Anglophone School District - North

Grade 4 Science - Unit Lesson Guide

Light

Table of Contents

The Aim of Science Education - Scientific Literacy

The aim of science education in the Atlantic Provinces is to develop scientific literacy.

Scientific Literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment.

The Three Processes of Scientific Literacy

An individual can be considered Scientifically Literate when he/she is familiar with, and able to engage in, three processes: Inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanation for phenomena. While there is a general agreement that there is no such sing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analysing data, and interpreting data are fundamental to engaging science. These activities provide students with opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of proposing, creating, and testing prototypes, products, and techniques to determine the best solution to a given problem.

Decision Making

The process of decision making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are important to their own right, and they also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Science Assessment Overview

Science is a hybrid term that houses different disciplines such as: Physics, Chemistry, Biology, Environmental Studies, Engineering, Math, etc. Given this broad spectrum, it is not realistic that we can paint science assessment with a single brush in terms of probes that work for every science activity. However, regardless of school subject, let alone science, the frequency of assessment should be unbalanced with formative assessment occupying 80% of practise and summative with the remaining 20%.

80% Formative - 20% Summative

Formative Assessment
Formative assessment is a range of formal and informal assessment procedures employed by teachers during their learning process in order to modify teaching and learning activities to improve student attainment. It typically involves qualitative feedback (rather than scores) for both students and teacher that focuses on the detail of content and performance. Feedback is the central function of formative assessment. It typically involves a focus on the detailed content of what is being learnt.

Science Formative Assessment falls into 2 distinct categories, and they are divided about how feedback is given. Please be aware that an activity could be informal or formal, it is the purpose of the task that determines purpose.

Informal Formative
Informal Formative Science Assessment acts as a monitoring probe and is distinct because it is not graded.

Formal Formative
Formal Formative Science Assessment provides specific feedback to students, the teachers corresponds via anecdotal feedback, rubrics, and written responses to offer progress to student attainment.

Summative Assessment
Summative assessment seeks to monitor educational outcomes, often for the purposes of external accountability. Usually occurring at the end of a learning unit and determines if the content being taught was retained.

Light

Focus and Context

The main focus of this unit is inquiry, with an emphasis on observing and making inferences. Students become involved with light interacting with a variety of materials. Some materials are opaque, transparent or translucent; some materials reflect, refract or disperse light. These interactions lead students to make qualitative inferences about the behaviour of light. The unit also has a strong technology focus, with students exploring the functions of various optical devices that have been developed over time. Towards the end of the unit, students will be involved in making optical devices using given procedures, or may design their own devices to suit a particular purpose. Students will start to become familiar with the difference between technological products and technological processes.

Comparing the science and technology of light could provide a context of this unit. Students will be involved in investigations of an inquiry type to explore the properties of light, but should also examine the optical devices that have been designed to make use of these properties. These optical devices have allowed scientists to enhance their senses, and learn more about the universe.

Unit Instructional Overview

Sources of Light	Light Radiates from a Source	Objects that Absorb, Transmit, and/ or Reflect Light	Bending Light	Dispersion of Light
Home Energy Audit	Understanding How Light Travels	Prior Knowledge	Bending Light	Making a Rainbow - Dispersion of Light
Does it Glow or Reflect		Access Prior Knowledge		Creating your own Optical Device
Understanding the Effects of Light		1st Cycle - Activity: Does light pass through?		
		2nd Cycle - Activity: Absorption and Shadows		
		3rd Cycle - Activity: Reflection		
		4th Cycle - Light Maze Activity		

* - EECD Grade 4 Inquiry package - available at https://portal.nbed.nb.ca/tr/lr/k-8Science/Pages/default.aspx

Light - Curriculum Outcomes

Optical Devices	106-1, 106-4 describe the knowledge of the properties of light that has led to the development of optical devices to extend our ability to observe		107-1, 303-8 compare how light interacts with a variety of optical devices
	205-10 construct an optical device that performs a specific task		107-10 identify women and men in their community who have careers that deal directly with lenses, mirrors, and prisms
Sources of Light	303-3 distinguish between objects that emit their own light and those that require an external source to be seen	205-5, 206-5 make observation and collect information during investigations to determine if an object emits its own light, and draw conclusions based on the evidence gathered	107-4 provide examples of how human-made sources of light have been designed to solve problems in the home and at school
	108-1 identify positive and negative effects of exposure to light		108-6 identify ways of conserving energy through conservative use of hone lighting
Light Radiates from a Source	205-5 make observations about how light is dispersed from a variety of light sources	303-2 demonstrate that light travels away from a source in all directions	206-5 conclude that light travels in a straight line based on evidence gathered through research and observations
Objects that Absorb, Transmit, and/or Reflect Light	303-4 investigate how light interacts with a variety of objects, in order to determine whether the objects cast shadows, allow light to pass through, and/or reflect light	206-1 classify objects as opaque, transparent, or translucent	303-5 predict changes in the location, shape, and relative size of a shadow when an object is placed in different positions and orientations relative to the light source and screen
	204-7, 205-5 plan a procedure and make observations to determine changes in a shadow's location, shape, and relative size when an object is placed in different positions and orientations relative to a light source and screen		205-5 make observations and collect information about the reflective properties of surfaces of different shapes and textures
Bending Light	303-6 demonstrate and describe how a variety of media can be used to change the direction of light		205-5 make observations and collect information about the refractive properties of materials of different shapes
Dispersion of Light	303-7, 104-6 demonstrate that while light can be separated into colours, and use the term "dispersion" for this process	205-3 follow a set of procedures to make and use a colour wheel	207-1 communicate and listen to others during investigations with colour wheels

Light

Strand - Optical Devices

General Curriculum Outcomes	Specific Curriculum Outcomes	Integrated Strand
106-1 describe examples of tools and techniques that extend our senses and enhances our ability to gather data and information about the world	106-1, 106-4 Describe the knowledge of the properties of light that has led to the development of optical devices to extend our ability to observe	Sources of Light (Understanding the Effects of Light)
106-4 describe instances in which scientific ideas and discoveries have led to new inventions and applications		
107-1 describe examples, in the home and at school, of tools, techniques, and materials that can be used to respond to their needs	107-1, 303-8 compare how light interacts with a variety of optical devices	Dispersion of Light (Creating your own Device)
303-8 compare how light interacts with a variety of optical devices such as kaleidoscopes, periscopes, telescopes, and magnifying glasses		
205-10 construct and use devices for a specific purpose	205-10 construct an optical device that performs a specific function	Dispersion of Light (Creating your own Device)
107-10 identify women and men in their community who work in science and technology related areas	107-10 identify women and men in their community who have careers that deal directly with lenses, mirrors, and prisms	Dispersion of Light (Making a Rainbow - Dispersion of Light)

*The outcomes from this section should be integrated throughout the unit.

Light

Strand - Sources of Light

General Curriculum Outcomes	Specific Curriculum Outcomes
303-3 distinguish between objects that emit their own light and those that require an external source of light to be seen	303-3 distinguish between objects that emit their own light and those that require an external source to be seen
205-5 make observations and collect information that is relevant to a given question or problems	205-5, 206-5 make observations and collect information during investigations to determine if an object emits its own light, and draw conclusions based on the evidence gathered
206-5 draw a conclusion, based on evidence gathered through research and observation, that answers an initial question	
107-4 provide examples of how science and technology have been used to solve problems in the home and at school	107-4 provide examples of how human-made sources of light have been designed to solve problems in the home and at school
108-1 identify positive and negative effects of familiar technologies	108-1 identify positive and negative effects of exposure to light
108-6 identify their own and their family's impact on natural resources	108-6 identify ways to conserving energy through conservative use of home lighting
106-1 describe examples of tools and techniques that extend our senses and enhances our ability to gather data and information about the world	*106-1, 106-4 Describe the knowledge of the properties of light that has led to the development of optical devices to extend our ability to observe
106-4 describe instances in which scientific ideas and discoveries have led to new inventions and applications	

*Has been integrated from Optical Devices Strand

Home Energy Audit

Outcomes:
108-6 identify ways of conserving energy through conservative use of home lighting

Lesson Activity Overview
At this grade level the focus can be restricted to ways to conserve electrical energy and reduce cost. In grade 6, students will take a more critical and in-depth look at the advantages and disadvantages of various ways of generating electricity.

Students should discuss ways to reduce the use of home lighting and how this will help to conserve energy. Students' suggestions could be posted in the classroom.

