidence is gathered, conclusions are drawn. This process is similar to what scientists go through with the inquiry method. For more details see About the Guides.

Begin the Investigation At School

A mystery unfolds, questions are asked...

There are several ways you can introduce the topic and start the investigation. Here are some ideas that will help students start thinking about the topic and generate questions:

- Create a mystery about making your own rainbow. Is it possible? (Mystery solved at Diffraction, Prism Tree and Color Removal exhibits)
- Create a mystery about going to a place where your friends shrink before your eyes (Distorted Room exhibit) and where you can look like you're flying (Anti-Gravity Mirror Exhibit).
- Create a mystery about shadows that can be blue-green, lavender, yellow, blue, red or green. (Mystery solved at Colored Shadow exhibit)
- Demonstrate one of the Laboratory Activities with no explanation-let the questions begin
- Do one of the Laboratory Activities and facilitate a probing discussion

Prepare for Investigation at the New York Hall of Science

Once students have generated questions around the topic tell them they are going to continue the investigation at the New York Hall of Science.

At this point you may want to begin one of the Continuum Activities. These activities have the following features:

- Vary in length and depth
- Provide continuity and purpose for the visit
- Provide a way of assessing student understanding

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Orientation and Planning: If you do nothing else, do this!
Here are five reasons to conduct student orientation and planning before going on a field trip:

1. Students focus on exploring and investigation versus the novelty of the location
2. Students don't have to worry about logistics like restrooms, schedule, eating etc.
3. Students who understand the plan and purpose of the visit are more likely to stay focused
4. Students who have clear goals for their visit are less likely to race from one exhibit to another with little

understanding

5. Students who get involved in the planning of the visit, take ownership and are less likely to misbehave

Read more about the Orientation and Planning Process

Investigation at the New York Hall of Science

Evidence is gathered...
Okay. The class has arrived at the next phase of the investigation. The students have questions and seek answers. Everyone knows what exhibits they should visit and why. Everyone knows the schedule for the day. Students have materials to record findings or work on a Continuum Activity if required.

If all of the above is true, congratulations on a successful Orientation and Planning.

If you are curious about what teachers can do on site, we've put together a little piece called Teacher Role.

Finish the Investigation Back at School

Conclusions are drawn...
There are several ways you can complete the investigation. Some require less time than others. Here are some ideas:

- Student or group oral or written reports on investigation questions and answers
- Student or group illustrations of visit with answers to questions or mystery
- Do one of the Laboratory Activities
- Complete the Continuum Activity

Continuum Activities

Continuum Activities are designed to carry through the entire investigation. Some activities require less time than others.

Investigation Map

Description: Detectives will often map out related events, evidence and suspects during an investigation. This helps them get an overall picture. Students can map out their investigations with a concept map. The concept map will help you assess what students learn.

Time: (3)15-30 min. Sessions

Materials Needed:

- Blank paper
- Pencils, crayons

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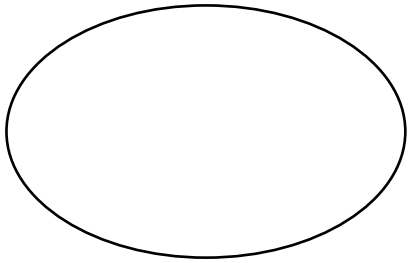
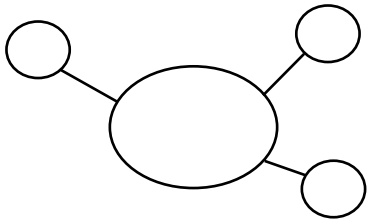
Procedure:

1. Begin with a center circle and write in the name of the main topic. (Students who have difficulty with writing can have an adult assist or draw a representation of the main topic)



2. As students generate questions about the topic, they can add offshoot circles. They can also add circles for facts they know about prior to the visit to the New York Hall of Science.



3. When students return from their investigation at the New York Hall of Science they add additional circles of information. Their final map should reflect everything they know about the topic. Teachers can easily assess what is learned based on how the map develops.

