Science resource Package: Grade 8

Optics:
Refraction and Dispersion

New Brunswick Department of Education
September 2009
Acknowledgements

The Department of Education of New Brunswick gratefully acknowledges the contributions of the following groups and individuals toward the development of the New Brunswick Science Resource Package for Grade 8 *Optics: Refraction and Dispersion*:

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- Science Learning Specialists and science teachers of New Brunswick who provided invaluable input and feedback throughout the development and implementation of this document.

Note that at the time of posting, all URLs in this document link to the desired science content. If you observe that changes have been made to site content, please contact Kathy Hildebrand katherine.hildebrand@gnb.ca, Science Learning Specialist, at the Department of Education.
# TABLE OF CONTENTS

**RATIONALE** .................................................................................................................................................................................. 1

**BACKGROUND INFORMATION** ...................................................................................................................................................... 3

- **PRIOR KNOWLEDGE:** ........................................................................................................................................................................ 3
- **COMMON MISCONCEPTIONS:** ............................................................................................................................................................. 3
- **DID YOU KNOW?** .................................................................................................................................................................................. 3

**INSTRUCTIONAL PLAN** ......................................................................................................................................................................... 4

- **ACCESS PRIOR KNOWLEDGE** .......................................................................................................................................................... 4
- **1ST CYCLE** .......................................................................................................................................................................................... 5
  - Pennies and Pencils Activities .......................................................................................................................................................... 5
  - Reflection: Class Discussion ........................................................................................................................................................... 7
  - Reflection: Journaling ........................................................................................................................................................................ 8
- **2ND CYCLE** .......................................................................................................................................................................................... 10
  - Introduce the terms: refraction, normal, angle of incidence, angle of refraction ............................................................................ 10
  - Lights and Blocks Activity ............................................................................................................................................................... 10
  - Reflection: Discussion ....................................................................................................................................................................... 12
  - Reflection: Journaling ....................................................................................................................................................................... 13
- **POSSIBLE EXTENSION:** ................................................................................................................................................................... 13
  - HTTP://WWW1.CURRICULUM.EDU.AU/SCIENCEPD/TEACHER/ASSESSMENT/LIGHT/REFR_GEMS.HTM ........................................ 13
- **3RD CYCLE** .......................................................................................................................................................................................... 14
  - Lenses Activities ................................................................................................................................................................................ 14
  - Reflection: Discussion ........................................................................................................................................................................ 16
  - Reflection: Journaling ........................................................................................................................................................................ 16

**SUPPORTING CLASS DISCUSSION** .................................................................................................................................................... 18

**MATERIALS LIST** .................................................................................................................................................................................. 20

**STUDENT VERSION OF OUTCOMES** .................................................................................................................................................. 21

**PENNIES AND PENCILS ACTIVITIES** .................................................................................................................................................. 22

**DISAPPEARING GLASS** ........................................................................................................................................................................ 23

**LIGHT AND BLOCKS ACTIVITY** ......................................................................................................................................................... 24

**MAKING GELATIN BLOCKS** ................................................................................................................................................................. 25

**LENSES ACTIVITIES** ............................................................................................................................................................................. 27

**STUDENT SELF-ASSESSMENT** ............................................................................................................................................................. 29

**OBSERVATION CHART SHEET** ............................................................................................................................................................ 30

**CHECKLIST SHEET** ............................................................................................................................................................................. 31

**OBSERVATION CHECKLIST** ............................................................................................................................................................... 33

**STUDENT RECORD** ............................................................................................................................................................................... 34
Rationale

This resource package models current research in effective science instruction and provides an instructional plan for one topic selected from the Grade 8 Atlantic Canada Science Curriculum. This curriculum includes STSE (Science, Technology, Society and Environment) outcomes, Skills outcomes, and Knowledge outcomes – all of which are important for building a deep understanding of science and its place in our world.