Task
Over the period of time use a table to note the electrical light being used wastefully (i.e. lights elft on for long periods of time). Where possible, note the amount of time the light source was efficiently used. 108-6

Does it Glow or Reflect

Outcomes:
303-3 distinguish between objects that emit their own light and those that require an external source to be seen
205-5, 206-5 make observations and collect information during investigations to determine if an objects emits its own light, and draw conclusions based on the evidence gathered

Lesson Activity Overview
This is an opportunity (via Brainstorm) for teachers to distinguish between objects that emit light (light sticks, bracelets, insects,and phytoplankton) and objects that can only be seen when light reflect from them into the eyes of the viewer.
The class can then develop an operational definition of a source of light.
This will give the teachers the opportunity to address many common misconceptions which students may have regarding sources of light (light from window or moon)
*Misconceptions are hard to change and will not happen over night, it takes constant evidence and experience to alter the students understanding. 303-3

Task
In groups, students should investigate manufactured sources of light that have been designed to solve problems. Use the task sheet and have students record their prediction, design, observations, and conclusions. 205-5, 206-5

Journal
Does the Moon emit its own light or does it reflect light from another source? Explain your answer 303-3

Assessment:Informal Formative
Ensure that students have participated in dialogue that differentiates between objects that emit light and objects that reflect light. 303-3

Ensure that students have created an operational definition of the different sources of light (emits vs reflects) 303-3

Assessment:Formal Formative
Ensure that students have recorded observations from work in groups to test different objects to determine if they emit their own light or if they reflect light from a source 205-5

Ensure that students have written conclusions that explain their perspective on if objects emit or reflect their own light 206-6

Ensure that students have created a journal entry the explains their perspective if objects emit or reflect their own light. 303-3

Object:_____	
Prediction (explain if you expect the object emit its own light or not, and explain WHY)	
Design (describe how you tested the object)	
Observations (describe what you observed)	
Conclusion (explain what actually happened and what you have learned)	

Object:_____	
Prediction (explain if you expect the object emit its own light or not, and explain WHY)	
Design (describe how you tested the object)	
Observations (describe what you observed)	
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Object:_____	
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Observations (describe what you observed)	
Conclusion (explain what actually happened and what you have learned)	

Object:_____	
Prediction (explain if you expect the object emit its own light or not, and explain WHY)	
Design (describe how you tested the object)	
Observations (describe what you observed)	
Conclusion (explain what actually happened and what you have learned)	

Understanding the Effects of Light

Outcomes:
107-4 provide examples of how human-made sources of light have been designed to solve problems in the home and at school
108-1 identify positive and negative effects of exposure to light
*106-1, 106-4 describe the knowledge of the properties of light that has led to the development of optical devices to extend our ability to observe

Lesson Activity Overview
Students should discuss the positive and negative aspects of exposure to light in their home and school. On the positive side, light sources allow us to see in dark places, and exposure to the sun can increase our production of vitamin D. Exposure to some sources of light, however, have health implications. Students should be cautioned, for example, about extended exposure to the sun and ways to prevent health effects resulting from sunburn and looking at a bright light source. 108-1

Investigate how the knowledge of properties of light have led to the development of optical devices in the past, present, and could lead to further development in the future. For example, past-microscope; present-laser disc walkman, fibre optics. Microscopes make visible objects that are too small to be seen with the naked eye, and binoculars extend our ability to see far away objects. (106-1, 106-4)

Journal
The things I think are good about the sun shining on me are...
The things I think are bad about the sun shining on me are... (108-1)

Explore the role of light in modern day devices. These could include but are not limited to X-rays, radiation therapy, photocopies, radio telescopes (SETI), or space telescopes. (106-1, 106-4)

Task
Make a poster to show how people have solved problems using light. Find or draw as many pictures of artificial sources of light as possible, and write underneath each picture the problem the sources of light solves. Examples might include street lights; watches that light up; bring, shadowless lights; and lights that indicate when a computer is on/ operating. 107-4 (each student could be responsible for 2-3 pictures with the explanation, gather all examples from students to make a class room poster)

Assessment:Informal Formative
Ensure that students have participated in discussions that highlight the positive and negative aspects to exposure to light. 108-1

Ensure that students have had a significant discussion about how devices that change over time (106-1, 106-4)

Assessment:Formal Formative
Ensure that students have created a journal entry that explain positive and negative effects of exposure to sun 108-1

Ensure that students participated in creating a poster that demonstrates their understanding of the problem the source of light solves 107-4

Ensure that students are able to explain the evolution of light in modern day devices (106-1, 106-4)

Light

Strand - Light Radiates from a Source

General Curriculum Outcomes	Specific Curriculum Outcomes
205-5 make observations and collect information that is relevant to a given question or problem	205-5 make observations about how light is dispersed from a variety of light sources
303-2 demonstrate that light travels away from a source	303-2 demonstrate that light travels away from a source in all directions
206-5 draw a conclusion, based on evidence gathered through research and observation, that answers an initial question	206-5 conclude that light travels in a straight line based on evidence gathered through research and observations

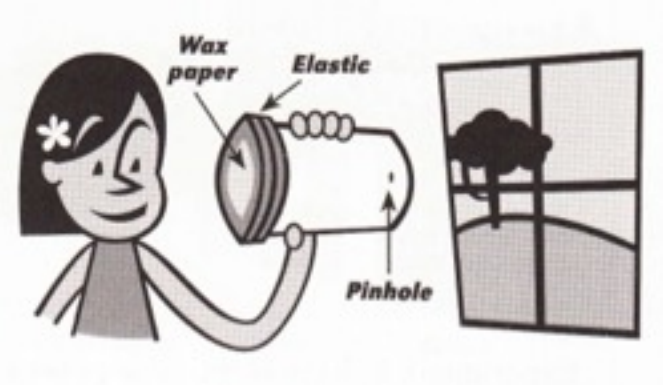
Understanding How Light Travels

Outcomes:
205-5 make observations about how light is dispersed from a variety of light sources
303-2 demonstrate that light travels away from a source in all directions
206-5 conclude that light travels in a straight line based on evidence gathered through research and observations

Lesson Activity Overview
Light radiates in all directions from a light source. Light rays travel in straight lines (you can't see around corners). When light rays from a source fall on an object, the object scatters (reflects) the light. We can see the object if some of the scattered rays enter our eyes.

Task 1 - Shadow Play
Have you ever tried to make a shadow of a rabbit or bird with your hands? How do you do it? What's the secret?

Task 2 - Pinhole Viewer
Make a pinhole viewer by punching a hole the size of a pin or thin nail in the bottom of a can. Cover the open end with wax paper. In a darkened room, look out a window or at a tv screen.



Journal
Explain, using illustrations, how light radiates from a flash light in a dark room. 303-2

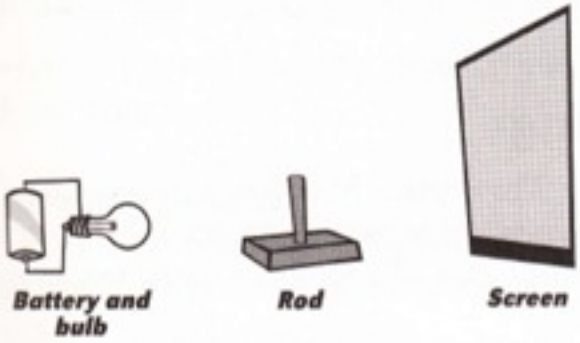
Assessment:Formal Formative
Ensure that students have recorded appropriate observations of how light is dispersed from a variety of light sources 205-5

Ensure that students have created conclusions that appropriately explain that students understand how light radiates from a source 206-5

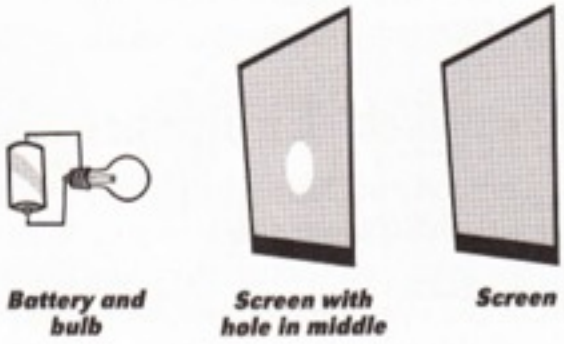
Ensure that students are able to appropriately respond to the journal entry that asks them to explain how light radiates from a source 303-2

Task 1 - Shadow Play

(a) What will the shadow of the rod look like? Its size? Where will it be on the screen?



(b) What will the lighted patch look like? Its size? Its position on the screen?



Predict
Try drawing carefully (with a ruler, if you like) your predictions on the diagram. Pay attention to (a) the size and position of the rod and (b) the size and position of the lighted patch.

Observe
What happened when we turned on the light? Were you surprised? (check one)

Size: Was the shadow of the rod: Bigger ____ Smaller ____ Same Size ____
Position: Where was the shadow of the rod?

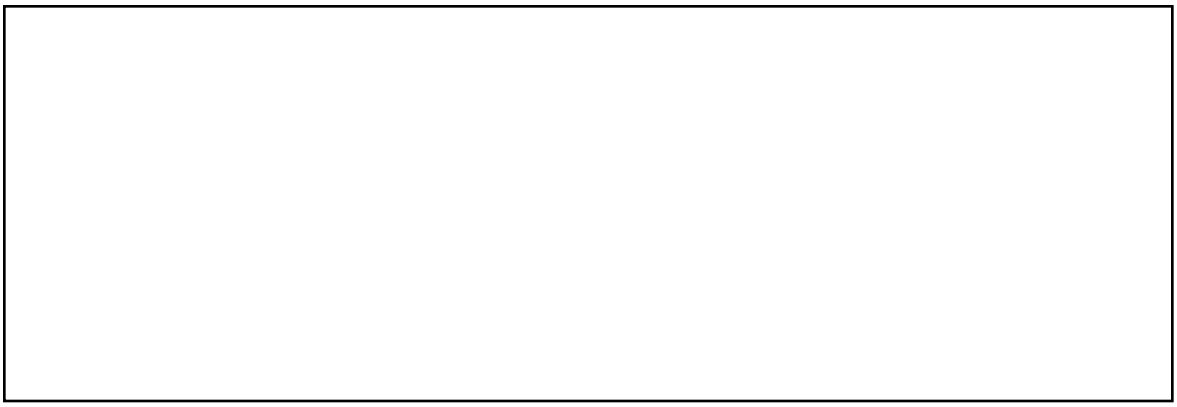
Where was the lighted patch?

