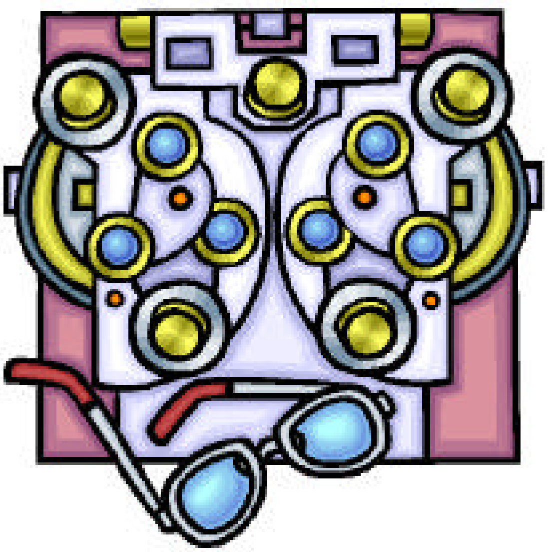
Optics

Energy and Control



Including:

Light and its Sources
Electromagnetic Spectrum
Visible Sources of Light
Transparency of Objects
Reflection and Mirrors
Refraction and Lenses
The Visible Spectrum and Colour
Optical Devices
OPTICS - SEEING IS BELIEVING!

An Integrated Unit for Grade 8

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Length of Unit: approximately: 20 hours

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Mathematics, Grades 1-8
Grand Erie District School Board
Kawartha Pine Ridge District School Board
Renfrew District School Board

Science and Technology, Grades 1-8
Lakehead District School Board
Thames Valley District School Board
York Region District School Board

Social Studies, History and Geography, Grade 1-8
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An Integrated Unit for Grade 8
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Task Context

Light is a powerful energy source which is important to human survival. The understanding of its properties allows for the harnessing of its powers. In this unit, students will learn about some of the sources and properties of light and how they are applied in optical devices and used for different purposes.

Task Summary

Students will investigate the question, "**HOW DOES UNDERSTANDING THE PROPERTIES AND CHARACTERISTICS OF LIGHT HELP US TO ENHANCE OUR QUALITY OF LIFE?**". Students will then apply knowledge gained though the unit in order to create an optical device.

Culminating Task Assessment

The topic of optics contains many properties which can be demonstrated in ways that appear "amazing". Students will work in pairs or individually to create an "optical illusion" that incorporates the concepts studied in the optics unit. Each illusion will be presented to the class members who will use their knowledge of optics and light to explain how each illusion was created. The class will then present their illusions, as a show, to other classes.

Links to Prior Knowledge

Throughout the Energy and Control strand of Science & Technology, students have been exposed to common forms of energy, energy conversion and energy uses. In Grade 4 specifically, students were introduced to the same basic characteristics and properties of light that will be investigated in this unit. Students also identified different ways in which light is produced and transmitted and technological innovations related to light.

In the previous year, grade 7 students have studied Heat as the focus of the Energy and Control Strand. Connections and comparisons of the different forms of energies are implicit in many of the activities. Prior to subtask one, a discussion/review/journal entry about what students know about Heat, and Energy and Control in general is an appropriate way of gauging what prior knowledge the students bring to the Optics Unit.

Considerations

Notes to Teacher

1. Equipment

For reflection and refraction activities, it is highly recommended that, beginning in subtask 4, you use ray boxes. It will be very difficult to achieve the valid results without the listed equipment.

2. I.N.S.I.T.E. Method
You will find the term "I.N.S.I.T.E. method" used in several of the activities. This is a method of inquiry that may help guide your students in their investigations. This method is used in a number of subtasks in the unit. Details about this method are provided in a unit wide blackline master (**BLM 8.uw.1**). A poster is also provided which may be enlarged and posted in the classroom (**BLM 8.uw.2**). After students have used the methods in an investigation the Inquiry/I.N.S.I.T.E. rubric (**BLM 8.uw.3**) may be used to evaluate student work. You will also find that the "S.P.I.C.E. model", the model for the design process, available in the unit wide resources (**BLM 8.uw4**).

3. The Science and Technology Journal using the K.I.L.E. approach

The K.I.L.E. approach is used thoughout this unit as a way of assessing students' learning in their science and technology journal. In the first subtask students will be asked to write down things they know about optics (K) and interesting questions, thoughts, or ideas (I) related to the topic. In the remainder of the subtasks students will be asked to add information about what they learned (L) in their journals and to provide examples of situations in which they have experienced this (E). This will provide the teacher with an opportunity to assess students' knowledge, and communication skills as well as their ability to relate learning to the outside world. An assessment rubric for the students' written work using the K.I.L.E. approach in their science journal is provided as a blackline master (**BLM 8.uw.5**).

In order to assist students to be successful communicators in science and technology, students will need to see models of good journals and will need lessons on journal writing.

