

Anglophone School District - North



Grade 8 Science - Unit Lesson Guide

Optics

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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 thing 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.

Optics

Focus and Context

The focus of the unit is inquiry. A possible context could be the variety of everyday experiences the students have with the reflection and refraction of light. Students encounter reflection when they get up in the morning and use a mirror, for example. Buses and cars have a variety of reflective devices that can be explored. Eyeglasses and other refracting technologies can be investigated and study various technologies that are associated with electromagnetic radiation and to explore their positive and negative attributes and their impact on our way of life.

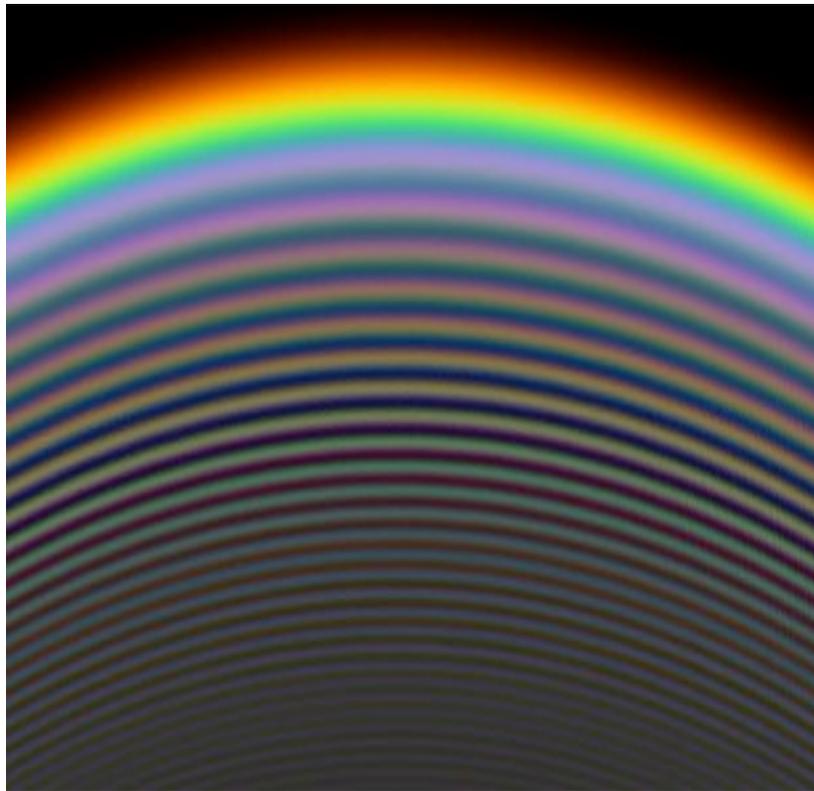


Image source: <http://www.splung.com/content/sid/4/>

Unit Instructional Overview

Properties of Visible Light	Reflection	Refraction and Dispersion	Electromagnetic Radiation
Properties of Light - Travels in a Straight Line	Reflection - Understanding Law of Reflection	Prior Knowledge	Electromagnetic Radiation
	Reflection - Regular vs Diffuse Reflection	Access Prior Knowledge	
	Reflection - Constructing an Optical Device	1st Cycle - Pennies and Pencils Activities	
		2nd Cycle - Lights and Blocks Activity	
		3rd Cycle - Lenses Activities	
		Determining the Size and Shape of the Blind Spot	

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

Water Systems on Earth - Curriculum Outcomes

Properties of Visible Light	308-8 identify and describe the following properties of Visible light: -travels in a straight line (rectilinear propagation) -Speed of light in air is 300,000km/s -reflection -refraction and dispersion -travels in a vacuum and in some types of media	
Reflection	308-9 describe the laws of reflection of visible light and their application in everyday life: -regular vs diffuse reflection -angle of incidence = angle of reflection	208-7 formulate operational definitions for incidence, reflection, and the normal
209-2 estimate angles of incidence and reflection	209-6, 211-1 work cooperatively and collaboratively with others to plan and safely construct an optical device using mirrors	210-14 identify and correct practical problems in the way a constructed optical device functions
Refraction and Dispersion	208-1 rephrase questions related to refraction in a testable form	208-5 predict the effect of transparent media of varying densities on the angle of refraction of light
209-2 estimate angles of refraction	210-11, 308-10 describe qualitatively how visible light is refracted	209-2 estimate focal length of convex lens by finding its focal point
109-5 describe how optical technologies have developed through systematic trial-and-error processes constrained by the optical properties of the materials		109-10, 111-3 provide examples of optical technologies that enable scientific research and relate personal activities associated with such technologies
Electromagnetic Radiation	308-11 describe different types of electromagnetic radiation, including infrared, ultraviolet, x-rays, microwaves, and radio waves	308-12 compare the properties of visible light to the properties of other types of electromagnetic radiation, infrared, ultraviolet, x-rays, microwaves, and radio waves
109-13 explain the importance of using the words frequency and wavelength correctly	112-8 provide examples related to optics that illustrate that scientific and technological activities take place individually and in group settings	113-2 describe possible negative and positive effects of technologies associated with electromagnetic radiation

Optics

Strand - Properties of Visible Light

General Curriculum Outcomes	Specific Curriculum Outcomes
308-8 identify and describe properties of visible light	308-8 identify and describe the following properties of visible light: <ul style="list-style-type: none">- travels in a straight line (rectilinear propagation)- speed of light in air is 300,000km/s- reflection- refraction and dispersion- travels in a vacuum and in some types of media

Properties of Light - Travels in a Straight Line

Outcomes:

308-8 identify and describe the following properties of visible light:

-travels in a straight line (rectilinear propagation)

-speed of light in air is 300,000km/s

-reflection*

-refraction and dispersion*

-travels in a vacuum and in some types of media

Lesson Activity Overview

In grade 4, students begin their formal investigation and study of light. Sources of light and how light travels are topics explored. As well, the students investigate how white light can be separated into its composite colours. They also compare how light interacts in a variety of optical devices such as kaleidoscopes, periscopes, telescopes and magnifying glasses.

Although the outcome mentions several properties of visible light for teachers to use, the focus of the lesson is on reinforcing the concept that light travels in a straight line. The next two sections deal specifically with reflection and refraction and dispersion so there is no need to focus on these at this point. There would be options if teachers choose to deal with speed of light and light traveling in a vacuum.

Students should have the opportunity to investigate the properties of light throughout the course of this unit. The suggestions on this page are not meant to be prerequisites or even sequential but they are intended to give suggestions about the types of activities that will help students to develop a conceptual understanding about the nature and properties of light.



Since students should have a previous understanding of light, it is advised to give a pre-assessment of understanding. Teachers can use the Pre-Assessment question of the Sun casting the shadow of the pole for this outcome. Students would be successful with this outcome if they realize that the shadow is cast in a fashion similar to this example. Teachers may also create their own.