Investigation Journals

Description: Investigation journals provide a way for students to record their questions and findings throughout the investigation.

Time: (3)15-30 min. Sessions

Materials Needed:

- Blank or lined paper
- Pencils or crayons
- On-Site Investigation Handout (print out from this web site and make copies)
- Zip-lock bags (for on-site handout only)
- Soft yarn or thick soft string (for on-site handout only)

Procedure:

1. Ask students if they have ever seen a detective take notes when trying to solve a mystery. Tell students that as "science detectives" they too will make a record of the mystery.
2. Have students begin their journal or report with questions that are generated when they Start the Investigation at School.
3. Students who do not have writing skills can make a large question mark and draw representations of their questions. If an experiment or demonstration is done, non-writing students can sketch what they observe.
4. Older students with writing skills can list their own and other students questions in their journal.
5. We strongly advise students not bring journals to the New York Hall of Science where they can get

lost. We have provided an On-Site Investigation Handout that can be copied if students want to record observations or make sketches.

6. When students return from their investigation at the New York Hall of Science have them write answers to questions or draw what they observed.

Become an Explainer

Description: Student science detectives investigate one exhibit with the goal of being able to explain it when they return to the classroom. Students can choose a variety of methods to explain and make presentations.

Time: (1) 15 min. Session (right before going on Field Trip)
(2) 45 min. Sessions (for in-class presentations)

Materials Needed:
- Interesting object (used for student observation)

(optional suggestions)
- Variety of craft materials (string, paints, glue, tape, colored paper, scissors, etc)
- Variety of clean, household recyclables (meat trays, cardboard tubes, aluminum foil, plastic wrap)
- Any other odds and ends students can construct with
- Poster board or paper
- Markers, crayons

Procedure:

First Session

1. Tell students as "science detectives" they will investigating exhibits at the New York Hall of Science and will choose one exhibit to explain to the class when they return. (students can work in groups or individually)
2. Help students prepare for careful observation of exhibits by showing them an interesting object. (make sure all students can see object)
3. Now ask students to verbally describe what they see. Encourage details.
4. After students have described the object in great detail, tell them they will need to use these same observation skills when they are investigating their chosen exhibit.
5. Go to the New York Hall of Science. (encourage observation and verbal descriptions)

Second Session

1. Upon return to class from the trip, tell students they will spend time preparing to explain one of the exhibits they saw.
2. Here are some suggestions for student presentations:
    - Verbal explanation (with or without picture)
    - Group or individual poster showing how an exhibit worked
    - Group or individual model using materials to represent exhibit (materials can be used to substitute and represent real materials from exhibit— ex. Clear plastic wrap simulates glass, cardboard tube becomes a rocket etc.)

Third Session (optional)
Use this time for students to make their class presentations if they made posters, drawings or models.

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Laboratory Activities

Laboratory Activities are designed for the classroom and generally require simple materials. These activities can be done before or after a visit to the New York Hall of Science. To help students use higher-level thinking and generate questions, facilitate discussion with these types of questions:

- What do you notice here?
- Tell me about this.
- What do you see?
- Why do you suppose this happens?
- What can you conclude from the evidence?

Spoon Magic

Description: Students explore the different types of reflecting surfaces on a shiny spoon and observe the effects of concave and convex mirrors.

Time: (1) 15 minute session

Materials Needed:
(Per every two students)

- Shiny tablespoon

Procedure:

1. Tell students they are going to work with partners to turn themselves upside down and catch a thief.
2. Distribute spoons to student pairs.
3. Tell students to select one partner for the first experiment and then they will switch.
4. Tell partners to keep a secret about what happens.
5. Tell partners to hold the spoon with the bowl-side facing them, up close to their face.
6. Ask partners if they can see their reflection or image in the spoon. (yes)
7. Now tell partners to keep looking at their reflection and move the spoon farther and farther away from their face. Remember not keep what happens a secret. (At first they will see a magnified, right-side up image of their eye. As they move the spoon further away, they will see an upside down image that seems to be projecting out of the spoon)
8. Have partners switch and repeat the experiment.
9. When partners are finished, ask students to tell you what they discovered. (Their image turned up-side down)
10. Now tell students to give the spoon back to the first partner.
11. Tell students that the other partner is going to play a thief and try to sneak up from behind on the other partner. The thief can only be caught by using the spoon.
12. Tell partners with the spoon that they must not move, but can move the spoon around. Once they see a reflection of the thief in the spoon they can call out, "Caught you!"
13. Tell students there is a trick to the way they hold the spoon that will help them catch the thief. (If they use the back of the spoon as a mirror they will see a wide area)
14. Let students experiment with using the spoon and sneaking up.

15. Some students may discover the wide angle reflection properties of the convex shape and catch their thief. Assist others who don't get it.

16. After a bit of sneaking and thief catching have partners switch roles.

17. When everyone is done, ask students if they have seen mirrors that are rounded like the back of the spoon and show a wide area? (Stores, car mirrors, New York Hall of Science)

18. If the class has not gone to the New York Hall of Science you can tell them they will see many kinds of mirrors and reflections when they visit.

Mixing Color

Description: Students experiment with the primary colors of pigments and observe differences between these and the primary colors of light.

Time: (1) 45 minute session

Materials Needed:
(Per every two students)

- Water
- Red, blue, and yellow food coloring
- 3 paper cups
- Empty ice try
- Three droppers or small spoons

Prepare:

1. To avoid food coloring disasters, prepare the three paper cups for student pairs by filling half way with water and adding the red, blue, and yellow food coloring. Add enough food coloring to each cup to get a rich color.

2. To save time you may want to fill ice trays with water before hand too.

Procedure:

1. Tell students they are going to experiment with making many colors from three different colors.

2. Distribute ice trays, colored water paper cups and three droppers or spoons to student pairs.

3. Tell students to be careful to use one dropper or spoon for each color filled cup.

4. Tell students to begin adding small amounts of colors from the cups to the water in the ice tray.

5. Tell students to try to remember how they made certain colors so they can share with the class later.

6. After a time of experimental mixing, have students empty the ice trays and refill with clean water.

7. Now ask students to share with class how they made certain colors.

8. Have students follow along as other students explain how they made colors.

9. If the class has gone to the New York Hall of Science and visited the Color Removal, Colored Shadows, Light Island or Light Palette exhibits, you can talk about how if the three colors in the cups were light they would make white light.

10. If the class has not gone to the New York Hall of Science, you can tell students they will see how the three colors in the cups can make white light.

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Shadow Colors Demonstration

Description:
Students observe a light and shadow phenomena with white and red light. The demonstration is a good introduction to how our brains perceive color.

Time: (1) 20 minute session

Materials Needed:

- dark room
- 40 watt white light and socket (lamp without a shade works)
- 40 watt red light and socket (You can buy a cheap, red light at most hardware stores)
- white wall or large sheet of white paper

Procedure:

1. To intrigue students, you can do this demonstration without saying a word until the end.
2. First, shine the white light onto the white wall.
3. Put your hand in between the light and the wall.
4. Have students watch the shadows as you move your fingers around.
5. See if you can make a shadow that looks like a bird, an alligator, or your favorite dinosaur.
6. Turn off the white light and turn on the red one.
7. Try making shadow pictures again. It works pretty much the same, except that now the wall looks red instead of white. The shadows are still dark.
8. Now it gets interesting. With the two lights about a foot apart, turn on both lights. With both lights shining on the wall, it will probably look white. The white light tends to overpower the red.
9. Place your hand to make a shadow again. It has two shadows now, one from each light. One shadow will be red. The other shadow is...green?
10. Ask students what color shadows they see?
11. Explain to students that:

    Well, the shadow is not really green. It looks green, but that is a result of the red light surrounding it. The color sensitive cells in your eye get "tired" of seeing the red and when you look away, they react more to the other colors than to the red, leaving a green image.