Explain
How can we predict the size and position of a shadow?

Task 2 - Pinhole Viewer

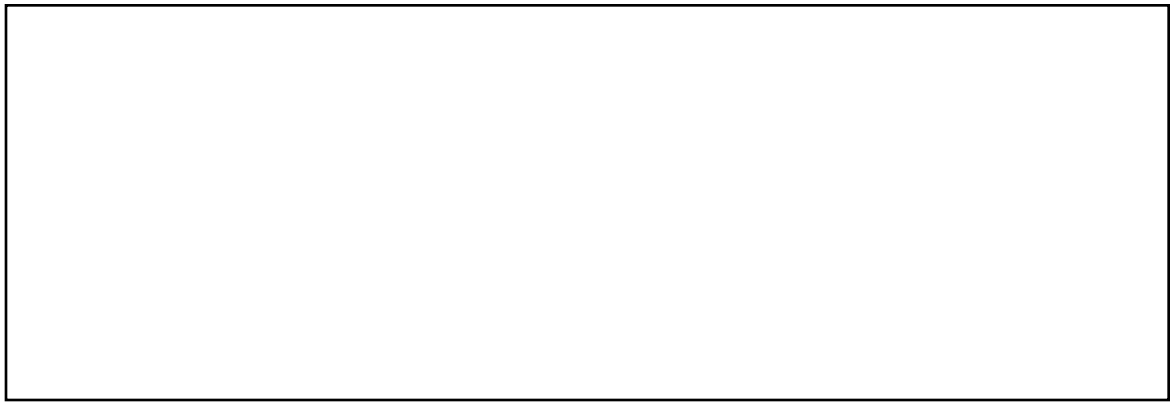
Predict

Draw what you think you will see on the wax paper when you look out the window



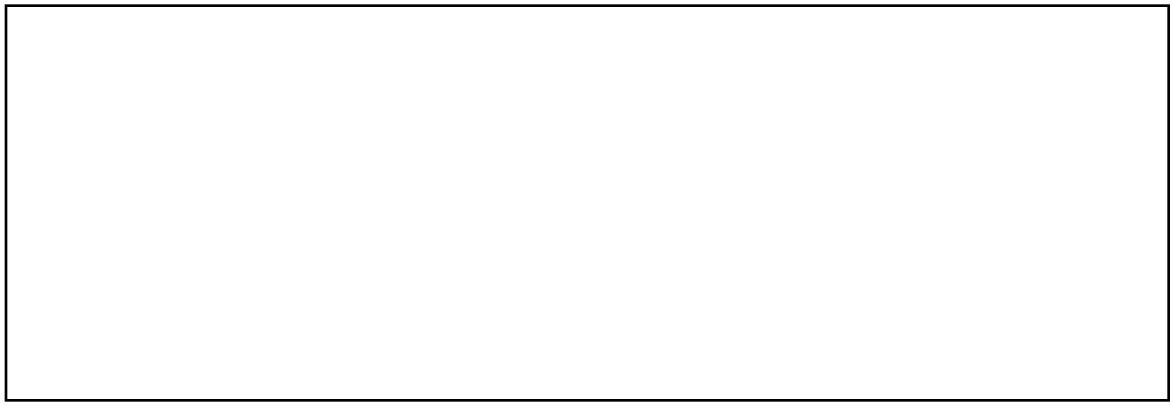
Observe

Take a look through your pinhole viewer. How is the image on the wax paper different from the real thing?



Explain

Try drawing a ray diagram that explain your observations



Light

Strand - Objects that Absorb, Transmit, and/or Reflect Light

General Curriculum Outcomes	Specific Curriculum Outcomes
303-4 investigate how light interacts with a variety of objects, in order to determine whether the object casts shadows, allow light to pass through, and/or reflect light	303-4 investigate how light interacts with a variety of objects, in order to determine whether the object casts shadows, allow light to pass through, and/or reflect light
206-1 classify according to several attributes and create a chart or diagram that shows the method of classifying	206-1 classify objects as opaque, transparent, or translucent
303-5 predict the location, shape, and size of a shadow when a light source is placed in a given location relative to an object	303-5 predict changes in the location, shape, and relative size of a shadow when an object is placed in different positions and orientations relative to the light source and screen
204-7 plan a set of steps to solve a practical problem and to carry out a fair test of a science-related idea	204-7, 205-5 plan a procedure and make observations to determine changes in a shadow's location, shape, and relative size when an object is placed in different positions and orientations relative to a light source and screen
205-5 make observations and collect information that is relevant to a given question or problem	
205-5 make observations and collect information that is relevant to a given question or problem	205-5 make observations and collect information about the reflective properties of surface of different shapes and textures

New Nouveau Brunswick
Be...in this place • Être...ici on le peut

Science Resource Package: Grade 4

Light:

Objects that Absorb, Transmit and/or Reflect Light

New Brunswick Department of Education

August 2010

ⓘ Background Information

Prior Knowledge:

In this unit before starting these activities, students should have already learned:

- Some objects give off their own light and some require an external source of light to be seen
- Light travels away from a source in all directions
- Light travels in straight lines

They may also know:

- Some history of manmade light
- Natural and artificial light are different
- Fireflies make light
- There are different colours of light
- Mixing two colours of light gives a third different colour

Common Misconceptions:

- Light either passes through or does not pass through an object, it cannot do both
- Only mirrors or smooth shiny things reflect light
- We see things because light shines on them and brightens them, not because they reflect light to our eyes
- Light is instantaneous, it does not travel over a distance

Did You Know?

For a more in-depth understanding of light, there are two very good online resources.

1) NSTA (National Science Teachers Association) has a variety of free resources. "Science Objects" are information packages about specific topics. Go to http://www.nsta.org. You may be required to register, however registration is free. Under Learning Resources and Opportunities click on Science Objects. There is a search box on the left. In this case, type "light". There are four Science Objects related to light.
2) The Physics Classroom found at http://www.physicsclassroom.com/Class/light/U12L2a.cfm talks about the electromagnetic spectrum, visible light and the eye, light absorption, transmission, and reflection and colours.

Models for light

With grade four students the ray model of light is used.

You should be aware that there are actually three models of light that scientists find useful when thinking about and discussing light:

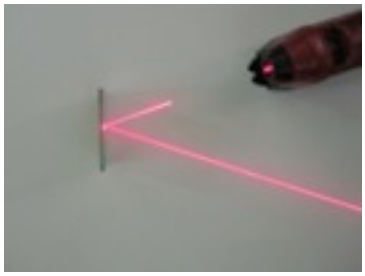
the ray model
the particle model
the wave model

Some properties of light are best described using rays, some using particles and some are best described using waves. None of the models by themselves, describe all of light's properties.

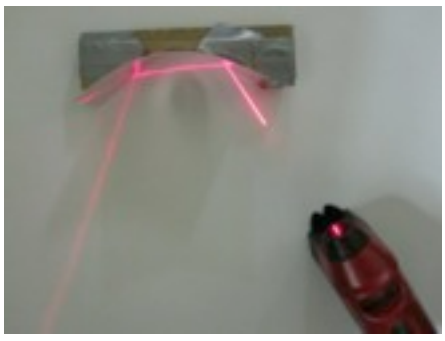
Information is given on each of the models to provide you with a better idea of how light acts, even though the particle and wave models will not be used with students at this level.

1) The ray model is an excellent model for visualizing how light refracts and reflects.

   An object that gives off light sends "light rays" in straight lines in every direction until they hit something. If it is a mirror, the rays are reflected in a very specific and predictable way. The angle of the incoming light ray determines the angle of the outgoing light ray. Those angles are always equal. You may have heard "the angle of incidence (the incoming ray) is always equal to the angle of reflection (outgoing ray)". This may be hard to see with a normal flashlight since the light rays are spread out. Lasers give a pretty accurate result. If you wanted to measure these angles, you could use a protractor.



   This is also true with curved mirrors. This site might help http://www.learner.org/teacherslab/science/light/lawslight/funhouse/index.html



2) The Wave model is very useful when talking about the electromagnetic spectrum. This includes visible light, microwaves, x-rays plus a few others. Electromagnetic waves are similar to sound waves and water waves in that they have a wavelength (the distance between two adjacent peaks) and a frequency (how many waves pass a given point in a certain amount of time). The wavelengths of visible light are exactly that, visible to the human eye, while wavelengths that are shorter or longer are not visible but still able to be perceived given the right equipment such as x-ray film, a TV (signals sent by a remote control), or a cell phone tower.