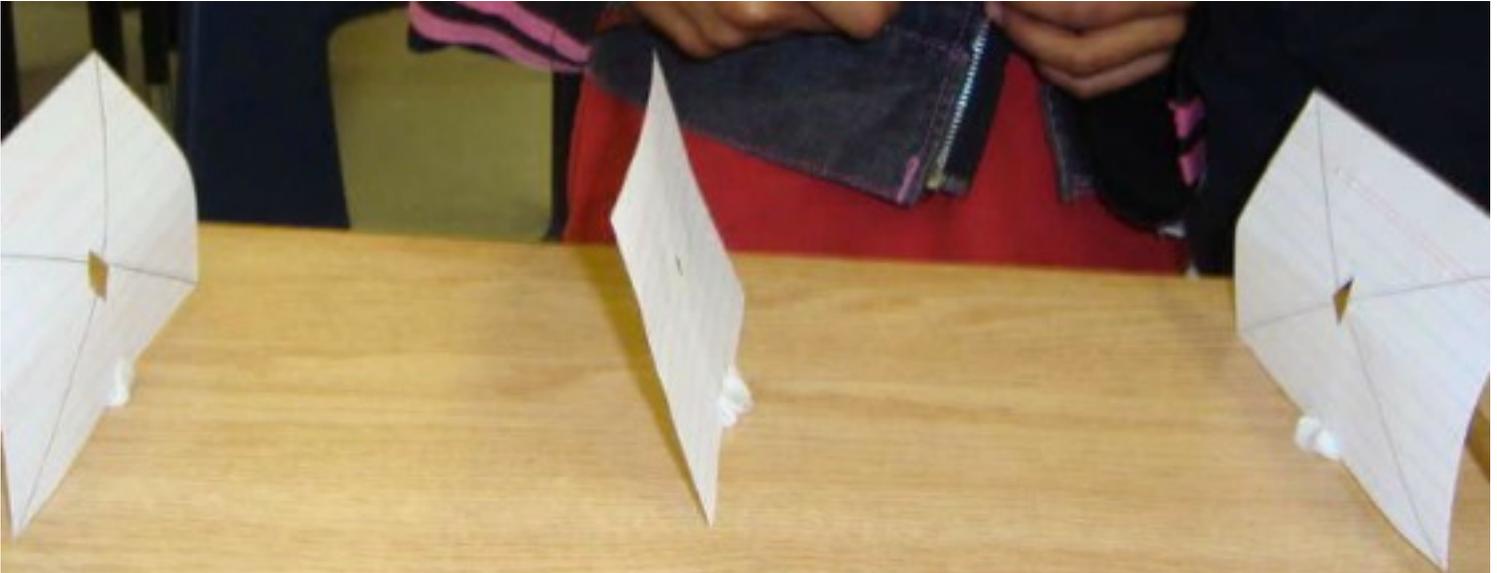


Activity: Light Travels in a Straight Line

Divide class into groups of 4 - Distribute worksheet

Teacher will prepare index cards using a ruler to draw lines on each card from one corner to the next forming an "X." A hole will be cut in each card where the lines intersect. The teacher will demonstrate by standing a book on the desk. Then line up the index cards approximately 15cm apart (standing upright with mounting tack). The

holes in each card will let the ray of light shine through the holes in the cards. The light should be shining through all the cards onto the "X" This shows that light travels in a straight line



Teacher will then distribute materials for groups to begin their experiments

Students stand the cards up on the mounting tack, spacing them about 15 cm apart, one behind the other so that they can see straight through the holes. One of the students shines a ray of light from the flashlight straight into the first hole and then into the hole from the side. Next ask the students to (carefully) string the string through the hole. Have one student hold onto one end firmly.

Students discuss among themselves what happens after each step of the experiment. Students also move the cards so that they cannot see straight through the holes, observing the results. Students are to place a piece of white paper behind each hole on the cards, shine the flashlight through the holes, what do they notice? Finally, students place a piece of black construction paper behind each hole on the card, shining the flashlight through the holes, discovering the light can pass through some objects and not others.

Questions -

1. What changed when you moved the cards?
2. How did you make the light travel through the holes in all



three cards of the same time?

3. What did you find out about light?

Journal:

1. How do you know that light travels in a straight line?

Extension:

Students should have experiences investigating light as it travels through some materials such as clear glass (transparent) and plastics (translucent). In most cases, light cannot travel through materials and is reflected totally (white) or partially (the colours we see).

Assessment:Informal Formative

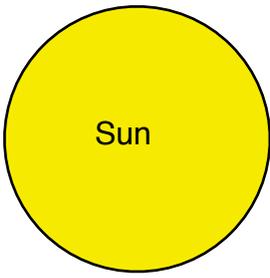
Ensure that students have completed a group investigation Activity: Light Travels in a Straight Line (308-8)

Ensure that students have responded to questions from Activity: Light Travels in a Straight Line (308-8)

Assessment:Formal Formative

Ensure that each student completes the pre-assessment question about light from the sun traveling towards Earth. (308-8)

Ensure that students have responded to a journal entry How do you know that light travels in a straight line? (308-8)



Draw the shadow, that would be cast by by the green pole from the light of the sun.

Explain why the shadow would be cast in this direction.

Activity: Light Travels in a Straight Line

Materials:

Index Cards
Flashlight
Mounting Tack
Black Construction Paper

Design

Stand the cards up on the mounting tack, spacing them about 15 cm apart, one behind the other so that they can see straight through the holes.

One of the students shines a ray of light from the flashlight straight into the first hole and then into the hole from the side. Next ask the students to (carefully) string the string through the hole. Have one student hold onto one end firmly.

Students discuss among themselves what happens after each step of the experiment.

1. Students also move the cards so that they cannot see straight through the holes, observing the results.
2. Students are to place a piece of white paper behind each hole on the cards, shine the flashlight through the holes, what do they notice?
3. Finally, students place a piece of black construction paper behind each hole on the card, shining the flashlight through the holes, discovering the light can pass through some objects and not others.

Questions

1. What changed when you moved the cards?
2. How did you make the light travel through the holes in all three cards of the same time?
3. What did you find out about light?

Journal

1. How do you know that light travels in a straight line?

Optics

Strand - Reflection

General Curriculum Outcomes	Specific Curriculum Outcomes
308-9 describe the laws of reflection of visible light and their applications in everyday life	308-9 describe the laws of reflection of visible light and their applications in everyday life: - regular vs diffuse reflection - angle of incidence = angle of reflection
208-7 formulate operational definitions of major variables and other aspects of their investigations	208-7 formulate operational definitions for <i>incidence, reflection, and the normal.</i>
209-2 estimate measurements	209-2 estimate angles of incidence and reflection
209-6 use tools and apparatus safely	209-6, 211-1 work cooperatively and collaboratively with others to plan and safely construct an optical device using mirrors
211-1 receive, understand, and act on the ideas of others	
210-14 identify and correct practical problems in the way a prototype or constructed device functions	210-14 identify and correct practical problems in the way a constructed optical device functions

Reflection - Understanding Law of Reflection

Outcomes:

308-9 describe the laws of reflection of visible light and their application in everyday life:

- angle of incidence = angle of reflection

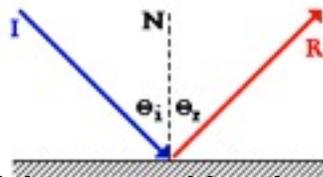
208-7 formulate operational definitions for incidence, reflection, and the normal

209-2 estimate angles of incidence and reflection

Lesson Activity Overview

Students have had numerous experiences with reflected light. The everyday use of and exposure to mirrors provide many personal references for students. Miras can be used to further investigate reflected light and the images they produce.

Light is known to behave in a very predictable manner. If a ray of light could be observed approaching and reflecting off of a flat mirror, then the behavior of the light as it reflects would follow a predictable law known as the law of reflection. The diagram below illustrates the law of reflection.



In the diagram, **the ray of light approaching the mirror is known as the incident ray (labeled I in the diagram). The ray of light that leaves the mirror is known as the reflected ray (labeled R in the diagram). At the point of incidence where the ray strikes the mirror, a line can be drawn perpendicular to the surface of the mirror. This line is known as a normal line (labeled N in the diagram). The normal line divides the angle between the incident ray and the reflected ray into two equal angles.** (208-7)

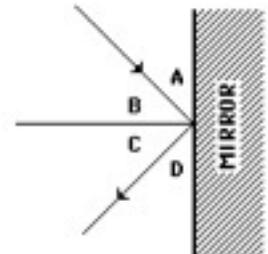
The angle between the incident ray and the normal is known as the angle of incidence. The angle between the reflected ray and the normal is known as the angle of reflection. (These two angles are labeled with the Greek letter "theta" accompanied by a subscript; read as "theta-i" for angle of incidence and "theta-r" for angle of reflection.) **The law of reflection states that when a ray of light reflects off a surface, the angle of incidence is equal to the angle of reflection.**

Questions:

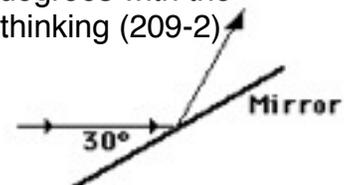
1. Consider the diagram at the right.