Suggested strategies are:
a) Explaining Criteria - The teacher explains the criteria for writing a journal entry by demonstrating each statement using examples from class journal entries e.g. find all the science and technology words used and circle these. Next students can use the criteria to assess a piece of scientific writing. The teacher displays the writing on an overhead or chart paper and, as a class, the students discuss the piece of writing.

b) Independent Writing - When students have had many experiences in shared writing, then they can record their ideas independently. The teacher can use a rubric to assess the first entry and provide feedback to individual students in order to improve science and technology writing skills. The information from this assessment could also be used for the development of class demonstrations in a specific area.

4. Integration
Each activity is designed to build skills and concepts which will be demonstrated in the summative task. Although these lessons may be taught independently, integrated learning opportunities in other subject areas may be addressed simultaneously.

Science is a form of knowledge that seeks to describe and explain the natural and physical world and its place in our universe. Technology is both a form of knowledge that uses concepts and skills from other disciplines (including science) and the application of this knowledge to meet an individual need or specific problem. Inherent in these studies is the need to both research and communicate ideas and findings, whether through specific use of scientific and technical vocabulary, or through the use of diagrams or illustrations. The study of science and technology is an opportunity for students to reinforce and extend expectations in other subject areas. When unit or term planning, teachers may wish to take advantage of opportunities to address and assess expectations from other curricula.

5. Assessment
In this unit, a variety of assessment strategies and recording devices have been included. The assessments provide the teacher with information on the development of students' skills in all areas of the achievement scale as outlined on page 13 in the Ontario Curriculum, Science and Technology document.

Assessment Accommodation Strategies
1. Consult Individual Education Plan and adapt the assessment format (e.g., oral, practical demonstration, interview, construction, tape-recorded test) to suit the needs of the student;
2. Allow the student to write the main points and expand verbally;
3. Allow additional time, when required for completion;
4. Read or clarify questions for the student and encourage student to rephrase questions, in his/her own words;
5. Provide highlighting of key words or instructions for emphasis;
6. Use several assessments to establish ability

6. Safety
Safety is an important aspect of any science and technology program. . For more information on safety considerations, please see page 8 and 9 of the Ontario Curriculum, Science and Technology document. Some safety concerns specific to this unit that might need to be investigated are:
-The district's policy (if any) on the use of lasers in the school
-The district's policy (if any) on the use of candles/open flames as a light source

- The Science Teachers' Association of Ontario (STAO) "Be Safe" document
The use of plastic mirrors and lenses for this unit is recommended.

7. Use of BlackLine Masters

Included in this unit is a large number of blackline masters. Due to the sophisticated scientific material covered in the unit and in order to meet the needs of teachers with various backgrounds, it was decided to include a broad range of blackline masters. Instead of photocopying all blackline masters the following strategies could be used:
Have students recreate the BLM as a science journal activity or in a group assignment.
Recreate BLM on a bulletin board (e.g., vocabulary/definition and fact bulletin board).
Recreate BLM as a wall chart or on chart paper.
Copy BLM on acetate and use it on an overhead projector.

8. Classroom Accommodations

All accommodations must take into account the student's Individual Education Plan. All of the tasks and activities are designed to accommodate the needs of students at different levels of abilities. Many of the activities include pictures and/or examples of a step-by-step process. These may be used at the discretion of the teacher for some or all students. As well, teachers can easily adapt the activities to allow for open-ended, student-directed tasks.
Teachers are encouraged to:
- involve the student in setting goals for work completion;
- encourage risk taking;
- provide varied opportunities for peer and/or group interactions (e.g., cooperative learning, sharing);
- teach visual strategies for journal writing and/or note making (e.g., use of diagram/picture to represent content);
- provide advance organizers to structure content (e.g., outlines, subtitles, paragraph frames);
- encourage the use of lists, advance organizers, personal planner for personal organization;
- allow opportunities for alternatives to writing (e.g., graphic representations, drama, media presentations, timelines, collages).

Optics
Energy and Control **An Integrated Unit for Grade 8**

1 **Light and its Sources**
In this subtask students will be introduced to the term Optics. As a baseline measure of what the students already know, or think they know about the topic, a K.I.L.E. entry will be made in their science and technology journals prior to the introductory lessons in this subtask. During this subtask students will view a video which presents a general overview of the topic. During the core lesson, students will investigate the difference between artificial and natural light.

2 **Electromagnetic Spectrum**
In this subtask students will be introduced to the entire electromagnetic spectrum. Through teacher-led lessons, brainstorming sessions and videos, the students will learn that all light energy shares the same properties. They will also investigate visible light, which is studied in subtask 3 and represents only a small part of the electromagnetic spectrum.

3 **Visible Sources of Light**
In this subtask students will explore the visible range of the electromagnetic spectrum (visible light), and begin to categorize different types of light sources, both natural and artificial.

4 **Transparency of Objects**
The students will have the opportunity to investigate what happens to light when it encounters various materials of different properties. The students will explore/investigate materials that allow for the full transmission of light are transparent, materials that allow for the partial transmission of light are translucent and materials that allow for no transmission of light are opaque.