As has been true of our ancestors, we all develop “explanations” about what we observe which may or may not be valid. Once ideas are established, they are remarkably tenacious and an alternate explanation rarely causes a shift in thinking. To address these misconceptions or alternate conceptions, students must be challenged with carefully selected experiences and discussion.

A key part of this instructional plan is accessing prior knowledge. It is recorded in a way that it can and will be revisited throughout the topic. The intent is to revise, extend, and/or replace students’ initial ideas with evidence-based knowledge.

Science is not a static body of facts. The process of exploring, revising, extending, and sometimes replacing ideas is central to the nature of science. Think of science as an ongoing evidence-based discussion that began before our time and that will continue after it. Science is often collaborative, and discussion plays a key role. Students’ learning of science should reflect this as much as possible.

The intent of this instructional plan is to encourage a constructivist approach to learning. Students explore an activity, then share, discuss and reflect. The telling of content by the teacher tends to come after, as an extension of the investigation (or experience) explored by the students.

The learning is organized into cycles. The partial conceptions and misconceptions are revisited in each cycle so that students’ ideas will be revised. Each cycle will result in deeper and/or extended learning.
Hands-on activities are part of the instructional plan. Inquiry activities tend to be most structured in the first cycle. The teacher provides the question to investigate and gives a procedure to follow. In subsequent cycles, less structure tends to be given. For example, students may be given a question and asked to develop an experimental plan which they then implement. The goal is to move towards open inquiry in which students generate a testable question, develop an experimental plan using available materials, implement the plan, record relevant observations, and make reasonable conclusions. The included activities are meant to start this journey.

Discussion and written reflections are key parts of the lessons. Discussion (both oral and written) is a vehicle that moves science forward. For example, when scientists publish their evidence and conclusions, other scientists may try to replicate results or investigate the range of conditions for which the conclusion applies. If new evidence contradicts the previous conclusions, adjustments will be required. Similarly, in this instructional plan students first do, then talk, then write about the concept. A section on supporting discussion is included in this resource package.

Assessment tasks are also included in the instructional plan and assess three types of science curricular outcomes: STSE, Skills, and Knowledge. These tasks are meant to be used as tools for letting the teacher and the students know where they are in their learning and what the next steps might be. For example: Has the outcome been met or is more learning required? Should more practice be provided? Is a different activity needed?

When assessment indicates that outcomes have been met, it will provide evidence of achievement. This evidence may be sufficient and further formal testing (paper-pencil tests) may not be required to demonstrate that outcomes have been met.
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/~jalward/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.
Optics: Refraction and Dispersion

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.
Optics: Refraction and Dispersion

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.

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
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?
Optics: Refraction and Dispersion

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

فعال

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.

فعال

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
**2nd Cycle**

<table>
<thead>
<tr>
<th>Curriculum Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>208-1 Rephrase questions in a testable form and clearly define practical problems.</td>
</tr>
<tr>
<td>210-1 State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea.</td>
</tr>
<tr>
<td>211-1 Receive, understand, and act on the ideas of others.</td>
</tr>
<tr>
<td>308-9 Describe qualitatively how visible light is refracted.</td>
</tr>
</tbody>
</table>

**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.
Optics: Refraction and Dispersion

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.

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

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 refraction

**Video clips that show real examples and analogies for refraction:**

http://www.s-cool.co.uk/gcse/physics/properties-of-waves/refraction-of-waves.html - 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/ - choose refraction then 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.

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?
Supporting Class Discussion

No one person is as smart as all of us together.

Page Keeley, in the book “Science Formative Assessment” (2008), uses the analogy of ping-pong and volleyball to describe discussion interaction. Ping-pong represents the back and forth question-answer pattern: the teacher asks a question, a student answers, the teacher asks another question, a student answers, and so on. Volleyball represents a different discussion pattern: the teacher asks a question, a student answers, and other students respond in succession; each building upon the previous student’s response. Discussion continues until the teacher “serves” another question.