A. Which one of the angles (A,B,C, or D) is the angle of incidence?

B. Which one is the angle of reflection? (208-7)



2. A ray of light is incident towards a plane mirror at an angle of 30-degrees with the mirror surface. What will be the angle of reflection? Explain your thinking (209-2)



Tasks

- Set up a flat mirror on a stable surface. Using a real image, based on your set up, estimate the angle of incidence. _____
- Draw a sketch of what your design looks like (place the real image, draw the ray of incidence, ray of reflection, angle of incidence, the normal, the virtual reflection and the angle of reflection)

Concave and Convex Mirrors

Because these mirrors are intentionally not flat, they do not behave like a flat mirror. However, the same law of reflection still applies. Light always follows the law of reflection, whether the reflection occurs off a curved surface or off a flat surface. The task of determining the direction in which an incident light ray would reflect involves determining the normal to the surface at the point of incidence.

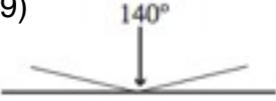
It is best to allow students to explore each mirror before they record their results

- Set up a concave mirror on the same surface. Using the same real image as earlier and at the same angle of incidence
- Draw a sketch of what your design looks like (place the real image, draw the ray of incidence, ray of reflection, angle of incidence, the normal, the virtual reflection and the angle of reflection)
- Set up a convex mirror on the same surface. Using the same real image as earlier and at the same angle of incidence
- Draw a sketch of what your design looks like (place the real image, draw the ray of incidence, ray of reflection, angle of incidence, the normal, the virtual reflection and the angle of reflection)

•Metal pots and spoons as well as fabricated concave and convex mirrors can be used to compare and contrast the reflections from each type. Surveillance mirrors in stores and vehicles, school-bus mirrors, some side-view mirrors, and “circus” or distorting mirrors may demonstrate the uses of these types of mirror. Ray diagrams can be used to help students conceptualize the reflection of light in many of the activities and explorations. Students can begin to gain a qualitative appreciation of the effects and uses of concave and convex mirrors.

Journal

Explain why an ambulance vehicle has the word “ambulance” in reverse lettering on its hood. (308-9)

Given that , estimate the angle of incidence and the reflection of the light beam (308-9)

Assessment: Informal Formative

Ensure that students are able to correctly answer questions related to the identification of the components of the law of reflection (208-7)

Ensure that students are able to correctly answer questions related to estimating the angle of reflection (209-2)

Ensure that students have participated in activities in which they manipulate angles of incidence and estimated the angle of reflection based on the normal. (308-9)

Assessment:Formal Formative

Ensure that students are able to form an operational understanding of incidence, reflection and the normal (208-7)

Ensure that students are able to estimate the angle of reflection using a mirror in a task (209-2)

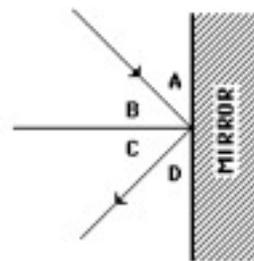
Ensure that students are able to correctly respond to journal questions about the laws of reflection (308-9)

Questions:

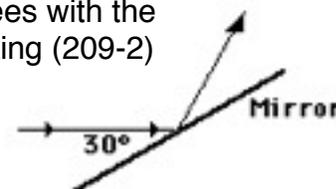
1. Consider the diagram at the right.

A. Which one of the angles (A,B,C, or D) is the angle of incidence?

B. Which one is the angle of reflection? (208-7)



2. A ray of light is incident towards a plane mirror at an angle of 30-degrees with the mirror surface. What will be the angle of reflection? Explain your thinking (209-2)



Tasks

•Set up a flat mirror on a stable surface. Using a real image, based on your set up, estimate the angle of incidence. _____

•Draw a sketch of what your design looks like (place the real image, draw the ray of incidence, ray of reflection, angle of incidence, the normal, the virtual reflection and the angle of reflection)

•Set up a concave mirror on the same surface. Using the same real image as earlier and at the same angle of incidence

•Draw a sketch of what your design looks like (place the real image, draw the ray of incidence, ray of reflection, angle of incidence, the normal, the virtual reflection and the angle of reflection)



•Set up a convex mirror on the same surface. Using the same real image as earlier and at the same angle of incidence

•Draw a sketch of what your design looks like (place the real image, draw the ray of incidence, ray of reflection, angle of incidence, the normal, the virtual reflection and the angle of reflection)



Reflection - Regular vs Diffuse Reflection

Outcomes:

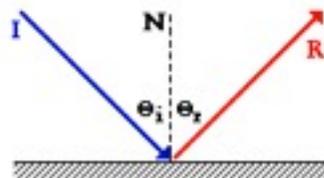
308-9 describe the laws of reflection of visible light and their application in everyday life:

- regular vs diffuse reflection
- angle of incidence = angle of reflection

209-2 estimate angles of incidence and reflection

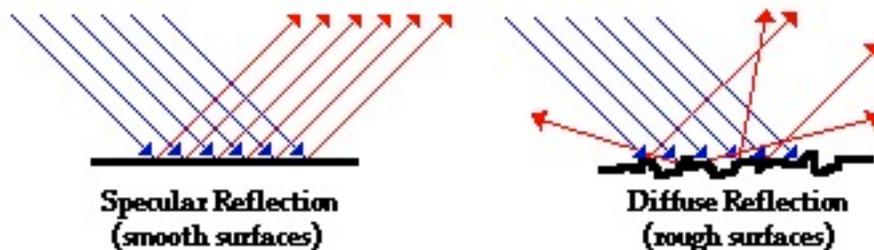
Lesson Activity Overview

The law of reflection states that when a ray of light reflects off a surface, the angle of incidence is equal to the angle of reflection.



The behavior of light is often studied by observing its reflection off of plane (flat) mirrors. Mirrors are typically smooth surfaces. As such, they offer each individual ray of light the same surface orientation. But quite obviously, mirrors are not the only types of objects which light reflects off of. Most objects which reflect light are not smooth at the microscopic level. Your clothing, the walls of most rooms, most flooring, skin, and even paper are all rough when viewed at the microscopic level.

Reflection off of rough surfaces such as clothing, paper, and the asphalt roadway leads to a type of reflection known as diffuse reflection. Whether the surface is microscopically rough or smooth has a tremendous impact upon the subsequent reflection of a beam of light. The diagram below depicts two beams of light incident upon a rough and a smooth surface.

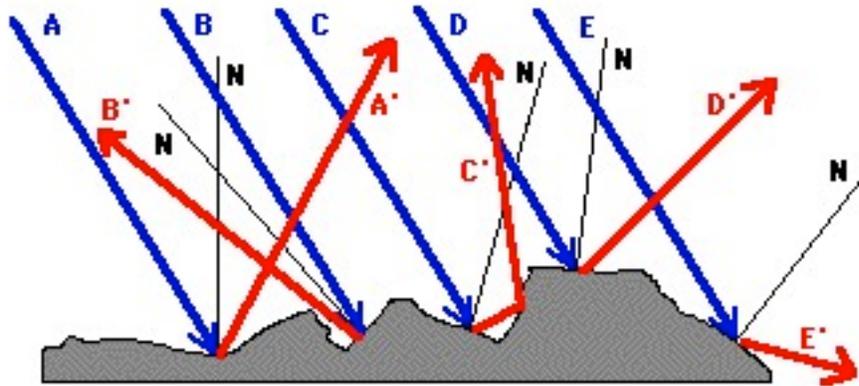


A light beam can be thought of as a bundle of individual light rays which are traveling parallel to each other. Each individual light ray of the bundle follows the law of reflection. If the bundle of light rays is incident upon a smooth surface, then the light rays reflect and remain concentrated in a bundle upon leaving the surface. On the other hand, if the

surface is microscopically rough, the light rays will reflect and diffuse in many different directions.

Why Does a Rough Surface Diffuse a Beam of Light?