5 **Reflection and Mirrors**
Students will investigate the properties of light as they relate to mirrors and reflections. They will explore what happens when light encounters an opaque object one of the possible outcomes is the reflection of the light. Students will explore and examine the differences in the reflections created by plane mirrors, concave mirrors and convex mirrors.

6 **Refraction and Lenses**
Students will investigate the properties of light as they relate to lenses, prisms and refraction. They will explore what happens when light encounters a transparent object and the rays of light are not perpendicular to the face of the object (refraction). Students will explore and examine the differences in the refraction created by lenses and prisms.

7 **The Visible Spectrum and Colour**
By studying the visible light range of the Electromagnetic Spectrum, the students will investigate how colour is perceived. They will also investigate Additive and Subtractive Colour Theories.

8 **Optical Devices**
Students have had an opportunity to learn what happens when light is reflected and refracted and have developed a basic understanding of other properties of light. In this subtask, students will research optical devices which make use of the properties of light they have studied. Each student will make a presentation to the class based on the research.

9 **OPTICS - SEEING IS BELIEVING!**
The topic of optics contains many properties which can be demonstrated in ways that appear "amazing". Students will work in pairs or individually to create an "optical illusion" that incorporates the concepts studied in the optics unit. Each illusion will be presented to the class members who will use their knowledge of optics and light to explain how each illusion was created. The class will then present their illusions, as a show, to other classes.

Light and its Sources

Subtask 1

100 mins

Description

In this subtask students will be introduced to the term Optics. As a baseline measure of what the students already know, or think they know about the topic, a K.I.L.E. entry will be made in their science and technology journals prior to the introductory lessons in this subtask. During this subtask students will view a video which presents a general overview of the topic. During the core lesson, students will investigate the difference between artificial and natural light.

Expectations

8s75 – formulate questions about and identify needs and problems related to the properties and behaviour of light (e.g., interactions between light and different materials), and explore possible answers and solutions (e.g., predict and demonstrate how various liquids will refract a light beam and describe the angle of refraction);

8s77 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as incidence, reflection, refraction, wavelength, frequency when describing the properties of light);

Groupings

Students Working Individually
Students Working As A Whole Class
Students Working In Small Groups

Teaching / Learning Strategies

Brainstorming
Direct Teaching
Inquiry
Learning Log/ Journal

Assessment

Assessment Strategies

Exhibition/demonstration
Learning Log

Assessment Recording Devices

Teaching / Learning

Part A: Prior Knowledge using the "K.I.L.E. method" / Introduction and Initial Entry in Science Journal (20 minutes)

1. Before beginning Activity One, introduce the K.I.L.E. method, which students will use to record information in their science and technology journals. An explanation of the K.I.L.E. method can be found in the unit-wide notes.

2. Introduce this topic by providing students with a definition of Optics (see Webster's dictionary - definition in Notes to Teacher). Briefly discuss and clarify the definition. Brainstorm to develop a list of words associated with the topic. Record the words on chart paper as they are generated.

3. Tell the students you wish to determine what they already know about the topic. This information will be recorded in their science and technology journals. This is the initial step in the K.I.L.E. method.

4. In their journals, under the topic Optics, have students write the title "What I Already Know About Optics" (K). Tell them their task is to generate a list of "facts" to demonstrate their current knowledge of optics. Give them no more than ten minutes to complete the list. After they have finished this list ask them to write them down any interesting questions, thoughts or ideas they may have about this topic (I), they may wish to include a title "Interesting Questions & Thoughts About Optics". Collect the journals.

5. Using the journals, generate a sample list of what the students have indicated they already know about

Optics and copy this list on chart paper for posting in the room. Similarly, generate lists questions about Optics that the students have included in their journal entries. Post the charts in the room and before the next class discuss the charts with the students. Indicate that throughout the unit, the charts will be referred to and facts will be confirmed or proved to be inaccurate and questions raised will be addressed during their study of Optics.

Part B: Video (20 minutes)

To provide a general introduction to Part B and to help motivate students, show a short video about light or optics This will also serve as a primer for students who have no background in Optics.

Part C: What is Light Activity (60 minutes)

1. Prior to the lesson, write the question "What Is Light?" on a piece of chart paper. Lead a class discussion of the question, and record student responses and ideas on the chart paper without editing them. Allow 15 minutes for this activity. When the activity is finished, tell the students they will review the information on the chart at the end of the unit to add, delete, confirm or edit the answers.

2. Begin the next part of the lesson by telling students they will be examining sources of light. Ask them to give two or three examples of light sources (correct students if they provide answers such as the moon. The moon is not a source of light. It reflects light. Tell them they will be studying the reflection of light later in the unit. Do not discuss reflection during this class).