A “volleyball” discussion encourages deeper student engagement with scientific ideas. Students state and give reasons for their ideas. Through the interaction, ideas may be challenged and clarified. Extensions and applications of ideas may arise as well. Discussions should avoid the personal and always revolve around ideas, explanations and reasons. The goal is for students to achieve better understanding.

Share the ping-pong and volleyball analogies with your students. Good discussion takes practice. You and your students will improve. Many teachers find discussion works best if all students can see each other, such as in a circle, at least until they become accustomed to listening and responding to each other.

As the teacher, you will need to:
- establish and maintain a respectful and supportive environment;
- provide clear expectations;
- keep the talk focused on the science;
- carefully orchestrate talk to provide for equitable participation.

It is important to establish discussion norms with your class. Your expectations may include:
- Everyone has a right to participate and be heard.
- Everyone has an obligation to listen and try to understand.
- Everyone is obliged to ask questions when they do not understand.
- The speaker has an obligation to attempt to be clear.

At first, discussions are apt to seem somewhat artificial. Initially, a bulletin board featuring carton talk bubbles with suggested sentence starters may be helpful.

I respectfully disagree . . .
I had a different result . . .
Could you show how you got that information?
When I was doing ____, I found that . . .
Even though you said ____, I think . . .
The data I have recorded in my notebook is different from what you shared. I found . . .
It is helpful if teacher questions refer to a big idea rather than specifics. (Could humans and chickens move their bones without muscles?) Questions should be phrased so that anyone can enter into the conversation. Opinion questions are especially good for this (What do you think . . . ? How do you think . . . ? What if . . . ? Why . . . ?).

Provide plenty of wait time for students. Students give more detailed and complex answers when given sufficient wait time. Allow wait time after student responses. When students are engaged and thinking, they need time to process other responses before contributing. If the discussion is not progressing, have students engage in partner talk. Partner talk enables the teacher the opportunity to insert “overheard” ideas.

Helpful teacher prompts:
1. What outcome do you predict?
2. Say more about that.
3. What do you mean by . . . ?
4. How do you know?
5. Can you repeat what ____ said in another way?
6. Does anyone agree or disagree with . . . ?
7. Does anyone want to add to or build on to . . . ?
8. Who understands ___’s idea and can explain it in their own words?
9. Let me see if I have got your idea right. Are you saying . . . ?
10. So you are saying that . . .
11. What evidence helped you to think that?
12. Okay, we do not agree. How does each position fit the evidence? What else could we find out?

References:

Materials List

Fewer materials are required if activities are done in stations instead of all students carrying them out at the same time.

Per group:
Laser pointer
Gelatin (or plexiglass) block

Per station:
Solid coloured cup or bowl or foil pie plate
2 Glass jars or clear plastic cups
Cooking oil
Pencil or straws
Gelatin convex and concave lenses
Variety of lenses
Binoculars
Glass bowl or beaker
Ordinary glass test tube, dish or plate
Pyrex test tube, dish or plate
Student Version of Outcomes

109-5 Describe the history of the development of eye glasses, microscopes and telescopes and relate this to the properties of available materials.

109-10; 111-3 Explore how optical devices have contributed to scientific research and relate your experiences with these devices.

208-1 Change questions or define problems so that they may be tested.

208-5 Write predictions and questions 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 Make conclusions, based on data, and explain how the data relates to the initial question of the experiment.

211-1 Listen, reflect, and respond to the ideas of others.

308-9 Explain how visible light is refracted
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?
Light and Blocks Activity

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

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.
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

- 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.