For each type of reflection, each individual ray follows the law of reflection. However, the roughness of the material means that each individual ray meets a surface which has a different orientation. The normal line at the point of incidence is different for different rays. Subsequently, when the individual rays reflect off the rough surface according to the law of reflection, they scatter in different directions. The result is that the rays of light are incident upon the surface in a concentrated bundle and are diffused upon reflection. The diagram below depicts this principle. Five incident rays (labeled A, B, C, D, and E) approach a surface. The normal line (approximated) at each point of incidence is shown in black and labeled with an N. In each case, the law of reflection is followed, resulting in five reflected rays (labeled A', B', C', D', and E').



Task

Students can explore and investigate regular and diffuse reflection in activities that compare the reflected light from smooth aluminum foil or a mirror with crumpled aluminum foil or paper. Through these experiences and discussions of reflected beams, students should be able to estimate angles of incidence and reflection. Students should come to understand that the angles of incidence and reflection are estimated or measured with respect to the normal.

Journal

Produce a simple ray diagram that helps to compare and contrast regular (specular) and diffuse reflection, explain your thinking (308-9)

Assessment: Informal Formative

Ensure that students participate in investigations using aluminum foil to create regular and diffuse reflection

Ensure that students are estimating the angle of reflection and normal in their investigations (209-2)

Assessment: Formal Formative

Ensure that students are able to form an operational understanding of Diffuse Reflection (308-9)

Ensure that students are able to produce a ray diagram that explain what they observed in their investigations (308-9)

Reflection - Constructing an Optical Device

Outcomes:

308-9 describe the laws of reflection of visible light and their application in everyday life:
209-6, 211-1 work cooperatively and collaboratively with others to plan and safely construct an optical device using mirrors
210-14 identify and correct practical problems in the way a constructed optical device functions

Lesson Activity Overview

Task

Students should be challenged to construct a periscope, or design and build a “classroom” surveillance system, using a number of small, plane and/or convex mirrors. Such problem-solving activities will permit the students to discover and use the laws of reflection in a given context. Observe the students to ascertain if they strive to assess the problem accurately by careful analysis of evidence gathered.

Students should have the opportunity to work in pairs or in small groups to plan, design and problem-solve these activities.

Students can defend their plans/designs/models by describing how they work to other groups, to the class as a whole, or by preparing a detailed poster or written report. Note whether the students share responsibilities for difficulties encountered during the activity. This is also an indicator for the attitudinal outcome on working collaboratively.

Assessment: Formal Formative

Rubric

211-1 - receive, understand, and act on the ideas of others

209-6 - use tools and apparatus safely

Exceeding (4)	Meeting (3)	Approaching (2)	Below (1)
Worked cooperatively and collaboratively with group members. Worked safely with materials.	Worked cooperatively and collaboratively with group members.	Worked well during most of the activity with group members.	Does not work well with group members.

210-14 identify and correct practical problems in the way a prototype or constructed device functions

Exceeding (4)	Meeting (3)	Approaching (2)	Below (1)
Optical device illustrates the laws of reflection very well.	Optical device illustrates the laws of reflection.	Optical device illustrated the laws of reflection.	Optical device is incomplete or is incapable of demonstrate laws of reflection.

308-9 describe the laws of reflection on visible light and their application in everyday life

Exceeding (4)	Meeting (3)	Approaching (2)	Below (1)
Student communicates understanding of law of reflection very well	Students derives law of reflection from activity	Student has difficulty explaining laws of reflection	Cannot describe laws of reflection

Optics

Strand - Refraction and Dispersion

General Curriculum Outcomes	Specific Curriculum Outcomes
208-1 rephrase questions in a testable form and clearly define practical problems	208-1 rephrase questions related to refraction in a testable form
208-5 state a prediction and a hypothesis based on background information or an observed pattern of events	208-5 predict the effect of transparent media of varying densities on the angle of refraction of light
209-2 estimate measurements	209-2 estimate angles of refraction
210-11 state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea	210-11, 308-10 describe qualitatively how visible light is refracted
308-10 describe qualitatively how visible light is refracted	
209-2 estimate measurements	209-2 estimate focal length of a convex lens by finding its focal point
109-5 describe how technologies develop as a systematic trial-and-error process that is constrained by the properties of materials and the laws of nature	109-5 describe how optical technologies have developed through systematic trial-and-error processes constrained by the optical properties of the materials
109-10 relate personal activities in formal and informal setting to specific science disciplines	109-10, 111-3 provide examples of optical technologies that enable scientific research and relate personal activities associated with such technologies
111-3 provide examples of technologies that have enabled scientific research	

Science resource Package: Grade 8

Optics:
Refraction and
Dispersion

New Brunswick Department of Education

September 2009

ⓘ Background Information

Prior Knowledge:

- Light travels in straight lines
- Students will have learned about reflection in this grade 8 unit

Common Misconceptions:

- Students don't usually think about light moving through materials besides air.

Did You Know?

There are two models that are useful when discussing light: the particle model and the wave model. Some properties of light are best described using particles and some are best described using waves. Neither model by itself, describes all of light's properties.

A more simplified way to represent light is by using rays. Straight lines representing rays are very useful for discussing reflection and refraction.

Refraction is the bending of light when it travels from one material to another. It occurs because the speed that light travels is different in different materials. Think of driving your car when the wheels on one side go into a puddle – the car is slowed on that side and it tries to turn (refract) in that direction.

<http://sol.sci.uop.edu/~jfalward/refraction/refraction.html> - This website has excellent diagrams showing refraction in a variety of different situations such as in water, in raindrops to create a rainbow, on the road to create an image of a puddle, a mirage in the desert, and through a prism.

Instructional Plan

Access Prior Knowledge

- Draw on students' personal experiences to make them think about how objects in water appear bent when seen from outside the water. Questions to get students thinking may include:

On the television show "Survivor", why is it hard for the participants to spear fish?

Is it harder to spear fish in water than to spear something on the beach?

Have you ever noticed anything strange when looking in the water when fishing?

How about when you look down at your legs when you are wading in water?

How about when you see a straw in a glass of water?

- Make a record of class observations on chart paper (to be revisited in subsequent lessons) of experiences and any explanations that have to do with refraction. The discussion tips on pages 18-19 may be helpful.

Assessment:

Note the examples given by the students. There will be an opportunity to follow up on some of these examples later.

 **Post student versions of curricular outcomes on chart paper (see page 21). 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

- 210-11** State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea.
- 211-1** Receive, understand, and act on the ideas of others.
- 308-9** Describe qualitatively how visible light is refracted.

Pennies and Pencils Activities

These activities may be done by students in stations or in sequence. The Penny activity is in the SCIENCEPOWER 8 resource on page 226. For convenience, the directions have also been included here and on page 22 (student version).

In Part 3, students look at the pencil in water **and** cooking oil. The Pencil activity in the textbook on page 227 only uses water. Instructions for the activity are included below and on page 23.

Part 1 - Compare the Pennies Activity

Materials:

- Water
- Cup or beaker
- 2 pennies

Have students place one penny on the bottom of a beaker filled with water. The other penny is placed on the table alongside the beaker.

What is noticed about the appearance of the penny in the beaker compared to the other penny?

Part 2 - Penny Activity

Materials:

- Water
- 1 Styrofoam cup (or solid coloured cup or coffee cup. If necessary, a plastic cup could be painted)

Students will make the penny reappear. They need to place the penny in a cup and look at it from an angle where they can just see it over the lip of the cup. Then they back up until the penny is just out of sight.

Without moving, they continue looking from the same angle while a partner slowly adds water to the cup. Observe what happens to the penny.

Part 3 - Pencil Activity

Materials:

- 2 Glass jars or clear plastic cups
- Water
- Cooking oil
- Pencil or straws



The students will observe the pencil in an empty glass jar (plastic cup). They will then half fill the jar with water and draw what the pencil looks like.

In another container, they will observe the pencil then half fill the container with cooking oil and draw what they see.