3. Group the students in two's, three's or four's and give them a piece of chart paper along with **BLM 8.1.1**, "Classifying Sources of Light". Review the information on **BLM 8.1.1**. to ensure students understand the task. This should provide students with a quick overview of the classification process. Review the example "How to Classify". Allow 20 minutes for students to group or classify the 15 items listed on the bottom of the blackline master. If they finish early, encourage the groups to add additional items to their classification groups, using a different coloured marker.

4. Have each group present its chart to the class. Ask the students to explain their answers. Most groups will have classifications which are accurate. Some groups will have errors which can be corrected by fellow classmates (or the teacher). Post all completed charts.

5. If any groups classified light using the terms ARTIFICIAL and NATURAL (or similar terms), focus on these charts at the end of the presentations. If none of the groups classified light in these terms proceed to step 6 below. ***Tell the students that all sources of light fit into these two broad categories and that in future classes they will be looking at breaking these categories into subcategories.***
* NOTE: If the terms artificial or natural appear as category headings, add these terms to one or all of the student charts which have this type of grouping.

6. If none of the groups classified light as artificial or natural, then create a two column chart on a new piece of chart paper. Title one column NATURAL and the other ARTIFICIAL. Discuss the terms:

NATURAL LIGHT: light which occurs without human intervention as a result of a natural process.

ARTIFICIAL LIGHT: light which can only occur because of human invention (technology).

* NOTE: Human intervention does not include the act of creating fire. Fire and the light it generates occurs as a result of a natural process.

7. Complete the chart with the 15 items on **BLM 8.1.1**. Finish by reminding the students that they will be examining these light sources more specifically in a future class.

Note that teacher answers to BLM 8.1.1 can be found in the "Notes to Teacher" Section of this subtask.

Adaptations

Resources

BLM 8.1.1 blm 8.1.1.cwk

an Optics video

Notes to Teacher

Definition

Websters:
Optics \Op"tics\, n. [Cf. F. optique, L. optice, See Optic.] That branch of physical science which deals with the nature and properties of light, the laws of its modification by opaque and transparent bodies, and the phenomena of vision.

Classifying Sources of Light: Teacher Answers

LIST OF LIGHT SOURCES

a light bulb - artificial
a campfire - natural (fire)
the sun - natural
a forest fire - natural
a flashlight - artificial
stars - natural
a glow in the dark sticker - natural (coated with phosphorous, a natural element)
headlights on a car - artificial
a firefly - natural
a television screen - artificial
fireworks - natural (a chemical reaction when heat energy is applied)
a lit candle - natural (fire)
propane barbecue flames - natural (fire)
a glow in the dark tube necklace - natural (a chemical reaction)
a fluorescent light tube - artificial

Note that many of these will seem to be artificial – a glow-in-the-dark tube necklace made of plastic may seem to be a product of technology; however, the chemicals inside the tube are natural and the reaction created (the "glow") is a natural chemical reaction.

Similarly, glow-in-the-dark stickers are coated with a phosphorescent material. The particles in this material absorb radiant (light) energy and emit the energy, as light, over a period of time.

Remember, fire is a natural source of light in any form so don't confuse the necessity of human intervention (e.g., a camper must light a campfire or a cook must light a barbecue) with the actual source of the light. The source of the light is fire so it is a natural source.

Teacher Reflections

Description

In this subtask students will be introduced to the entire electromagnetic spectrum. Through teacher-led lessons, brainstorming sessions and videos, the students will learn that all light energy shares the same properties. They will also investigate visible light, which is studied in subtask 3 and represents only a small part of the electromagnetic spectrum.

Expectations

8s66 – compare the properties of visible light with the properties of other types of electromagnetic radiation, including infrared and ultraviolet rays, X-rays, microwaves, and radio waves;
8s77 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as incidence, reflection, refraction, wavelength, frequency when describing the properties of light);
8s79 – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., prepare a brochure informing the public of the risks of a specific type of electromagnetic radiation).
8s80 – describe how energy comes to earth as radiation in a range of wavelengths, some of which are visible;

Groupings
Students Working Individually

Teaching / Learning Strategies
Demonstration
Direct Teaching
Learning Log/ Journal

Assessment
The Science and Technology Journal Assessment Rubric (**BLM 8.uw.5**) should be used to assess their journal entry.

Assessment Strategies
Observation
Learning Log

Assessment Recording Devices
Anecdotal Record
Rubric

Teaching / Learning
Part A: The Sun (15 minutes)

1. Ask the students to identify the primary source of light in the world. They should come up with "the Sun".

2. Discuss the question: "Other than light, what else do we get from the Sun?"

3. Remind students that the sun is our primary source of light (or "radiant") energy and heat energy. Heat has been covered in grade seven. Introduce the concept that the visible light is only a small part of the "range" of light that "radiates" from the sun.

Part B: Properties of Light (40 minutes)

There are five key concepts in this subtask:

- Light radiates in all directions
- Light travels in straight lines from the source
- Light travels in waves
- The frequency of waves affects the length of the wave which in turn affects the energy of the wave. That is, short wave lengths have high frequency and high energy while longer wave lengths have lower frequency and lower energy.