![Diagram of light beam through gelatin lenses]

- 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.
## Student Self-assessment

<table>
<thead>
<tr>
<th>“Got it”</th>
<th>Student self-assessment</th>
<th>Teacher feedback</th>
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</thead>
<tbody>
<tr>
<td>Question is <strong>stated clearly</strong> and in a <strong>testable</strong> form</td>
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<tr>
<td>Data is recorded <strong>in detail</strong> in an <strong>organized</strong> manner with titles and headings; <strong>necessary units</strong> are included.</td>
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<tr>
<td>Discussion of results/Conclusion <strong>relates to question</strong> and is <strong>based on data</strong> from the experiment.</td>
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<tr>
<td>Spelling and grammar <strong>errors are absent or rare</strong>.</td>
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# Observation Chart Sheet

**Outcomes:**

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</table>
# Checklist Sheet

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Correlations with Cycles</th>
<th>Yes</th>
<th>No</th>
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<tbody>
<tr>
<td><strong>STSE</strong></td>
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<tr>
<td>109-5 Describe how optical technologies have developed through systematic trial-and-error processes constrained by the optical properties of the materials.</td>
<td>3rd cycle: Mark/record observations during class discussion; journal entry; assessment activity pg.17</td>
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<tr>
<td>109-10 Relate personal activities associated with optical technologies</td>
<td>3rd cycle: Mark/record observations during class discussion; journal entry</td>
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<tr>
<td>111-3 Provide examples of optical technologies that have enabled scientific research.</td>
<td>3rd cycle: Mark/record observations during class discussion; journal entry; assessment activity pg.17</td>
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<td><strong>SKILLS</strong></td>
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<tr>
<td>208-1 rephrase questions in a testable form and clearly define practical problems</td>
<td>2nd cycle: Mark/record observations during Lights and Blocks activity; student activity sheets; student write up</td>
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<td>208-5 State a prediction and a hypothesis based on background information or an observed pattern of events</td>
<td>3rd cycle: Mark/record observations during Lenses activities and class discussion</td>
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<tr>
<td>209-2 Estimate focal length of a convex lens by finding its focal point</td>
<td>3rd cycle: Student activity logs</td>
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<td>210-11 State a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea</td>
<td>1st cycle: Mark/record observations during activities and class discussion, student written responses to activities 2nd cycle: Mark/record observations during Lights and Blocks activity and class discussion; student lab sheets; revisiting class prior knowledge chart; student write up; assessment question pg.12 3rd cycle: Mark/record observations during Lenses activities and class discussion (especially when revisiting the prior knowledge chart); journal entry</td>
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<td>211-1 Receive, understand, and act on the ideas of others</td>
<td>1st cycle: Mark/record observations during activities, class discussion especially when the class revisits the class chart created when they were accessing prior knowledge; student</td>
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<td><strong>KNOWLEDGE</strong></td>
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<tr>
<td>308-9 Describe qualitatively how visible light is refracted</td>
<td>1st cycle: Mark/record observations during activities and class discussion; assessment question pg.8; journal entry 2nd cycle: Mark/record observations during Lights and Blocks activity and class discussion; assessment question pg.12; journal entry 3rd cycle: Mark/record observations during Lenses activities and class discussion; student activity logs</td>
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<td>Observation Checklist</td>
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**Student Record**

<table>
<thead>
<tr>
<th>Outcome goal</th>
<th>Evidence</th>
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<tbody>
<tr>
<td>I can describe the history of optical devices and relate it to available</td>
<td></td>
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<tr>
<td>materials of the time. (109-5)</td>
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<tr>
<td>I can explain how optical devices have contributed to scientific research</td>
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<td>and my own experiences with them. (109-10, 111-3)</td>
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<td>I can change questions or define problems so that they may be tested.</td>
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<tr>
<td>(208-1)</td>
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<tr>
<td>I can write predictions and questions based on information or an observed</td>
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<tr>
<td>pattern of events. (208-5)</td>
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<td>I can estimate the focal length of a convex lens by finding the focal point.</td>
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<tr>
<td>(209-2)</td>
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<tr>
<td>I can make conclusions, based on data, and explain how it relates to the</td>
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<td>initial question of the experiment. (210-11)</td>
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<td>I can listen, reflect, and respond to the ideas of others. (211-1)</td>
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<td>I can describe how visible light is refracted. (308-9)</td>
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