Protractors should be made available without giving directions about what to do with them. In the directions for students, the students are asked to compare what they observe about the pencil in the water versus the pencil in the oil and think about how the differences can be compared more easily. (This question provides a hint to use the protractors in some way).

Optional Part 4 – Disappearing Glass

Materials:

- Glass bowl or beaker
- Cooking oil
- Ordinary glass test tube, dish or plate
- Pyrex test tube, dish or plate

Have students fill a glass bowl or beaker with cooking oil. They should also put cooking oil into the test tubes. The students should gently lower the ordinary glass into it. They should gently lower the Pyrex glass into it. Have students record their observations.

i Teacher note: The refractive index of Pyrex and cooking oil is very similar so the glass cannot be easily distinguished from the oil. It sort of disappears.

This video clip shows a Pyrex test tube being placed in cooking oil: <http://www.youtube.com/watch?v=gER8z7Y19wU>

✓ **Assessment:**

During 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 (on pages 30-33) on a clipboard may be helpful to you. Develop your own code for quick notes.

A suggested code:

✓ observed and appropriate,
WD with difficulty,
RTT refused to try,
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 will also help you when it is reporting time.

Reflection: Class Discussion

Have students share their results through discussion and by sharing their diagrams. The tips for supporting classroom discussion on pages 18-19 may be helpful.

Ask students:

- *What differences were there in the cooking oil and water results? Is there a way to compare them more easily? Did anyone use the protractor?*

(Could take digital pictures of water and oil with pencils and put on Smart Board to measure angles with protractor.) The term refraction may come up but don't make a point of introducing it yet if it doesn't.

- *I heard someone talk about putting both water and oil in the same jar. Did anyone do this? Could actually do this at this time as another way to see the differences between water and cooking oil.*

You may want to raise how refraction occurs because of a change in the speed light is travelling. If light travels a different speed there will be refraction. This is called the index of refraction for a material. If two materials have the same index of refraction, there is no refraction of light.

- Revisit the list made in the Accessing Prior Knowledge activity on page 4. *Does this experiment give any insight to the experiences or observations we talked about before? Can any be added to or modified? Can some new statements be added?*

http://www.teachertube.com/viewVideo.php?video_id=92586&title=Refraction_experiment This clip shows water being added to a glass with a pencil in it. It could be used to revisit what happened if coming back to this on another day.

Shows refraction examples in the real world: http://www.youtube.com/watch?v=8ZxG_vyZWCw&feature=related

Shows why a pencil appears shifted in water: <http://www.glenbrook.k12.il.us/gbssci/Phys/class/refrn/u14l1c.html>

✓ **Assessment:**

Karen tried to net a fish from her fish tank. She moved the net through where she saw the fish but the fish was not in the net. The fish did not swim away until after the net passed. Can you explain to Karen what is happening?

Reflection: Journaling

Draw and explain what is going on with the pencil in the water and in the oil.

✓ **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.

When reading the journal entries, note who has the idea that objects appear to be in a different position in water (or oil) than in air. Note if the student names this as refraction or has additional knowledge about refraction other than what has been explored.

Possible extension activities:

Alaska Native Knowledge Network. http://www.ankn.uaf.edu/publications/Alaska_Science/Spear.html

This site describes the importance of understanding refraction to spear fish. It also provides a challenge where students use a stick and a wooden fish to practice hitting the fish in the air and then in the water under different conditions.

or

Look at how the day/night lever on the rear view mirror of your car works because of refraction

<http://sol.sci.uop.edu/~jfalward/refraction/refraction.html>

Pennies and Pencils Activities

Compare the Pennies Activity

Materials:

Water
Cup or beaker
2 pennies

- Place one penny on the bottom of the beaker filled with water.
- The other penny is placed on the table alongside the beaker.
- What do you observe about the appearance of the penny in the beaker compared to the other penny?

Penny Activity

Materials:

Penny
Dixie cup or foil pie plate
Water

- Place the penny in a cup, bowl or foil pie plate.
- Position yourself so that the penny can just be seen over the edge of the container.
- Now back up until the penny just disappears.
- Without moving, have your partner gently pour water into the container.
- What do you observe?

Pencil Activity

Materials:

2 Glass jars or plastic cups
Water
Cooking oil
Pencil or straws

- Observe the pencil in a glass jar (or plastic cup).
- Half fill the jar with water and draw what the pencil looks like.
- In another container, observe the pencil.
- Half fill the container with cooking oil. Observe the pencil and draw.
- Is there any difference in cooking oil and water results?
- Why do you see what you see?

Disappearing Glass

Materials:

Glass bowl or beaker
Cooking oil
Ordinary glass test tube, dish or plate
Pyrex test tube, dish or plate

- Put cooking oil in the glass bowl (beaker) and the test tubes.
- Gently lower the ordinary glass into the bowl of oil. Observe how it appears.
- Gently lower the Pyrex glass into the bowl of oil. Observe how it appears.
- Record your observations. Is there any difference?
- Why do you think you see what you see?

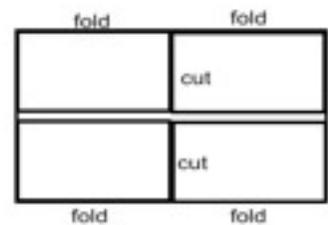
2nd Cycle

Curriculum Outcomes

- | 208-1 Rephrase questions in a testable form and clearly define practical problems.
- | 210-11 State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea.
- | 211-1 Receive, understand, and act on the ideas of others.
- | 308-9 Describe qualitatively how visible light is refracted.

Introduce the terms: refraction, normal, angle of incidence, angle of refraction

Instead of copying definitions into their notebooks, you may wish that students create a foldable. Students fold the two ends of a sheet of paper to the center of the sheet. Then cut up the center of each of these flaps to create four flaps that open from the center. One term is placed on each flap with the explanation and diagrams in the space underneath the flap.



Lights and Blocks Activity

For instructions on making gelatin blocks, see page 25. It is also possible to fill a glass or plastic container with different materials (such as water, salt water and so on) to observe how light refracts differently in different materials. The thin plastic covers from greeting card boxes will work for this if the corners are reinforced with duct tape so they do not leak. Your school may also have acrylic blocks which can be used.



Note that if the rubric is to be used for assessing student work, it should be given to students and discussed **before** the investigation. Examples of previous experimental write ups should be displayed. If this is new to students, the process should be modeled by the teacher several times before expecting students to complete one independently.

Materials:

- Laser pointers or laser levels
- Gelatin (or plexiglass) blocks
- White unlined paper

Laser pointers and laser levels are not toys. Laser light can be harmful if used improperly. Never shine a laser directly into eyes.

Have students place the block on a piece of white paper and draw its outline. Students will trace the path of light as it enters and exits the gelatin or plexiglass block. They should try a variety of angles of incidence to see what happens.



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

Students should write up their question, data, results, and conclusion to hand in. Have students self-assess their write up before handing it in to you. Give students the guidelines (see “got it” column) and ask them to comment on how well their work meets each criteria. The third column will be for you to give feedback (see sheet on page 29).

✓ **Assessment:**
Note if students are able to write up a lab report or if mini-lessons on specific parts of the report are needed. The following rubric may be helpful.

Got it	Nearly there	Not yet
Question is stated clearly and in a testable form	Question is clear but not in a testable form.	Question is unclear .
Data is recorded in detail in an organized manner with titles and headings; necessary units are included.	Data is recorded, more detail needed or difficult to interpret ; necessary units may be missing.	Data is not complete and organized .
Discussion of results/ Conclusion relates to question and is based on data from the experiment.	Discussion of results/ Conclusion relates to the question but data is not referred to or data does not support statements.	Discussion of results/ Conclusion missing or does not relate to question
Spelling and grammar errors are absent or rare .	Some spelling and grammar errors .	Spelling and grammar errors common .

Reflection: Discussion

Have each group briefly describe their activity and their results to the class.