- Visible light is only one form of radiant energy

Prior to the lesson, collect the following materials: a flashlight, a flashlight bulb and flashlight bulb holder from a flashlight. Have a flashlight battery available so you can create a simple circuit to light the bulb.

1. **Light Travels in All Directions**
To introduce this concept use a lamp without a shade. Turn off all of the lights in the room and turn on the lamp. Ask the students, "What can you tell me about the light from this source?" The answer, "It is everywhere because light travels out in all directions from the source of the light". Now turn the lamp off and use a flashlight. The flashlight produces a controlled beam of light. This seems to contradict the first statement. Take the flashlight bulb. Turn off the lights. Light the bulb by connecting it to the flashlight bulb holder circuit. Students should note that once again light radiates in all directions. Examine the mirror which is behind the bulb in a flashlight. Students should conclude that while the bulb in the flashlight emits light in all directions, the mirror reflects the light, producing a controlled beam of light. Tell the students that reflection will be examined in a future lesson.

2. **Light Travels In Straight Lines From Its Source**
To illustrate this concept, use a ray box with a single beam. Turn off all of the lights in the room. The ray box may be held vertically along the board or a wall. Ask the students to describe the direction of the light (the answer should be "a straight line").

Demonstrate that light does not curve or bend around an object, by holding a piece of bristol board or cardboard about a meter above the light beam to "stop" the light. Light simply stops when encountering an obstacle. Discuss this with the students. Ask them to explain what happened.

3. **Light Travels in Waves**
The next part of the lesson should focus on helping students understand that light travels in waves and, that all waves are not the same length. Use an overhead of blackline master **BLM 8.2.1** "The Electromagnetic Spectrum" to introduce students to the different kinds of radiant energy. Tell them that visible light and the other forms of radiant energy in the spectrum travel in waves. Examine the diagram at the bottom of the page, and have students describe the properties of the waves along the spectrum. Have students focus on frequency and wave length and through discussion, draw out the conclusion that the waves get "shorter" and more "frequent" as one moves from left to right along the spectrum.

*note that it is important to remind students that light travels in a straight line from source to destination, but in a wave-like manner.

4. **Looking at Waves**
Display blackline master BLM 8.2.2 "Looking at Waves" on the overhead. Look at the diagram of a single wave. Identify and briefly discuss each of the terms used to describe the components of a wave. Encourage students to use "proper" scientific vocabulary when discussing light waves.

Refer to the wave length diagram to further develop the concept of frequency. Define frequency as simply "how often the same things happen". Explain that the more frequently a wave occurs in a fixed period of time, the stronger it is and the more energy it has. Conversely, the less frequent the occurrence, the weaker the wave, and the less energy it has.

Explain that as we move along the electromagnetic spectrum, frequency is described in general terms as ranging from "low" to "high" and the waves are described as "long" or "short". Have the students practice using the terminology by comparing the waves and rays in the spectrum. (For example: ultraviolet are shorter than radio waves and have a higher frequency.)

5. **Visible Light is Only One Form of Radiant Energy**
To conclude this lesson, return to the the blackline master, "The Electromagnetic Spectrum" (**BLM 8.2.1**) and review the kinds of rays on the spectrum. Review the relationship between the length, frequency and energy output of waves. Again allow students to compare the "waves" on the spectrum. Students should be able to conclude that as we move along the spectrum from low frequency, long waves to higher frequency, short waves, the energy of the rays increases. Again you need only to compare radio waves to x-rays to emphasize this point.

Part C: Science Journal Entry (20 minutes)

1. Provide students with a copy of all three blackline masters used in this subtask. Instruct them to make an entry in their science and technology journals to record what they have learned (the L of the K.I.L.E. method). Encourage them to use proper scientific terminology in their entries.

Adaptations

Resources

- **BLM 8.2.1** blm 8.2.1.cwk
- **BLM 8.2.2** blm 8.2.2.cwk
- **a lamp (without shade)**
- **flashlight**
- **flashlight bulb**
- **flashlight bulb holder**
- **ray box**
- **10 gauge insulated copper wire**
- **Batteries (9V or D cell)**

Notes to Teacher

Teacher Reflections

Description

In this subtask students will explore the visible range of the electromagnetic spectrum (visible light), and begin to categorize different types of light sources, both natural and artificial.

Expectations

8s67 – describe how incandescent, fluorescent, and phosphorescent sources produce light;
8s86 – recognize that energy can be a significant cost in the manufacture and use of products or systems and explain how that determines its production (e.g., analyse the costs and benefits of producing and using solar panels).
8s77 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as incidence, reflection, refraction, wavelength, frequency when describing the properties of light);

Groupings
Students Working As A Whole Class
Students Working In Small Groups

Teaching / Learning Strategies
Direct Teaching
Collaborative/cooperative Learning
Brainstorming

Assessment

Assessment Strategies
Observation

Assessment Recording Devices
Anecdotal Record

Teaching / Learning

In subtask one, students classified a variety of light sources as either natural light or artificial light sources. In this subtask, students will classify these light sources into more specific categories.