   White light is made up of all the colours of the spectrum (ROYGBIV) and black is the complete absence of those colours. Every colour has a very specific wavelength or frequency. Depending on the wavelengths reflected, different objects appear as different colours. If a certain material absorbs every wavelength but red, the red is reflected making the object appear red. This also explains why some objects can be transparent, translucent or opaque. It depends on how many light waves are absorbed.

3) The third model for light is the photon model and it is helpful in explaining fluorescence and phosphorescence. The idea is that everything is made up of atoms which contain protons, neutrons and electrons. Usually electrons have a certain amount of energy and stay in the same “energy level” of their atom. Sometimes, however, when energy is added, the electrons use that energy to jump to a higher “energy level”. A useful analogy would be having electrons on a beach in a lower energy level then getting an energy injection that allows them to jump up onto a cliff. When the electrons jump from the higher energy level back down to the lower energy level, they emit light (photons). Fluorescent light bulbs work this way. They contain a bit of mercury that gets excited when electricity is passed through. The mercury atoms, in turn, excite the electrons in the coating of the glass which glow as the electrons move back from the higher energy level to the lower energy level.

Instructional Plan

Access Prior Knowledge

Have students think about objects and materials that allow light to pass through and those that prevent light from passing through (block light). The list can be generated on 2 separate pieces of chart paper, or each item could be written on an index card and placed under the appropriate heading on a bulletin board. The lists shared as a group could also be recorded on your smart board.

Light passes through	Light is blocked (does not pass through)

✓ **Assessment:**
Note the concepts and misconceptions students are expressing. You will need to know these to plan effective questions for subsequent activities and discussions so that students will examine and adjust their alternate conceptions.

Post student versions of curricular outcomes on chart paper (see page 28).
Inform students that these outcomes will be addressed over the next portion of the unit. Point out to students which outcomes are being addressed in each activity.

1st Cycle

✪ Curriculum Outcomes

104-6 Demonstrate that specific terminology is used in science and technology contexts
106-4 Describe instances in which scientific ideas and discoveries have led to new inventions and applications
107-1 Describe examples, in the home and at school, of tools, techniques, and materials that can be used to respond to their needs
205-3 Follow a given set of procedures
205-5 Make observations and collect information that is relevant to a given question or problem
206-1 Classify according to several attributes and create a chart or diagram that shows the method of classifying
206-5 Draw a conclusion, based on evidence gathered through research and observation, that answers an initial question
207-1 Communicate questions, ideas, and intentions, and listen to others while conducting investigations
303-4 Investigate how a beam of light interacts with a variety of objects, to determine whether the objects cast shadows, allow light to pass through, or reflect the light

Explore various materials for how much light they let through and/or block and classify them. The purpose of the activity below is to help students investigate materials that keep light out and materials that easily permit light to pass through. To minimize the amount of materials, this activity can be set up in centres where each centre has only one or two materials to test. Students would rotate through the centres to test all objects.

Activity: Does light pass through?

Materials:

Flashlight

Variety of materials such as: popsicle sticks, ball, book, different kinds of paper (such as bristol board, construction paper, tracing paper, newspaper, tissue paper, overhead transparency paper, coloured cellophane paper), a variety of different items to wrap food (such as plastic wrap, aluminum foil and waxed paper), nylons, different types of fabric, glass, plastic water bottles, mira, piece of cardboard or white paper at each centre

Additionally – You could ask students to bring objects from home to test

Student instructions and observation table can be found on page 30.

Does light pass through?

1. Before testing each item, predict whether the object will allow all, some or none of the light to pass through. Record your prediction on the table below.

2. Turn on the flashlight. Aim it at the object being tested. Record your observations.

Material	Predict how much light passes through (all, some, none)	The actual amount of light passing through (all, some, none)

3. After you have tested all of the items, classify your items as “all light passed through”, “Some light passed through”, or “no light passed through”.

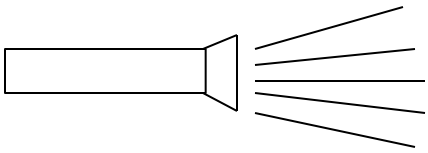
4. As a group compare and discuss your predictions and your results from your experiment.

All light passed through	Some light passed through	No light passed through

Seeing the Light

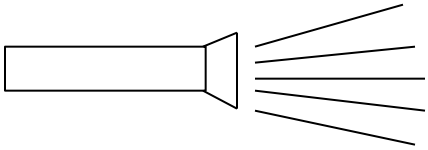
Draw where you think the light rays go when they:

Pass through an object



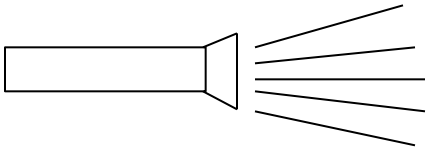
Flashlight **Draw your object** **screen (paper)**

Are blocked by an object



Flashlight **Draw your object** **screen (paper)**

Some light passes through the object



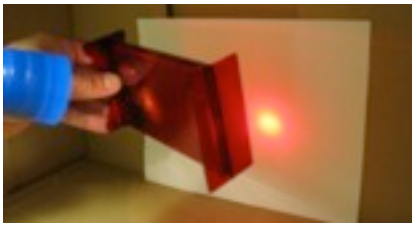
Flashlight **Draw your object** **screen (paper)**

Remember: Light always travels in straight lines!

Explain that students will be exploring different materials to determine if light can pass through.

- Ask them to predict whether the object will allow all, some, or none of the light to pass through before they test each object. Their predictions should be recorded.

- Do one sample all together. (They do not all need to have the same sample, just one so they can be walked through the steps of the exploration.) Turn the lights off in your classroom. Tell students to turn on the flashlight and aim it at the object being explored. How will they decide if all, some, or none of the light is passing through the object? **Lead students to the idea that they should point the flashlight towards a solid coloured background and hold the object between the light source and the screen. This will help them see the interaction more clearly.**



- Make sure that students are taking turns holding the flashlight, the screen and making observations.

- Once they have tested all the materials, they will group the items under the headings “All light passed through”, “Some light passed through”, and “No light passed through”.

- Have students choose one object that allowed all of the light to pass through and draw where the light rays are going. Have them do the same thing for one object that blocked the light and one object that allowed some light to pass through. Labels will be assigned to each after the discussion. See page 31 for student page.

ⓘ Teacher note: A connection may be made to the Rocks and Minerals unit. Several different minerals could be included in these experiments since opacity is a mineral property that can be used to distinguish between similar minerals, such as gypsum and quartz.

Cross-curricular links:

ELA

1. Students will be expected to:
   a) Explore and discuss their thoughts, ideas, and experiences and consider those of their peers
   b) Ask and respond to questions to clarify information and explore solutions to problems
   c) Explain personal opinions and respond to questions and opinions of others

2. Students will be expected to:
   a) Contribute to conversations, small-group and whole-group discussion, showing an awareness of when to speak and when to listen
   b) Use word choice, tone of voice, facial expressions, and gestures appropriate to the speaking occasion
   c) Give and follow instructions and respond to questions and directions

3a. Students will be expected to:
   Show basic courtesies of conversation in group interactions

8. Students will be expected to:
   a) Use strategies in writing and other ways of representing to
   - formulate questions and organize ideas
   - record experiences

.

✓ **Assessment:**
During the student activity, make notes on outcomes (or parts of outcomes) you observe being addressed. Process skill outcomes are part of the curriculum and should be assessed. Using the observation chart or the checklist (see pages 34 to 36) on a clipboard may be helpful to you. Develop your own code for quick notes.

A suggested code:
√ for observed and appropriate,
WD with difficulty,
A absent.

This chart may be used on multiple days, using a different coloured pen or pencil each day and putting the date in the corner. You may not have a symbol or note for every child every day. Some teachers like to focus on a group or two each time. However you choose to make note of your observations, you will always have a sense of who you need to take more notice of and who might need extra support. The information

Reflection: Class Discussion

Which objects let all (or most) of the light pass through?
Discuss their 1st drawing.

Did all students show this the same way? Is there one representation that is easier to understand than the others?

Which objects did not let any light pass through?
Discuss their 2nd drawing.

Were there any that let some of the light pass through?
Discuss the 3rd drawing.

Ask students to work together to answer this question: *If you had to come up with a rule to help people predict if light would pass through an object, what would that rule be?*

Introduce vocabulary: transparent, translucent, and opaque.

ⓘ Teacher note: Translucent can be defined as material that allows some light to pass through. There are other more specific definitions that can be found online or in the dictionary, but for our purposes, this will suffice.