Discuss: *How many paths of light do you see? What direction is the light traveling? Why are there multiple paths?*

Which way does the light bend (relative to the normal) when it goes through the block of gelatin? What about from the gelatin back to the air?

i Teacher note: The light bends towards the normal or inwards when it moves from air to gelatin (enters a material with a higher index of refraction). The light bends away from the normal or outwards when it moves from the gelatin back to air (enters a material with a lower index of refraction).

The Bill Nye video “Light Optics” may be a useful video at this point. It can be found at <http://learning.aliant.net/school/index.asp> Type light optics into the search box. When you click on the picture, the video will start with a table of contents to the right of it. Note that you can click on any part of the contents list to go to that portion. There is no need to view the entire video. (You need to register to use the videos on the Aliant site. Registration is free. If you try to watch the video without logging in, you are prompted to do so.)

Revisit the list made in the Accessing Prior Knowledge activity on page 4. *Does this experiment give any insight to the experiences or observations we talked about before? Can any be added to or modified? Can some new statements be added?*

✓ **Assessment:**

Revisit the fish in the aquarium to see if students can revise or refine their idea of netting a fish.

Does the refraction of light make a swimming pool seem deeper, shallower or the real depth? Explain.

🗨️ Reflection: Journaling

Compare and contrast: reflection and refraction

✓ **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.

Ideas to look for include:

reflection = shiny stuff, stays in one kind of stuff (air), angle of incidence and reflection equal, bounces off

refraction = light bends, goes through 2 or more kinds of stuff, passes through material, when the angle of incidence is 90° (straight on), there is no bending or

Video clips that show real examples and analogies for refraction:

<http://www.s-cool.co.uk/gcse/physics/properties-of-waves/revise-it/refraction-of-waves>

an animation showing a car moving from pavement to sand

<http://sol.sci.uop.edu/~jfalward/refraction/refraction.html> - excellent diagrams showing refraction

<http://www.youtube.com/watch?v=-r6usyEQYHA&> – shows a lawn mower on grass/sidewalk borders and the motion due to the two textures

This site has an animation that allows you to change the angle of incidence. http://www.physics.uoguelph.ca/applets/Intro_physics/refraction/LightRefract.html

<http://videos.howstuffworks.com/hsw/6241-out-of-darkness-refraction-video.htm> - swimming pool with net and diagram of penny explaining how light rays move from an object to your eye

Possible extension:

This site has an activity where students need to identify the gem stone by the angle of refraction. It is an interesting application of refraction.

http://www1.curriculum.edu.au/sciencepd/teacher/assessment/light/refr_gems.htm

Light and Blocks Activity

Materials:

Laser pointer or laser level
gelatin (or plexiglass) blocks
white unlined paper

Laser pointers and laser levels are not toys. Laser light can be harmful if used improperly. Never shine a laser directly into eyes.

1. Place the block of gelatin on the paper and trace it.
2. Lay the laser pointer on the table and shine the beam through the block at various angles of incidence.
3. For each angle, draw the entry and exit points for the beam. Be sure to use different colours of pencils for each attempt or to label the entry and exit points so you know which lines go together.
4. Remove the block of gelatin and draw the path from the entry to the exit point for each attempt.

What do you notice?

You need to write up your question, data, results, and conclusion to hand in. Use the rubric your teacher has shown you.

3rd Cycle

Curriculum Outcomes

- | 109-5 Describe how optical technologies have developed through systematic trial-and-error processes constrained by the optical properties of the materials.
- | 109-10 Relate personal activities associated with optical technologies.
- | 111-3 Provide examples of optical technologies that have enabled scientific research.
- | 208-5 State a prediction and a hypothesis based on background information or an observed pattern of events.
- | 209-2 Estimate focal length of a convex lens by finding its focal point.
- | 210-11 State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea.
- | 211-1 Receive, understand, and act on the ideas of others.
- | 308-9 Describe qualitatively how visible light is refracted.

Lenses Activities

These activities may be done by students in stations or in sequence.

Part 1 Gelatin Lenses

Materials:

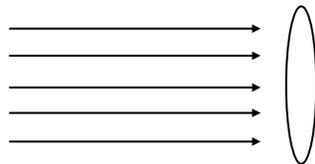
 Laser level or laser pointer

 Gelatin convex and concave lenses

 Use the template provided on pages 25-26 to make convex and concave lenses for the students.

Ask students to predict the entry and exit points for a laser beam when moving through a convex and then a concave gelatin block. They should draw these using the outlines of the convex and concave lenses.

Students should carry out this experiment in a similar way to that in Cycle 2 where they placed the block of gelatin on a white piece of paper and then determined entry and exit points. However, this time they should shine the laser at a 90° angle to various points along the block.



What happens to the light rays?

Part 2 Looking through Lenses

Materials:

Variety of lenses

Book

Have students look at an open book from about a metre away. They should hold a lens at arm's length and look at the print through the lens.

What happens if they change the position of the lens and/or their eyes? Have students record what they notice by using diagrams and words (approximate distances may be helpful). They should look for changes in the size of the image and note any changes in orientation of the image (upright or inverted).

Part 3 Images on Screens

Materials:

Variety of lenses

Light-coloured cardstock for screen

Have students hold a convex lens up by a window and place the cardstock on the room side. They should move the card closer to or away from the lens until an image can be observed. Have them record the appearance of the image and approximate distances.

Have students record what happens when other lenses are used.

Part 4 Image of the Sun

Materials:

Binoculars

Light-coloured cardstock for screen

Have students project an image of the sun onto the screen. The large end of the binoculars should be facing the sun. The screen should be moved closer and farther from the eyepiece end of the binoculars until the image can be seen.

Based on what they see and their experience from Part 3, what sort of lenses do they predict are in the binoculars?

✓ **Assessment:**

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

Reflection: Discussion

Ask students what share what “facts” they learned through the activities. Add to list made in the Accessing Prior Knowledge activity on page 4. Do any of the statements already there need to be revised?

Let student discussion happen. See the tips on supporting class discussion on pages 18-19.

What was observed with convex lenses?

What was observed with concave lenses?

What do you think refraction has to do with it?

Why do you think the convex lens could focus an image on the screen but the concave lens could not?

What kind of lenses do you think are in binoculars? Explain why you think that?

What are other instruments with lenses? (eyeglasses, magnifying glasses, microscopes, telescopes)

What kind of lenses do you think they might have and why?

Why do you think the screen had to be in a certain place to see an image? Why is the image clear in a certain place and not in others?

Introduce the ideas of **focus** and **focal length** if students do not raise them.

The following site has an applet in which the focal length can be changed – it shows how the double convex lens is shaped differently for the different focal lengths. The applet will also let you do the same with a concave lens.

<http://www.school-for-champions.com/science/experiments/simopticslens.htm>

Reflection: Journaling

What sort of lenses are inside a microscope? Explain why you think that. Use diagrams to help you explain.

✓ **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 which students are able to describe how convex images can both magnify and produce images.

✓ **Assessment:**

Have students research the history of the development of one of the following and create a timeline of significant developments:

Spectacles/eye glasses

Microscope

Telescope

<http://amazing-space.stsci.edu/resources/explorations/groundup/> has information on the history of the telescope

Possible extensions:

Show a prism bending light – Is this magic or can we maybe explain what is happening?

Have students research: *Why is this happening?*

Making Gelatin Blocks

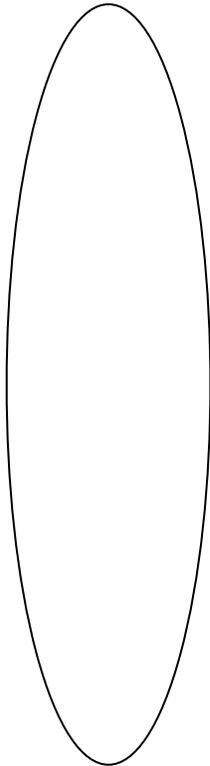
Use 2 packages of plain Gelatin or light-coloured Jello and 2 cups of water.

The slab should be about 1 cm thick. This will make about a 20 cm by 20 cm square block of gelatin.