1. Make an overhead, or chart of the following "Light Sources - Example Chart". Review the items on this chart. Note that the sources of light have been classified into two broad categories "Natural" and "Artificial".

Natural
a campfire
the sun
a forest fire
stars
a glow in the dark sticker - natural
a firefly
fireworks
a lit candle
propane barbecue flames
a glow in the dark tube necklace

Artificial
a light bulb
a flashlight
headlights on a car
a television screen
a fluorescent light tube

2. Pose the following question: "Can the sources of light on the chart be grouped into more specific categories?"

3. Distribute the blackline master "Visible Sources of Light" (**BLM 8.3.1**). Note that these are the items that were sorted in subtask one. Tell the students you want them to reclassify and regroup the items into new categories based on how the items (objects) produce light.

4. Have the students work in groups of two or four for no more than twenty minutes. Give each group a piece of chart paper and a marker. Remind the students that they should "name" each group or category by giving it a title. The title should describe why the items have been grouped together.

5. Have each group present their charts to the class. Do not correct any of the presentations. Use leading questions to help students evaluate and clarify the groups or categories. Encourage students to suggest any changes or modifications.

6. At the conclusion of the presentations, display an overhead of **BLM 8.3.2** "Visible Sources of Light". On the blackline master the items are grouped in categories, but no titles are provided. Examine and discuss each category and have students suggest an appropriate title. They may wish to select a title they used for a category on their charts. Example answers are as follows.

1. light is produced naturally from a living thing
2. light is produced when things are heated up to a high temperature
3. light is produced when energy is added to a material so that it glows only while the energy is being added
4. light is produced when energy is added to a material so that it glows for a longer period of time, even after the energy has stopped being added
5. light is produced when chemicals mix

Note that there may be some difficulty with fluorescent light tubes.

7. Provide each student with a copy of **BLM 8.3.3**. The blackline master provides the scientific terms used to describe the various ways visible light is produced. Review each of the terms and discuss the explanations provided. Have the students re-examine the classifications on **BLM 8.3.2** "Visible Sources of Light". Ask the students to replace the "general titles" with the correct scientific term. (i.e.. light produced naturally from a living thing - bioluminescence)

Adaptations

Resources

BLM 8.3.1	blm 8.3.1.cwk
BLM 8.3.2	blm 8.3.2.cwk
BLM 8.3.3	blm 8.3.3.cwk

Notes to Teacher

Teacher Reflections

Transparency of Objects

Subtask 4

Optics

Energy and Control **An Integrated Unit for Grade 8**

75 mins

Description

The students will have the opportunity to investigate what happens to light when it encounters various materials of different properties. The students will explore/investigate materials that allow for the full transmission of light are transparent, materials that allow for the partial transmission of light are translucent and materials that allow for no transmission of light are opaque.

Expectations

8s77 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as incidence, reflection, refraction, wavelength, frequency when describing the properties of light);

8s65 – identify the properties of visible light through experimentation;

8s70 – investigate how objects or media refract, transmit, or absorb light (e.g., non-luminous objects are seen when reflected light enters the eye; stars are seen when transmitted light enters the eye);

Groupings

Students Working As A Whole Class
Students Working In Small Groups

Teaching / Learning Strategies

Classifying
Inquiry
Direct Teaching

Assessment

The Science Journal Assessment Rubric (BLM 8.uw.5) should be used to assess their journal entry.

Assessment Strategies

Observation
Learning Log

Assessment Recording Devices

Anecdotal Record
Rubric

Teaching / Learning

Part A: The Tramission of Light through Various Materials/Objects (40 minutes)

Pre-planning: Students will require a variety of translucent and transparent objects or materials to complete the investigation in this lesson. Ensure they are available prior to the lesson. **Note**: opaque objects are also required, but they should be readily available in the classroom (i.e.. desks, books, etc.)

1. At the beginning of the class review the properties of light studied to date:
- light is a form of energy
- light travels out in all directions from the source
- light travels in straight lines
- light travels in waves

2. Pose the following question before you begin the activity: "What happens to light when it comes into contact with an object or material?" Have the students brainstorm a list of possible answers and write these on the board or on a piece of chart paper. Some possible answers may be:
- it goes through
- it stops
- it reflects
- some of it goes through
- it makes the object hot
- it makes the object shine

- it changes direction
- it changes colour

3. Examine the responses, then pose the question, "Why do different things happen to the light when it encounters different objects or materials?" Try to illicit the following response: "Because the objects are different." The properties of the objects or materials the light encounters create the various effects. Tell the students they will be examining various objects and materials in the classroom to determine what happens to the light when it encounters that material. Students will then classify the materials.