Where would we use materials that are transparent (let all of the light pass through)? *Translucent* (let most of the light pass through)? *Opaque* (light does not pass through)? (For example: opaque material for clothing, opaque or translucent materials for window coverings)

Cross-curricular links:
ELA
1. Students will be expected to:
a) Explore and discuss their thoughts, ideas, and experiences and consider those of their peers
b) Ask and respond to questions to clarify information and explore solutions to problems
d) Listen critically to others' ideas or opinions expressed

2. Students will be expected to:
a) Contribute to conversations, small-group and whole-group discussion, showing an awareness of when to speak and when to listen
b) Use word choice, tone of voice, facial expressions, and gestures appropriate to the speaking occasion
c) Give and follow instructions and respond to questions and directions
d) Engage in and respond to oral presentations

3a. Students will be expected to:
Show basic courtesies of conversation in group interactions

To introduce students to the idea that we are only able to see objects that reflect light back to our eyes, do the following as a demonstration or ask students to work in small groups.

Use an object such as a mug or pencil and ask students to observe how easy it is to see the object through a transparent material, a translucent material and an opaque material. Not only does light pass through objects, all objects reflect at least a little bit of light, allowing us to see that object. Students can read page 11 in the student resource *Light Up Your Life* to get a clearer understanding of this concept.

ⓘ Teacher note: The fact that we only see objects that reflect light to our eyes is an abstract concept. It is not expected that students master this concept. The purpose is to introduce the idea.

Revisit the Accessing Prior Knowledge activity (page 6). Ask: *Are there any items that should be added to or revised? Is there other information we could add?* Add any rules to the list/chart such as a rule that predicts when light will or will not pass through objects. Students may now wish to sort into three categories instead of two: transparent, translucent, opaque. Remind your class about respectful discussion. The discussion tips on pages 26-27 may be helpful.

Cross-curricular links:
ELA
8. Students will be expected to:
a) Use strategies in writing and other ways of representing to
- formulate questions and organize ideas
- record experiences

b) Experiment with different ways of making their own notes

c) Experiment with language appropriate to purpose, audience, and form, that enhances meaning and demonstrate imagination in writing and other ways of representing

Reflection: Journaling

Students can create a 3-flap foldable to reinforce the new vocabulary and assign examples. Take a piece of construction paper and make a “hamburger” fold. Make 2 cuts from the edge to the fold. Have students cut out each of their drawings from the activity and glue the 3 drawings under a flap (it will need to be glued under the flap and stretched across the fold). The outside of the flap should be labelled with the word (transparent, translucent, opaque) that matches the example.

Fold cut drawings label

✓ **Assessment:**
Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

Note whether students can correctly match their drawings with the words opaque, transparent, and translucent.

Storage options for foldables:

- Insert into a large zippered plastic bag. The bag can be hole-punched and put inside a duotang or binder. A strip of wide tape folded over the left edge of the bag before punching the holes will keep the bag from ripping
- Glue into notebooks or duotangs
- Display them on bulletin boards

Possible Extension:

- Early settlers used oiled paper for windows http://www.capelinks.com/cape-cod/main/entry/bring-oiled-paper-for-your-windows/ Research about this practice and try oiling paper to see what they might have been like.

- Art: Create a "stained glass" window design using construction paper (opaque) and tissue paper (translucent).

  The following sites show some ideas:

  http://www.kinderart.com/sculpture/paperscreen.shtml

  http://www.teamsmedieval.org/news/2000-2001/stainedglass.pdf

2nd Cycle

✪ Curriculum Outcomes

204-7 Plan a set of steps to solve a practical problem and to carry out a fair test of a science-related idea
205-5 Make observations and collect information that is relevant to a given question or problem
206-5 Draw a conclusion, based on evidence gathered through research and observation, that answers an initial question
207-1 Communicate questions, ideas, and intentions, and listen to others while conducting investigations
303-5 Predict the location, shape, and size of a shadow when a light source is placed in a given location relative to an object

Activity: Absorption and Shadows

Tell students that they are going to look at shadows. Ask students: *From what we learned about how light interacts with objects, what kind of object should we use for this activity (opaque, translucent or transparent)?*
We are going to test three different objects then use the object that gives the best shadow to do another experiment.

Materials:

Flashlights
Several pieces of white paper
Object that casts a shadow (e.g. their heads or a toy)
Bright light (slide, overhead, LCD projector)
Measuring tape or another way to estimate distance
For larger objects - wall or flat vertical surface (back of a bookshelf, door);
For smaller objects – flat vertical surface as well as a horizontal surface
One of the “translucent” objects
One of the “transparent” objects

- Provide students with the necessary materials.
- Start by having students test which type of object (transparent, translucent, or opaque) gives the best shadow.
- Using the object that provides the best shadow, ask them to create a shadow then figure out how to change its:
    a) shape
    b) location
    c) size

Cross-curricular links:
ELA
1. Students will be expected to:
a) Explore and discuss their thoughts, ideas, and experiences and consider those of their peers
b) Ask and respond to questions to clarify information and explore solutions to problems
c) Explain personal opinions and respond to questions and opinions of others

2. Students will be expected to:
a) Contribute to conversations, small-group and whole-group discussion, showing an awareness of when to speak and when to listen
b) Use word choice, tone of voice, facial expressions, and gestures appropriate to the speaking occasion
c) Give and follow instructions and respond to questions and directions

3a. Students will be expected to:
Show basic courtesies of conversation in group interactions

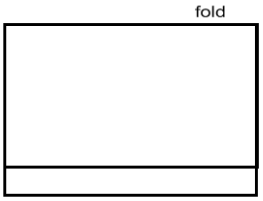
8. Students will be expected to:
a) Use strategies in writing and other ways of representing to
- formulate questions and organize ideas
- record experiences

9a. Create written and media texts, collaboratively and independently, in different modes and in a variety of forms
Recognize that particular forms require the use of specific features, structures, and patterns

Health
Independently apply decision making and problem solving processes

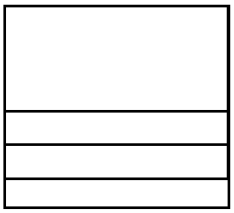
Objects could be something large like their heads or something smaller like a toy or pencil. For larger objects the paper can be mounted on the wall, cupboard or door. For smaller objects, the paper can be mounted on a wall, book, or box, but there should also be either a portion of the paper or another piece of paper that is on the horizontal surface.

Have students generate rules for how to change a) the size, b) the shape, and c) the location of a shadow. On a layered book foldable, draw a labelled picture that shows the positions of the light source, object and shadow to help explain their rules.



Fold one sheet of paper unevenly so there is a flap

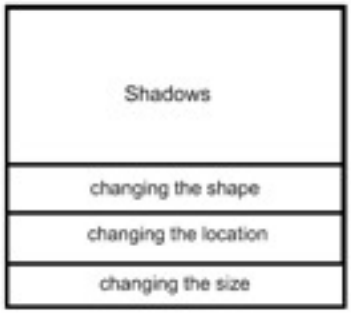
Fold a second sheet more unevenly



Place the folds inside each other to create 4 layers.

Layered book instructions:

- The top flap can be labelled: Shadows.
- The second layer has notes and diagrams about changing the shape of shadows.
- The third layer would have notes and diagrams about changing the location of shadows.
- The fourth layer would have notes and diagrams about changing the size of shadows.



ⓘ Teacher note: Shadows

The shorter the distance between the object and the light source, the bigger the shadow (when the screen stays in one place).

The farther away the screen, the bigger the shadow is (when the light source and object stay in the same place).

Brighter light makes a darker shadow.

✓ **Assessment:**
On observation chart (or other record), note how students are performing on the skill outcomes.

Reflection: Class Discussion

Cross-curricular links:
ELA
1. Students will be expected to:
   a) Explore and discuss their thoughts, ideas, and experiences and consider those of their peers
   b) Ask and respond to questions to clarify information and explore solutions to problems
   d) Listen critically to others' ideas or opinions expressed
2. Students will be expected to:
   a) Contribute to conversations, small-group and whole-group discussion, showing an awareness of when to speak and when to listen
   b) Use word choice, tone of voice, facial expressions, and gestures appropriate to the speaking occasion
   c) Give and follow instructions and respond to questions and directions
   d) Engage in and respond to oral presentations
3. Students will be expected to:
   a) Show basic courtesies of conversation in group interactions
   c) Show an awareness of the kinds of language appropriate to different situations and audiences

Ask students:

What did you do to change the size of the shadow?
Why do you think that changed the size of the shadow?
What did your diagram look like?
Is there another way to show this? Did anyone try anything different?

Have the students share their diagrams. There should be differences among them depending on how they changed the size of the shadows. If students do not use them, use ray diagrams also as a way to show what is happening.

Repeat the same questions for changing the shape of shadows, and then the location of shadows.

If something makes a shadow, where does the light go? (opportunity to introduce the terms "absorb" and "reflect")

When would shadows be useful? (shady areas – to avoid the heat and some of the UV rays of the sun, shadow puppets, to grow different types of plants, to measure the time of day)

To test the students' rules for changing shadows, the following website can be used. It allows users to choose an object inside a room and to change how close the light source is to the object. It also lets the user change the brightness and angle of the light source to see how each affects the shadow cast by the object. Students can also click on "outside" and choose from 4 different objects then move the sun across the sky to see the shadows cast by the object. http://www.sciencekids.co.nz/gamesactivities/lightshadows.html .