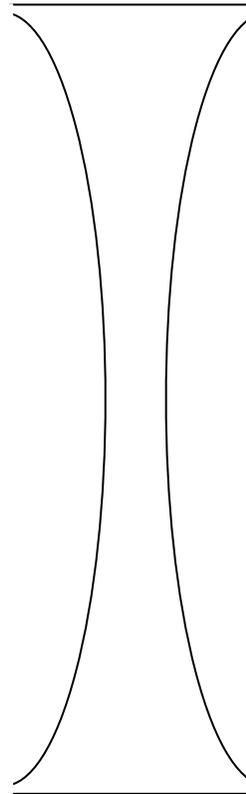
The slab can be cut into little blocks of about 5 cm x 5 cm, using an un-serrated knife (such as an exacto blade).

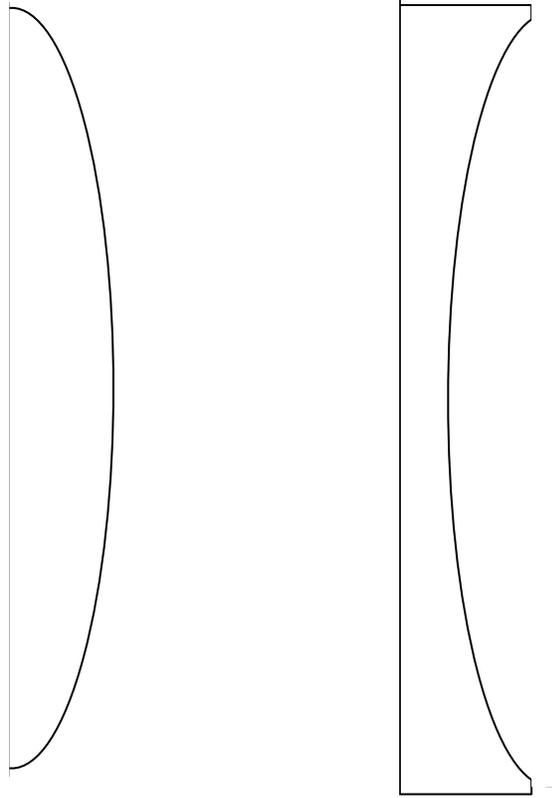
Patterns for lenses

convex



concave





Lenses Activities

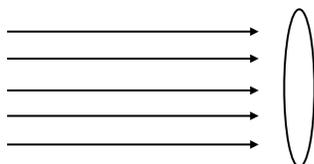
Gelatin lenses

Materials:

Gelatin convex and concave lenses
Laser pointer or laser level

Laser pointers and laser levels are not toys. Laser light can be harmful if used improperly. Never shine a laser directly into eyes.

- Predict the entry and exit points for a laser beam when moving through a convex and then a concave gelatin block.
- Draw these using the outlines of the convex and concave lenses.
- Place the gelatin lens on a white piece of paper and then determine entry and exit points of the light beam.
- Test a series of light positions as shown below.



- What happens to the light rays?

Looking through Lenses

Materials:

Variety of lenses
Book

- Place an open book with text about a metre away.
- Hold a lens at arm's length and look at the image of the text through the lens.
- What happens if you change the position of the lens and/or your eyes?
- Record what you notice using diagrams and words (approximate distances may be helpful).

(HINT: look for changes in the size of the image and note any changes in orientation of the image (upright or inverted).

Images on Screens

Materials:

Variety of lenses
Light-coloured cardstock for screen

- Hold a convex lens up by a window.
- Using a piece of cardstock, move the card closer to or away from the lens until an image can be observed.
- Record the appearance of the image and approximate distances.
- What happens when other lenses are used?

Image of the Sun

Materials:

Binoculars
Light-coloured cardstock for screen

- Project an image of the sun onto the cardstock.
- Hold the binoculars with the large end facing the sun.
- The cardstock should be moved closer and farther from the eyepiece end of the binoculars until the image can be seen.
- What sort of lenses do you predict are in the binoculars?

Never look directly at the sun with your eyes or through an optical instrument such as lenses or binoculars.

Determining the Size and Shape of the Blind Spot

Outcomes:

308-10 Describe qualitatively how visible light is refracted

209-2 Estimate measurements

210-11 State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea

210-16 Identify new questions and problems that arise from what was learned

Materials:

- Paper
- Pencils for fine-point marking pens
- Metric rulers
- Chalkboard/Whiteboard
- Chalk/Whiteboard Marker
- Calculators (optional)

Lesson Activity Overview

Inquiry Lesson:

1. Say to the class,

- “Did you know that you have a blind spot in each eye? Today we’ll find it, determine the size, and determine the shape.”

Instruct pairs of students in the following procedures:

- On a piece of paper, make a small X (about 1 cm long) with a marking pen, then make a dot (about 0.5 cm in diameter) about 5 cm to the right of the X.
- Closing our left eye and holding the paper close to your face, focus on the X.
- Then slowly move the paper away from your face, still focused on the X, until the dot disappears from your peripheral vision
- The dot should disappear at a distance of about 20 cm.
- Try this procedure a number of times so that you are very comfortable with locating your blind spot. Be sure that your partner can find his/her blind spot too. If not, offer helpful suggestions.
 - Can you find the blind spot in the left eye?
 - How did you have to change the experimental setup? (You must flip the dot to the left of the X, as opposed to the right.)

After students report their findings, explain the basic structure and function of the human eye. Once they understand the fundamental structure of the eye, ask,

- Can anyone explain why we have a blind spot in each eye, based on the eye’s anatomy?

Encourage a variety of ideas, and assist students in recognizing that where the optic nerve meets the retina there are no sensory cells, forming a small blind spot. Ask students what questions they have about the blind spot.

2. Just how much of the field of view is taken up by the two blind spots? To estimate, first students will determine the approximate field of view, and then subtract the approximate size of the two blind spots from it. To determine the approximate field of view, students stand approximately 20 cm (or whatever distance you used to make the entire X disappear) from a chalkboard and look straight ahead. With a partner assisting, each student finds out how much of the chalkboard he or she can see at this distance (with eyes straight ahead) by marking the outer limits of what can be seen. The student should move a pencil to determine the points above, below, to the right, and to the left at which the pencil just moves into view. That is, he or she should make the outer limits of the entire field of view at approximately 20 cm (or at whatever distance the entire X disappeared). These four points describe a rectangle, whose area the student can now determine. Using the approximate size of the blind spot, students can now calculate the approximate percentage of their entire fields of view that are taken up by their two blind spots (remember, there is a blind spot in each eye.) Ask the class why this would be considered a rough approximation and not an accurate measurement.

3. What is the approximate shape of the blind spot? Students will modify the “X and dot” method a bit. They will use the same sort of dot, but instead of an X they’ll try different shapes and see which ones are the easiest to make disappear. Have students try a square, a triangle, a rectangle, an oval, a circle, and any other shapes they think might fit. Ask,
 - Which do you predict will be closest to the shape of the blind spot?
 - Hint: Think of the cause of the blind spot: It occurs when the optic nerve meets the retina, resulting in a small area with no optical sensory cells.
 - What is the shape of the optic nerve?
 - How might its shape affect the shape of the blind spot?

4. Ask students,
 - How might the blind spot affect everyday life? Could we miss seeing things because of the blind spot?
 - Is it possible that something as big as a person could fall within the blind spot so that we would be unable to see him or her?

Have students use the “X and dot” method from Step 1 to determine how tall an X they can “lose” at about 20 cm distance from their eyes. (They should start with a small X and continue making larger Xs until they find the tallest X that will fit entirely into the blind spot, keeping the distance of the paper with the X and dot constant at 20 cm throughout the process.) Instruct students to use proportion to determine how far away a person would have to be to be able to be completely “lost” in the blind spot. That is, X (the approximate blind spot size, i.e., the size of the tallest X) divided by the constant distance (20 cm) equals human size divided by distance from the observer. (Consider human height to be 1.5 m) This gives us an equation, $X \text{ cm} / 20 \text{ cm} = 1.5 \text{ m} / \text{unknown meters}$, where X cm is the tallest X determined via the “X and dot” method. Change all units into meters, and solve for the unknown distance in meters. That is approximately the distance at which a person can “disappear” into your blind spot.