    The same thing is happening with the shadows. If you focus carefully on the green shadow and switch off the red light, you will see that it does not change color, but it no longer seems green.

Adapted from Experiment of the Week #219, Robert Krampf's Science Education Company www.krampf.com

Take a Peek Inside Your Eye

Description: In this quick and simple activity, students observe their pupils expand and contract due to the intensity of light entering their eyes.

Time: (1) 10 minute session

Materials Needed:
(per two students)

- Safety Mirror

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Procedure:

1. Tell students they are going to take a peek inside their own eyes.
2. Distribute materials to student pairs.
3. Tell students they will do the activity twice so both students in the pair will have a chance to participate.
4. Tell students to bring the mirror up close to their eye so they can see the black circle in their eye.
5. Tell students that the colored part of their eye is called the iris and the black circle is called the pupil.
6. Tell students you are now going to turn off the classroom lights and they should pay careful attention to what happens to the pupil in their eye.
7. Turn off the lights.
8. Ask students if they noticed something happen to the black pupil. (It should get larger)
9. Tell students you are now going to turn on the classroom lights and they should pay careful attention to what happens to the pupil.
10. Ask students if they noticed something happen to the black pupil. (It should get smaller)
11. Now have student pairs switch positions and repeat the same action.
12. After students have observed their pupils changing size, ask them why they think this happens?
13. Explain to students that:

    The pupil expands when there is little or no light and contracts when the eye is exposed to light.

    The pupil is actually a small hole in the iris, the colored part of the eye. The iris is a circular muscle that controls how much light enters the eye. When there is too much light the iris will contract causing the hole (pupil) to shrink limiting the amount of light entering the eye. When there isn't enough light the iris expands causing the pupil to get larger allowing more light to enter the eye.

ROY G. BIV's Rainbow Bubbles

Description:
Students learn an acronym to remember the colors of the rainbow and observe rainbows in bubbles.

Time: (1) 15 minute session inside
(1) 30 minute session outside

Materials Needed:

- Image of a rainbow (draw your own or use other source)
- Words and colors of rainbow (Optional, but helps explain ROY G BIV)
- Liquid dish detergent (Dawn and Joy work best)
- Small bottle of Glycerin (found in local pharmacy)
- Aluminum foil roasting trays (for soap mixture)
- Straws
- Yarn (30" long lengths)

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Preparation:

1. Each student will need a bubble maker made of two straws and yarn threaded through the straws. You may want to do this ahead of time for younger students who would have difficulty threading the yarn.
2. Cut yarn into 30" lengths
3. Prepare soap mixture. There is no exact recipe, but add much more dish liquid than you would for doing dishes and add about a tablespoon of glycerin to keep the bubbles intact longer.
4. Write down and display the letters ROY G BIV. (blackboard, poster board, etc.)
5. Display rainbow image for all to see.

Procedure:

First Session

1. Tell students you would like to introduce them to a very colorful character named ROY G. BIV.

(You can point to the letters of his name)

2. Now point to the rainbow and tell them that this rainbow is called ROY G. BIV. Why you ask?
3. Explain to students that the letters stand for the following:

   R-Red

   O-Orange

   Y-Yellow

   G-Green

   B-Blue

   I-Indigo

   V-Violet

   (Point to the color words and colors as you explain, or simply point to the colors in the rainbow)

4. Practice repeating the ROY B. GIV letters and relating them to the colors in the rainbow. (if you are feeling really creative you can make up a story about ROY B. GIV and how he appeared after a rainstorm and sun came out).

Second Session: (Outside)

1. Tell students they are going to look for Roy G. Biv-the rainbow, but they're not going to look in the sky.
2. If students are going to make their own bubble makers, distribute the following to each student:

   2 straws

   (1) 30" piece of yarn

3. Have students thread the yarn through the straws and tie the yarn together.
4. Go outside and bring the following:

   - Aluminum roasting trays
   - Soap bubble mixture

- Bubble makers

5. Show students how to use bubble makers:
   - Grab both straws and separate so that the yarn and the straws form a hollow rectangle.
   - Place bubble-maker in soap mixture and bring straws together.
   - Pull bubble-maker out of mixture and separate straws. You should have nice soapy film in between the straws.
6. The soap film is where they may see ROY G. BIV so make sure students examine the film carefully.
7. Of course you're going to want to make bubbles too. Gently draw the soap filmy straws through the air. Once you have a big bubble, pull the straws together to let the bubble form and release.
8. Help students perform the bubble-making action and look for ROY G. BIV.