Revisit the Accessing Prior Knowledge activity (page 6). Ask: *Are there any items that should be added to or revised? Is there other information we could add?* Add any rules to the list/chart. For example, the rules for shadows when light is blocked by an object can be written on the "Light is Blocked" or "Opaque" chart paper. Remind your class about respectful discussion. The discussion tips on pages 25-26 may be helpful.

Reflection: Journaling

Cross-curricular links:
ELA
8. Students will be expected to:
a) Use strategies in writing and other ways of representing to
- formulate questions and organize ideas
- record experiences

b) Experiment with different ways of making their own notes

c) Experiment with language appropriate to purpose, audience, and form, that enhances meaning and demonstrate imagination in writing and other ways of representing

Draw where the light (sun) must be. Explain how you know.

or

You are planning on having a picnic in the shade of a large tree. Draw where the tree shadow is and explain how you know.

✓ **Assessment:**
Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

Note whether students can identify the position of the sun or tree shadow and how they know.

Think like a scientist

Asking good questions is an important skill in science. Initially students will need support. Model the skill with the whole class and students will begin to have the confidence to contribute. After some practice, students will be able to generate questions successfully individually.

Cross-curricular links:
ELA
8a. Students will be expected to:
Use writing and other forms of representation to
- formulate questions

Present students with a situation and ask them to generate questions that could be investigated scientifically. (These situations and questions do not have to be limited to those that can be done in a classroom.)

Situation:

> Trees planted in the right places around your house can help save energy used for heating and air-conditioning. Computer models show planting only three trees could save up to $300 a year in energy costs.
>
> What is one question concerning planting trees to save money that could be investigated scientifically?

For example:

> What kind of tree blocks the most sunlight?
> How close to the house should I plant a maple tree?

Possible Extensions:

- Write a skit or play that uses shadow puppets.
- Look at the video, *Shadow Tricks*. http://pbskids.org/curiousgeorge/video/td/video_pop.html?clip=td/103B&title=Shadow%20Tricks&ar=16:9&cc=true&filetype=mov&bandwidth=_hi Try to make your own shadow tricks.
- How does your shadow change?

The students will go outside to measure the change in shadow size and location over the course of a day. Keep a record or have students take digital pictures.

You could have students measure and keep track of the changes of their own shadow every hour or measure the shadow of an object such a flagpole, tree or large stick placed in the ground throughout a day.

- Choose a pattern block (or other object) and a flashlight. Set the pattern block near the centre of an edge of a paper. Use the flashlight to have it cast a shadow on the paper. Choose a colour and trace the shadow. Choose a way of moving the flashlight (closer, farther away, or change the angle). Move the flashlight a little the way you have chosen. With another colour trace the shadow now. Move

- the flashlight more in the direction you have chosen, and trace the changed shadow. Continue as many times as you like.
  Starting with the first shadow traced, colour it in. Colour the part of each shadow not under the one before. What do you notice about your design?

- Draw a pattern block and its shadow using shading to show the different degrees of shadow and brightness.

3rd Cycle

✪ Curriculum Outcomes

104-6 Demonstrate that specific terminology is used in science and technology contexts
106-4 Describe instances in which scientific ideas and discoveries have led to new inventions and applications
107-1 Describe examples, in the home and at school, of tools, techniques, and materials that can be used to respond to their needs
205-3 Follow a given set of procedures
205-5 Make observations and collect information that is relevant to a given question or problem
206-5 Draw a conclusion, based on evidence gathered through research and observation, that answers an initial question
207-1 Communicate questions, ideas, and intentions, and listen to others while conducting investigations
303-4 Investigate how a beam of light interacts with a variety of objects, to determine whether the objects cast shadows, allow light to pass through, or reflect the light

Students will be testing to see what happens when light hits different surfaces.

Activity: Reflection

Materials:

Flashlight
Tinfoil – smooth and crumpled
Bowl or pan of water
Mira (from Math program)
Smooth mirror
Curved mirror
Spoon
Piece of paper to act as a screen
Optional: Large cardboard box or desk/table that can be covered with a blanket to eliminate or reduce the amount of ambient light
Additional materials could be brought in by students

Students will shine a flashlight on the different surfaces to investigate what happens to the path of light when it hits various surfaces. With the water, the students can observe the reflection when the water is still and then when the water has ripples.

Cross-curricular links:
ELA
1. Students will be expected to:
a) Explore and discuss their thoughts, ideas, and experiences and consider those of their peers
b) Ask and respond to questions to clarify information and explore solutions to problems
c) Explain personal opinions and respond to questions and opinions of others

2. Students will be expected to:
a) Contribute to conversations, small-group and whole-group discussion, showing an awareness of when to speak and when to listen
b) Use word choice, tone of voice, facial expressions, and gestures appropriate to the speaking occasion
c) Give and follow instructions and respond to questions and directions

3a. Students will be expected to:
Show basic courtesies of conversation in group interactions

8. Students will be expected to:
a) Use strategies in writing and other ways of representing to
- formulate questions and organize ideas
- record experiences

9a. Create written and media texts, collaboratively and independently, in different modes and in a variety of forms
Recognize that particular forms require the use of specific features, structures, and patterns

The easiest way to see the light is to have a “low ceiling”. Putting samples inside a cardboard box on its side, under a desk or table or even holding a large piece of cardboard, book or chart paper over where the students are working will help them see the path of the light.

Students will rotate through different stations containing different materials.

✓ **Assessment:**
On observation chart (or other record), note how students are performing on the skill outcomes.

Reflection: Small Group

Ask students to work as a group to discuss then draw and label a diagram to show the light’s path from the light source to:

a) One of the flat surfaces and its reflection.

b) One of the rough surfaces and its reflective path.

Students may need to retest some of the samples to get a better idea of what their drawings should look like.

Reflection: Class Discussion

Is light getting reflected? How do you know?

Did every material reflect light in the same way? Why or why not? (Did they notice anything different when testing the Mira – some light goes through and some light is reflected)

Discuss the diagrams they made for smooth surfaces. *Did every group have the same diagram? If not, why?*

Discuss the diagrams they made for rough surfaces. *Did every group have the same diagram? If not, why?*

Why does light reflect differently from the differently shaped surfaces?

Page 19 of the student resource, *Light up Your Life,* explains that “when light strikes an uneven surface, it is reflected in many different directions. That is why people in different positions can see the same object.” Have students look at the picture and read page 19 of the student resource.

Cross-curricular links:
ELA
1. Students will be expected to:
a) Explore and discuss their thoughts, ideas, and experiences and consider those of their peers
b) Ask and respond to questions to clarify information and explore solutions to problems
d) Listen critically to others’ ideas or opinions expressed
2. Students will be expected to:
a) Contribute to conversations, small-group and whole-group discussion, showing an awareness of when to speak and when to listen
b) Use word choice, tone of voice, facial expressions, and gestures appropriate to the speaking occasion
c) Give and follow instructions and respond to questions and directions
d) Engage in and respond to oral presentations
3. Students will be expected to:
a) Show basic courtesies of conversation in group interactions
c) Show an awareness of the kinds of language appropriate to different situations and audiences

ⓘ Teacher note: Students may challenge this concept asking why they can see the smooth tin foil since it reflects light in one direction. Remind them that there are a lot of light rays being directed at the objects in the room. With the flashlights, we are being more specific about the direction we are aiming those rays, but the room is not completely dark and there are still other light beams that will be reflected from different angles.

Where would we use reflection in our daily lives? (For example: reflectors on a bicycle, security mirrors in stores, fiber-optics for sending phone and television signals, identifying chemicals using a special machine called a spectrophotometer, telescopes, etc.)

Tell students the story about Archimedes and his mirror invention. (See page 32)

http://www.teachersdomain.org/asset/lsps07_vid_lightreflect/ has a video, *Light and the Law of Reflection*, that shows a model for light and how it reflects from smooth and rough surfaces. It also discusses how light is reflected off things like a leaf, even though we are not able to see our reflection in it. This site does not always work well but the visuals are worth giving it a try.

Revisit the Accessing Prior Knowledge activity (page 6). Ask: *Are there any items that should be added to or revised? Is there other information we could add?* Add any rules to the list/chart such as rules for reflecting by an object that allows light to pass through, those that block light and reflections from different surfaces. Remind your class about respectful discussion. The discussion tips on pages 26-27 may be helpful.

Reflection: Journaling

On a calm day, you can see your reflection in the water. On a windy day, you cannot. Why?

Cross-curricular links:
ELA
8. Students will be expected to:
a) Use strategies in writing and other ways of representing to
- formulate questions and organize ideas
- record experiences

b) Experiment with different ways of making their own notes

c) Experiment with language appropriate to purpose, audience, and form, that enhances meaning and demonstrate imagination in writing and other ways of representing

✓ **Assessment:**
Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

Note whether students can explain that the type of surface affects the way light is reflected.

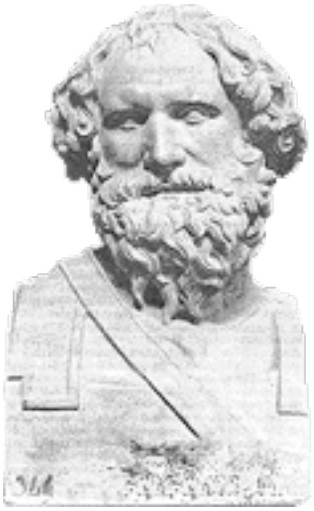
Possible Extensions:

- Use the site http://www.learner.org/teacherslab/science/light/lawslight/funhouse/index.html

to explore concave and convex mirrors and the combinations that are possible which are often seen in a funhouse at the fair.