5. Ask,

- Who should be concerned about the presence of their blind spots? (drivers, meat cutters, baseball players)
- How can a driver, for instance, surmount the problem of the blind spot?

Offer students the reminder that the blind spot is only a problem if the eyes are focused on a single point, so if you keep your eyes moving, you get a good view of the entire area in front of you. Drivers should remember this and keep their eyes moving around, looking here and there ahead of them, rather than just at a single part of the road ahead.

Extension:

1. Ask students to make a survey of adult drivers and find out how many of them are aware of the potential hazards associated with their blind spots. Students should share their findings with the class. Keep class record and discuss the implications of the survey.
2. On the playground, show students how to make friends “disappear” by aligning them with their blind spots (Procedure 4). Recommend that students use their findings from this activity, including the placement, shape, and size of the blind spot. Students should report their results to the class.

Discussion Questions:

1. How much of the field of view is taken up by the blind spot? How do you know?
2. What shape is the blind spot? How do you know?
3. How might this blind spot be a problem for drivers? How else might it affect a person’s life? How could the blind spot affect your life?

Assessment:

1. Were students able to successfully locate blind spots in each eye? (Use observations made during Procedure 1 as a performance assessment.)
2. Were students able to determine the approximate percentage of the field of view that is taken up by the two blind spots? (Use observations made during Procedure 2 as a performance assessment, and use Discussion Question 1 as embedded evidence or as a writing prompt for a science journal entry.)
3. Were students able to come to a conclusion about the approximate shape of the blind spot? (Use observation made during Procedure 3 as a performance assessment, and use Discussion Question 2 as embedded evidence or as a writing prompt for a science journal entry.)
4. Could students calculate how far away a person would have to be to be able to become completely “lost” in his or her blind spot? (Use observations made during Procedure 4 as a performance assessment.)

5. Were students aware of the implication of the blind spot for everyday life? (Use Discussion Question 3 as an embedded assessment or as a writing prompt for a science journal entry.)

Rubric:

	Developing 1	Proficient 2	Exemplary 3
Were students able to successfully locate the blind spot in each eye?	Attempted to locate the blind spots but were unsuccessful	Successfully located the blind spots	Successfully located the blind spots and were able to describe their work in detail using appropriate terminology
Were students able to determine the approximate percentage of the field of view that is taken up by the two blind spots?	Attempted to determine the size of the blind spot but were unsuccessful	Successfully determined the approximate size of the blind spot	Successfully determined the approximate size of the blind spots and were able to describe their work in detail using appropriate terminology
Were students able to come to a conclusion about the approximate shape of the blind spot?	Attempted to determine the shape of the blind spot but were unsuccessful	Successfully determined the shape of the blind spot	Successfully determined the shape of the blind spot and were able to describe their work in detail using appropriate terminology
Could students calculate how far away a person would have to be to be able to become completely “lost” in one’s blind spot?	Attempted to calculate the distance but were unsuccessful	Successfully calculated the distance at which a person may be visually “lost”	Successfully calculated the distance at which a person may be visually “lost” and were able to describe their work in detail using appropriate terminology
Were students aware of the implications of the blind spot for everyday life?	Attempted to explain the implications but were not successful to any significant extent	Successfully explained the basic implications of the blind spot in daily life	Successfully explained in detail and using appropriate terminology the implications of the blind spot in daily life

Optics

Strand - Electromagnetic Radiation

General Curriculum Outcomes	Specific Curriculum Outcomes
308-11 describe different types of electromagnetic radiation, including infrared, ultraviolet, x-rays, microwaves, and radio waves	308-11 describe different types of electromagnetic radiation, including infrared, ultraviolet, x-rays, microwaves, and radio waves
308-12 compare properties of visible light to the properties of other types of electromagnetic radiation, including infrared, ultraviolet, x-rays, microwaves, and radio waves	308-12 compare the properties of visible light to the properties of other types of electromagnetic radiation, including infrared, ultraviolet, x-rays, microwaves, and radio waves
109-13 explain the importance of choosing words that are scientifically or technologically appropriate	109-13 explain the importance of using words <i>frequency and wavelength</i> correctly
112-8 provide examples to illustrate that scientific and technological activities take place in a variety of individual or group settings	112-8 provide examples related to optics that illustrate that scientific and technological activities take place individually and in group settings
113-2 describe possible positive and negative effects of a particular scientific or technological development, and explain how different groups in society may have different needs and desires in relation to it	113-2 describe possible negative and positive effects of technologies associated with electromagnetic radiation

Electromagnetic Radiation

Outcomes:

308-11 describe different types of electromagnetic radiation, including:

- infrared, ultraviolet, X-rays, microwaves, and radio waves

308-12 compare the properties of visible light to the properties of other types of electromagnetic radiation, including:

- infrared, ultraviolet, X-rays, microwaves, and radio waves

109-13 explain the importance of using the words *frequency* and *wavelength* correctly

112-8 provide examples related to optics that illustrate that scientific and technological activities take place individually and in group settings

113-2 describe possible negative and positive effects of technologies associated with electromagnetic radiation

Lesson Activity Overview

The focus of this lesson is for students to know that light is a wave and to understand the characteristics of a light wave

Mini-Task

Have students at each end of either a slinky or a rope. Next, students in opposition, will oscillate the rope/slinky that will create a wave. During this demonstration students will have a visual representation of some of the key features of waves such as wave speed, wavelength, amplitude, and frequency.

It should be a point of focus to ensure that students understand each of these terms: wave-speed, wavelength, amplitude, and frequency (109-13) and how using precise language is critical to correctly describe each effect.

Next, students should have a discussion to try to identify any existing waves that they may have prior understanding of. This is also a good opportunity to identify misconceptions. These discussion should narrow to identify:

- infrared, ultraviolet, X-rays, microwaves, and radio waves (308-11)

Therefore, students should be able to make the connection to these different types of waves and light waves.

Journal

Use the terms wavelength and frequency to describe several types of electromagnetic radiation. (109-13, 308-11)

Next, students will have to do some research to compare the properties of visible light to the different types of electromagnetic radiation.

- infrared, ultraviolet, X-rays, microwaves, and radio waves, and Light waves

Task

The end product of the research should be to create a chart or diagram of the various wave types to determine:

Produce a visual representation or model of each of the types of waves based on wavelength and frequency (308-12)

The primary use of each wave in society (112-8)

Possible positive effects (if any) of each type of wave (113-2)

Possible negative effects (if any) of each type of wave (113-2)

i.e Microwave ovens, X-ray machines, cellular phones, and the nuclear industry are some examples of technologies that can be explored.

Extension:

Students should come to realize that white light, when refracted by a prism, illustrates the different wavelengths of visible electromagnetic radiation. The spectrum is often indicated as a continuum of colours with the shortest waves being at the violet end and the longest at the red end. Students can investigate the color combinations when the three primary colours of light (red, green, and blue) are mixed.

Assessment:informal Formative

Ensure that students have participated in a demonstration using ropes or slinkys to model how a wave behaves (308-11)

Ensure that students have had discussion about wave speed, wavelength, amplitude, and frequency and the need to precise use of the language (109-13)

Ensure that students have had discussion to identify common waves and that that conversation has led to understanding infrared, ultraviolet, X-rays, microwaves, and radio waves, and Light waves

Assessment:Formal Formative

Ensure that students have responded to journal entry about using the terms frequency and wavelength to describe various types of waves (109-13)

Ensure that students have created a chart or diagram:

Produce a visual representation or model of each of the types of waves based on wavelength and frequency (308-12)

The primary use of each wave in society (112-8)

Possible positive effects (if any) of each type of wave (113-2)

Possible negative effects (if any) of each type of wave (113-2)