Note: Humid, windless weather is best for bubble-making. Dry windy days are not favorable. Glycerin should help. Adjust your mixture as needed.

ROY G. BIV's Rainbow Lights

Description:
Students learn an acronym to remember the colors of the rainbow and observe rainbows made by mirrors, a flashlight and water.

Time: (1) 45 minute session

Materials Needed:

- Image of a rainbow (draw your own or use other source)
- Words and colors of rainbow (Optional, but helps explain ROY G BIV)

(per student pairs)

- Safety mirror
- Flashlight
- Bowl large enough to submerge mirror
- Water source

First Session

Preparation:

1. Write down and display the letters ROY G BIV. (blackboard, poster board, etc.)
2. Display rainbow image for all to see.

Procedure:

1. Tell students you would like to introduce them to a very colorful character named ROY G. BIV.

(You can point to the letters of his name)

2. Now point to the rainbow and tell them that this rainbow is called ROY G. BIV. Why you ask?
3. Explain to students that the letters stand for the following:

R-Red

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I-Indigo

V-Violet

(Point to the color words and colors as you explain, or simply point to the colors in the rainbow)

4. Practice repeating the ROY B. GIV letters and relating them to the colors in the rainbow. (if you are feeling really creative you can make up a story about ROY B. GIV and how he appeared after a rainstorm and sun came out).
5. Tell students they are now going to make their own ROY B. GIV rainbows.
6. Distribute mirrors, flashlights and bowls.
7. Fill bowls halfway with water.
8. Instruct student pairs to do the following:

   One student puts the mirror under the water and holds it at an angle.

   The other student shines the flashlight on the mirror.
9. When they get the angle and flashlight just right they should see ROY B. GIV rainbows on the wall or ceiling.

Book List

Books you can use throughout the investigation are:

Light

Adler, David A. *A Picture Book of Benjamin Franklin*. Holiday House, 1990.
Broekel, Ray. *Experiments with Light*. Children's Press, 1986.
Cole, Joanna. *The Magic School Bus Gets a Bright Idea; A Book about Light*. Scholastic Inc., 1999.
Crews, Donald. *Light*. Greenwillow Books, 1981.
Stwertka, Eve and Albert. *Heat, Light and Action!: How Electricity Works*. Julian Messner, 1991.

Color

Dorling Kindersley Ltd. *My First Look at Colors*. Random House, 1990.

Vision

Iveson-Iveson, Joan. *Your Eyes*. The Bookwright Press, 1985.
Murata, Michinori. *Water and Light: Looking through Lenses*. Lerner Publications Company, 1993.
Showers, Paul. *Look at Your Eyes*. Thomas Y. Crowell Co., 1962.
Smith, Kathie Billingsley. *Seeing*. Troll Associates, 1988.
Suhr, Mandy. *Sight*. Carolrhoda Books, Inc., 1993.
Ziebel, Peter. *Look Closer!* Clarion Books, 1989.

LASERs

Olesky, Walter. *Lasers*. Children's Press, 1986.
Whyman, Kathryn. *Light & Lasers*. Gloucester Press, 1986.

Illusions

Anno, Mitsumasa. *Topsy-Turvies*. Philomel Books, 1968.
Baum, Byarline and Joseph. *An Illusionary Tale*. Puffin Books, 1989.

Mirrors

Fitzpatrick, Julie. *Mirrors: Including Simple Experiments*. Silver Burdett, 1985.

Shadows

Simon, Seymour. *Shadow Magic*. Lothrop, Lee & Shepard Books, 1985.