- Use the video *Mirrors* at http://teachertube.com/viewVideo.php?video_id=12292&title=Mirrors to explore how to use a mirror to write code.

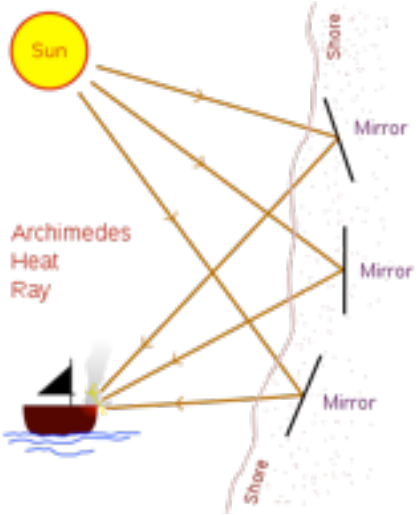
Archimedes



Archimedes was a famous scientist and inventor who lived in Sicily about 2,000 years ago.

Archimedes created machines that were powerful enough to lift ships out of the water. His inventions were used to defend his city against enemy ships.

One of Archimedes' famous inventions is called the Archimedes Heat Ray. Using just the sun's rays and mirrors, it is said the heat ray could cause an enemy ship to burst into flames!



Using his knowledge of reflection, Archimedes placed flat mirrors (or perhaps polished shields) along the shore. The sunlight was reflected off the mirrors and focused on to an enemy ship.

Enemy sailors were blinded by the reflected light. It is said the heat from the sun's rays was so intense the cotton sails would burst into flames. The rest of the wooden ship would then catch on fire.

How did the enemies react to Archimedes' invention?

They sailed on cloudy days!

Sources:

Archimedes sculpture http://www.crystalinks.com/archimedes.html

Painting of weapon in use http://www.math.nyu.edu/~crorres/Archimedes/Mirrors/Tzetzes.html

Archimedes Heat Ray diagram http://en.wikipedia.org/wiki/Archimedes

Archimedes painting http://en.wikipedia.org/wiki/Archimedes

Hakim, Joy. (2004). *The Story of Science: Aristotle Leads the Way.* Washington, DC: Smithsonian Books.

4th Cycle

✪ Curriculum Outcomes

104-6 Demonstrate that specific terminology is used in science and technology contexts
106-4 Describe instances in which scientific ideas and discoveries have led to new inventions and applications
107-1 Describe examples, in the home and at school, of tools, techniques, and materials that can be used to respond to their needs
204-7 Plan a set of steps to solve a practical problem and to carry out a fair test of a science-related idea
205-5 Make observations and collect information that is relevant to a given question or problem
205-10 Construct and use devices for a specific purpose
206-5 Draw a conclusion, based on evidence gathered through research and observation, that answers an initial question
207-1 Communicate questions, ideas, and intentions, and listen to others while conducting investigations
303-4 Investigate how a beam of light interacts with a variety of objects, to determine whether the objects cast shadows, allow light to pass through, or reflect the light

Light Maze Activity

Students will use a variety of materials to design a light maze.

Materials:

Flashlight
4-5 flat mirrors per group
1 curved mirror per group
Mira (math program)
Spoon
Tin foil (crumpled and/or smooth)
Shoe box or box with a lid in it
Play dough
Nail or skewer to poke holes in boxes

- Using a shoe box or other type of box with a lid, students will make a hole in the side of the box where the light will enter the box and also make a hole in the side of the box where the light will exit the box.

The holes should be small. Larger holes make the light from the flashlight too diffuse and more difficult to reflect. A toothpick or skewer makes a nice small hole.

Cross-curricular links:

ELA

1. Students will be expected to:
   a) Explore and discuss their thoughts, ideas, and experiences and consider those of their peers
   b) Ask and respond to questions to clarify information and explore solutions to problems
   c) Explain personal opinions and respond to questions and opinions of others
2. Students will be expected to:
   a) Contribute to conversations, small-group and whole-group discussion, showing an awareness of when to speak and when to listen
   b) Use word choice, tone of voice, facial expressions, and gestures appropriate to the speaking occasion
   c) Give and follow instructions and respond to questions and directions

3a. Students will be expected to:
Show basic courtesies of conversation in group interactions

Health

Independently apply decision making and problem solving processes

- Inside the box, students will need to place their reflective materials so the light will travel from the starting hole to the exit.

These materials can be held in place with play dough, allowing students to make adjustments to the reflective materials easily and to change the number and location of the objects they are using.

- Students should draw a diagram of their completed maze.

The first entry point and exit point for the light can be the same for everyone and determined by you. Students can be given the choice of using as few or as many of their objects as they would like.

Optional Part 2

Repeat the activity and the discussion, with students also changing the entry and exit points for the light.

✓ **Assessment:**
On observation chart (or other record), note how students are performing on the skill outcomes.

Reflection: Class Discussion – Part 1

Have students share their diagrams and discuss their strategies for reflecting the light from the entrance to the exit. *Did anyone use anything in addition to their mirrors? Did anyone use the crumpled tin foil? The Mira? What challenges did you run into?*

Were there any groups that tried using different materials, but gave up?

Have students try the activity again using a diagram from a group that successfully used different materials and/or different positions for their mirrors so they see there is more than one way to complete the challenge.

If you used more mirrors, what did you notice about the amount of space between the mirrors and the angle of the reflections? (mirrors are closer together and angles of reflection are sharper)

The following site may be useful during your discussion: http://www.bbc.co.uk/schools/ks2bitesize/science/physical_processes/how_we_see_things/play.shtml

Tell students: *For us to be able to see objects that do not give off their own light, we must see the light reflected off of them. This is similar to our activity where, when the cover was on the box, we could only see the light coming out if the mirrors were in the correct orientation so the light was reflected from the entrance to the exit.* The diagrams created earlier (see pages 9 and 19) could be revisited.

Revisit the Accessing Prior Knowledge activity (page 6). Ask: *Are there any items that should be added to or revised? Is there other information we could add?* Add any rules

to the list/chart such as rules for reflecting by an object that has a smooth surface versus one that has a rough surface. Remind your class about respectful discussion. The discussion tips on pages 26-27 may be helpful.

Reflection: Journaling

Draw how you would place 3 mirrors to reflect the light from the flashlight to the target.

Target

Cross-curricular links:
ELA
8. Students will be expected to:
a) Use strategies in writing and other ways of representing to
- formulate questions and organize ideas
- record experiences

b) Experiment with different ways of making their own notes

c) Experiment with language appropriate to purpose, audience, and form, that enhances meaning and demonstrate imagination in writing and other ways of representing

✓ **Assessment:**
Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.

Note whether students can place the mirrors in a configuration that would have the light hit the target.

Possible Extensions:

- Have students set challenges for other groups where they provide the entrance and exit holes, plus have answer keys available that show 2 ways to accomplish the task.

To change the location of the entry or exit holes, holes can be covered with thick paper or stuffed with play dough.

- Building a periscope:
  http://www.exploratorium.edu/science_explorer/periscope.html
  or http://www.ceismc.gatech.edu/kidsclub/documents/News4.pdf
  or http://www.teachingk-8.com/archives/integrating_science_in_your_classroom/up_periscope_by_john_cowens.html

- Use large paper to outline a large pair of mirrored sunglasses. Draw the scene reflected on the lenses

Light

Strand - Bending Light

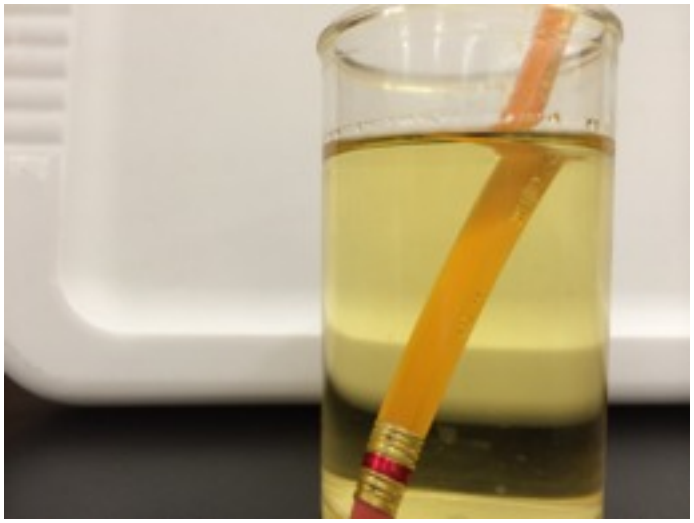
General Curriculum Outcomes	Specific Curriculum Outcomes
303-6 demonstrate and describe how a variety of media can be used to change the direction of light	303-6 demonstrate and describe how a variety of media can be used to change the direction of light
205-5 make observations and collect information that is relevant to a given question or problem	205-5 make observations and collect information about the refractive properties of materials of different shapes

Bending Light

Outcomes:
303-6 demonstrate and describe how a variety of media can be used to change the direction of light
205-5 make observations and collect information about the refractive properties of materials of different shapes

Lesson Activity Overview
Refraction is caused by light changing speed when it travels from one medium to another.