4. Hand out the blackline master, "Shining Light at Various Objects" (**BLM 8.4.1**). The students, working in pairs, will have 20 minutes to complete this task. Quickly review the task:

- using the flashlight in a dark area or in the darkened room
- shine a light on a variety of objects/materials
- record your observations in the "results" column of the sheet.

Using chart paper, make a chart similar to **BLM 8.4.1**. Discuss the results of the investigations. On the chart paper, list the objects/materials investigated, and record student observations. Make sure the observations are accurate, before recording them on the overhead.

5. After all the objects/materials have been discussed, tell the students you want them to classify the objects into three categories:

<u>Transparent Objects/Materials</u>
Ask the students to identify the objects/materials which allowed "all" the light to pass through, and to explain how they knew all the light passed through.

Ask the students for the term used to describe these materials (transparent) then develop a definition (i.e.. capable of transmitting light so that objects or images can be seen as if there were no intervening materials).

<u>Translucent Objects/Materials</u>
Ask the students to identify the objects/materials which allowed some "light" to pass through. Ask them how they knew only some of the light passed through. Answers such as "It was dimmer, or less bright," or "It was a different colour," should be given. Ask the class for the word used to describe these objects/materials ("translucent"). ***(i.e.: "Transmitting rays of light without permitting objects to be distinctly seen; partially transparent.")***

<u>Opaque Objects/Materials</u>
Ask the students to identify the items which allowed <u>**no**</u> light to pass through. Ask them how they knew no light passed through. Students may suggest that no light passed through because a shadow was cast.

It is important to point out to students that "a shadow test" is not a reliable way of determining that an object allows no light to pass through. To demonstrate this, in a darkened room, hold a translucent object close to (not touching) a flashlight. The object should be close to a wall, so a shadow can be seen. The shadow may make it seem like the object is stopping the transmission of all light. However, if the object is held against the flashlight, and the flashlight is turned towards the students, they will see that the object is allowing some light to pass through and is therefore, translucent. Conduct the same demonstration with an opaque object to demonstrate the difference.

Ask the students to give the word that describes materials or objects that do not allow any light to be passed through. Again, some may be familiar with the term "opaque" from a previous year. If no students are able to give the term then introduce the term to them. Define the term. (i.e.: "preventing light from travelling through, and therefore, not allowing you to see through it")

Note: Intensity plays a role in helping students determine whether or not an object is translucent or opaque. Since intensity is the number of rays being emitted from the source, a more intense light source may reveal that an object which at first seems translucent, is actually opaque. You may wish to include a brief discussion of intensity in this lesson.

Part B: Review, Science Journal Entry , Guiding Question (40 minutes)

1. Before the students make a journal entry review the three main concepts developed in this lesson:
- When light encounters a transparent object all of the light passes through the object
- When light encounters a translucent object some of the light passes through the object
- When light encounters an opaque object none of the light passes through the object

2. Students will write an entry about what they learned from this lesson (L. of the K.I.L.E. approach). Remind the students that including labelled diagrams with explanations is an effective way of recording information.

3. Have students copy the following question into their science and technology journals, "What happens to light when it does not pass through an object?" As they respond, they will be demonstrating what they already know (K). Next, encourage students to record any interesting ideas, questions, or thoughts they might have about what happens to light when it does not pass through an object (I). Allow them to reinvestigate any of the materials/objects used during the lesson.

Adaptations

Resources

BLM 8.4.1 blm 8.4.1.cwk

flashlights

chart paper

Notes to Teacher

Light can pass through some objects and materials but is stopped by others. Materials can be classified into the following three categories:

Transparent – When light strikes a transparent material almost all of the light travels directly through that object. A clear image can be seen (examples: air, shallow water, and clear glass).

Translucent - When light strikes a translucent material, only some of the light passes directly through it. The light changes direction many times and is scattered about. As a result, we cannot see a clear image. The image usually appears fuzzy and unclear. A strongly translucent material emits mainly shadows (examples: frosted glass, some plastics, and fingernails).

Opaque - When light strikes an opaque material, none of the light passes through. Most materials are opaque. We cannot see through opaque materials. The light is either reflected by the material or absorbed and converted into heat (examples: your desk, wood, and rock).

Teacher Reflections

Reflection and Mirrors

Subtask 5

Optics

Energy and Control **An Integrated Unit for Grade 8**

220 mins

Description

Students will investigate the properties of light as they relate to mirrors and reflections. They will explore what happens when light encounters an opaque object one of the possible outcomes is the reflection of the light. Students will explore and examine the differences in the reflections created by plane mirrors, concave mirrors and convex mirrors.