Small demonstrations that help students to understand how light bends:
1. Put a pencil in a glass of water so half of it is sticking out. Notice how from the side the pencil appears to be broken.



2. Put a coin in a bowl , and back away. Notice how the coin appears in different locations

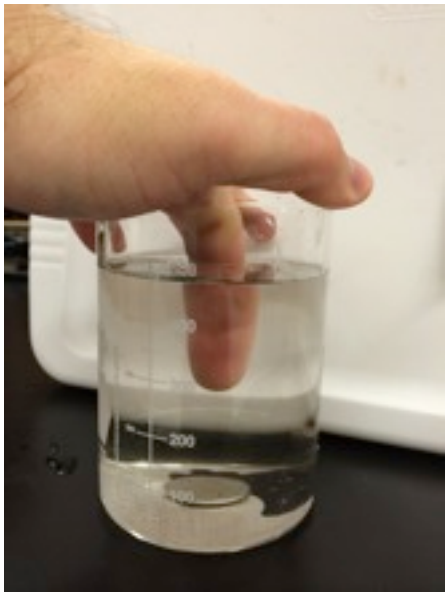
Task

Students can investigate the properties of images produced by lenses in a similar manner to that of mirrors. They can use water droplets or lenses to see how images can be magnified or made smaller, depending on the type of lens used. Convex, concave, and variations of these shaped lenses can be explored. Students can record their observations in charts that detail the shape of the lens, and the characteristics (relative size, orientation, relative distance) of the image. 303-6, 205-5

Description of Lens	Description of Image
small water droplet	
large water droplet	
convex lens	
concave lens	

Journal

Have students explain what is happening that makes the finger appear to be larger then normal when submerged in water in this picture. 303-6



Assessment:Informal Formative

Ensure that students have participated in demonstrations that explain the concept of refraction of light 303-6

Assessment:Formal Formative

Ensure that students have recorded observations based on using different lenses 205-5

Ensure that students have appropriately explained the journal question. 303-6

Light

Strand - Dispersion of Light

General Curriculum Outcomes	Specific Curriculum Outcomes
303-7 demonstrate that while light can be separated into colours	303-7, 104-6 demonstrate that white light can be separated into colours, and use the term “dispersion” for this process
104-6 demonstrate that specific terminology is used in science and technology contexts	
205-3 follow a given set of procedures	205-3 follow a set of procedures to make and use a colour wheel
207-1 communicate questions, ideas, and intentions, and listen	207-1 communicate and listen to others during investigations with colour wheels
107-10 identify women and men in their community who work in science and technology related areas	*107-10 identify women and men in their community who have careers that deal directly with lenses, mirrors, and prisms
107-1 describe examples, in the home and at school, of tools, techniques, and materials that can be used to respond to their needs	*107-1, 303-8 compare how light interacts with a variety of optical devices
303-8 compare how light interacts with a variety of optical devices such as kaleidoscopes, periscopes, telescopes, and magnifying glasses	
205-10 construct and use devices for a specific purpose	*205-10 construct an optical device that performs a specific function

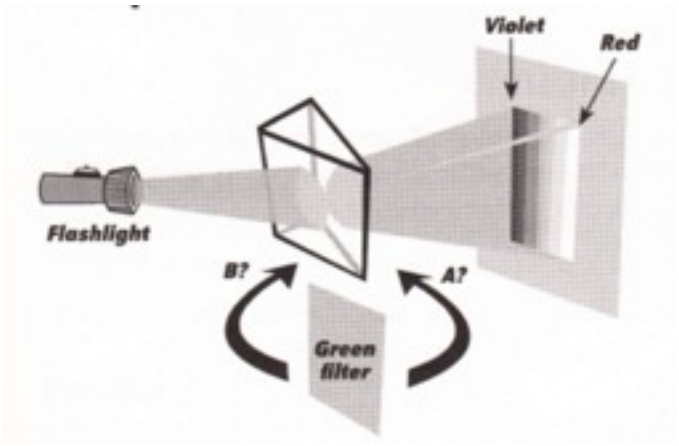
*Has been integrated from Optical Devices Strand

Making a Rainbow - Dispersion of Light

Outcomes:
303-7, 104-6 demonstrate that while light can be separated into colours and use the term “dispersion” for this process
205-3 follow a set of procedures to make and use a colour wheel
207-1 communicate and listen to others during investigations which colour wheels
*107-10 identify women and men in their community who have careers that deal directly with lenses, mirrors, and prisms

Lesson Activity Overview
Research indicates that there often is confusion between light as a physical entity and light as sense perception. The “role of the observer” is ignored. This might result in difficulty understanding phenomena such as colour. Many students believe that colour and light are different phenomena.
As they investigate with prisms, they should see that glass prisms and lenses are basically the same thing, but have different shapes. Students should see that the white light entering the prism bends (refracts), but the different colours that make up light do not all bend to the same degree. By the time the light comes out of the prism, the various colours have been separated. Filters take out from white light all the colours but their own. A perfect filter lets only its own colour through. For example, a green filter lets only the green light through. (303-7). During investigations of separation of white light, the term “dispersion” should be emphasized. (104-6)

Invite a person who works with light to visit the class. For example, telecommunication or Internet personnel, opticians, photographers, amateur astronomers, or lab technicians. The prevalence of optical devices and their practical applications in the community should be emphasized. Care should be taken to include both genders and a variety of cultural backgrounds in any career discussion so as to encourage an attitude that recognizes women and men of any cultural background can contribute equally to science and technology. 107-10



<u>Task - Rainbow</u>
Use the Rainbow work sheet below

<u>Journal</u>
How could you show me that ordinary light is made up of different colour? Can you show an example of this occuring naturally? Where have you seen this happening outside? (303-7, 104-6)

Assessment:Informal Formative
Ensure that students have followed the procedures in the Rainbow task to make a colour wheel 205-3

Ensure that students communicate and listen to others during the Rainbow task 207-1

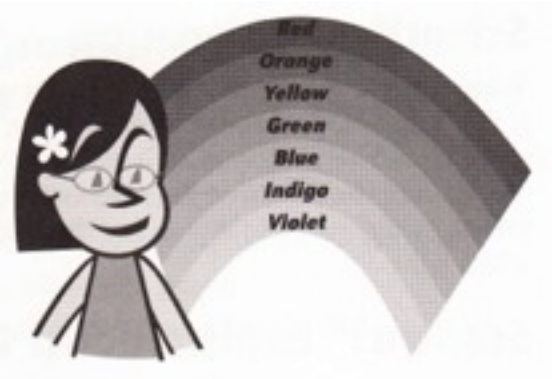
Ensure that students have been exposed to STEM careers via discussion, a guest speaker would be desired (107-10)

Assessment:Formal Formative
Ensure that students have appropriately completed their Rainbow investigation 303-7

Ensure that students respond to the journal in a manner that explain separation of light into colours 303-7

Ensure that students have used dispersion to describe separation of light 104-6

Rainbow



Use a prism to make a rainbow
Try putting a green filter in the light path
A) between the prism and the screen
B) between the flashlight slit and the prism

Predict

Position A: What will the rainbow look like? _____

Please give your reasons

_____

_____

Position B: What will the rainbow look like? _____

Please give your reasons

_____

_____

Observe

Position A	Position B

Explain

How do you explain what you observed?

_____

_____

_____

_____

_____

Creating your own Optical Device

Outcomes:
*107-1, 303-8 compare how light interacts with a variety of optical devices
*205-10 construct an optical device that performs a specific function

Lesson Activity Overview
This lesson focusses on students exploring optical devices and ultimately constructing their own device to perform a specific function.

To begin, students should explore various optical devices, such as magnifying glasses, binoculars, reading glasses, telescopes, microscopes, fibre optics, mirrors, projection units, kaleidoscopes, and periscopes. The focus should be on exploring what the device allows you to see, and how the student's view of the object (the image) is enhanced or changed. (303-8, 107-1)

Device	Image Size	Image Position	Image Distance
Microscope			
Binoculars			
Reading Glasses			

Task
In groups students should construct a simple optical device using mirrors, and/or lenses to perform a simple function. Equipment could consist of lenses, mirrors, light sources, various size paper tubes, and supporting materials. Students should be encouraged to be as creative as possible.(205-10)

Assessment:Informal Formative
Ensure that students have worked in groups cooperatively to create a personal optical device

Assessment:Formal Formative
Ensure that students have interacted with various optical devices and have recorded changes to the image 303-8, 107-1

Ensure that students have created an optical device and have completed the worksheet to explain the purpose and ensure the device performs that task. 205-10

Creating your own Optical Device

Purpose: What are you going to build and why?

Materials Needed:

Diagram: Draw a labelled diagram of your model.

Testing: How will you test it? (your process to test the device)

Discussion: How does your model apply to real-world situations?