Expectations

8s65 – identify the properties of visible light through experimentation;

8s71 – identify ways in which the characteristics of mirrors and convex and concave lenses determine their use in optical instruments (e.g., in a camera, a telescope, binoculars, a microscope);

8s72 – investigate and describe the laws of reflection of visible light (e.g., using a plane mirror);

8s75 – formulate questions about and identify needs and problems related to the properties and behaviour of light (e.g., interactions between light and different materials), and explore possible answers and solutions (e.g., predict and demonstrate how various liquids will refract a light beam and describe the angle of refraction);

8s77 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as incidence, reflection, refraction, wavelength, frequency when describing the properties of light);

8s81 – identify ways in which the properties of reflection are used in everyday situations (e.g., cosmetology, rear-view mirrors in cars, security mirrors, night reflectors on jackets or bicycles);

Groupings

Students Working In Pairs
Students Working In Small Groups

Teaching / Learning Strategies

Demonstration
Experimenting
Direct Teaching
Collaborative/cooperative Learning

Assessment

The Science and Technology Journal Assessment Rubric (**BLM 8.uw.4**) should be used to assess their journal entry.

Assessment Strategies

Exhibition/demonstration
Performance Task
Learning Log

Assessment Recording Devices

Rubric

Teaching / Learning

Part A: An Introduction to Reflection (40 minutes)

1. Review the concepts developed in the previous lesson by having the students define/explain: transparent, translucent, opaque.

2. Reiterate the question posed at the end of the last lesson, "What happens to light when it does not pass through an object?" Do not ask for any answers, but immediately begin with the following demonstration.

3. Have two plane mirrors ready to show to the class. The mirrors should have a backing on one side, such as a metallic substance or glazed finish. Show the class the mirrors, then turn off the lights. Turn on a flashlight. Place the mirrors between the flashlight and the students. Establish that the object is opaque. Reverse the mirror, so the other side is now facing the light to demonstrate that the result is the same, point out that although each side has a different surface, the mirror is still opaque.

4. Turn the flashlight off and turn on an overhead. Place both mirrors on the overhead, one with the mirrored surface down, the other with the mirrored surface up. Remind students that in a previous lesson they learned that light travels in straight lines. Given this fact, ask them what is happening to the light which is

hitting the mirrored side of the mirror (the answer "reflect" should be given or introduced). Ask the students to define "reflect". Tilt the mirror on an angle to reflect light around the room to demonstrate that they are indeed correct. Put the mirror back on the overhead with the mirrored side down.

5. Ask the students what is happening to the light striking the back side of the second mirror. Tilt the second mirror on an angle to eliminate reflection as a possibility. The students may suggest, "It is being absorbed," or "It is being converted into heat." Challenge them to prove that light energy is being absorbed and converted into heat energy. If they suggest touching the back side of the mirror remind them heat energy is produced by the overhead, so it could merely be heat energy being absorbed. If the students are unable to propose a test, tell them to compare the temperature of the mirror side of the first mirror with the back side of the second mirror to see which is hotter. Ensure that the mirror side of the first mirror and back side of the second mirror have both been on the overhead for an equal length of time. Have a student volunteer touch the mirror side of the first mirror and the back side of the second mirror. They should notice that the back side feels hotter. Have the students discuss what they think is happening. Draw out or indicate to the students that the back side of the second mirror must have absorbed some of the light energy, and converted it to heat energy, otherwise the surfaces of the two mirrors would be the same temperature.

6. To review, ask students to summarize what happened when light encountered the two different opaque materials on the two mirrors. They should be able to explain that when light hit the mirror, it was either reflected or absorbed.

7. Have the students make a short journal entry to explain what they learned during this lesson.

Part B: Properties of Light (30 mins)

1. Students will work in pairs or small groups. Provide each pair or group with a ray box and distribute **BLM 8.5.1** to all students. Following the instructions (1 to 3), students will experiment with the ray boxes to identify the properties of light. A quick review of the instructions might be beneficial. Caution students that ray boxes are fragile and must be handled gently. The experiments work best in a darkened room.

2. Allow students sufficient time to conduct the experiment, then discuss the questions at the bottom of the page. Teachers may wish to record student responses on the board or on chart paper. Students can then transfer this information to their own sheets. Illustrate the convergence and divergence of light on the chalkboard or on the overhead. Convergence: when numerous beams of light come together, often seeming to make one beam. Divergence: when beams of light fan out away from each other, often seeming to come from the same point of origin.

3. Note that should the ray box not have a focusing knob then a teacher demonstration with the use of lenses to diverge and converge the beams may be substituted.

Part C: Reflections Using Plane Mirrors (40 mins)

1. Have the students, working in pairs or small groups, set up a ray box to emit a single focussed beam of light (use the narrow light filter). Have the students play Ray Box Pool (**BLM 8.5.2**). The aim of Ray Box Pool is to use a mirror to reflect a beam of light into the various pockets of the pool table. Ray Box Pool is a cooperative game and works best when partners work together to get the light into the pocket.

2. Distribute a plane (flat) mirror and a copy of **BLM 8.5.2** (the pool table) to each group or pair . Instruct the students to set up their pool table with the ray box at one end. Be sure that everything fits on the desk(s) or table where the students are playing, in order not to damage the ray box.

3. Challenge the students to find as many ways as possible to get the light into all six of the pockets (one

pocket at a time). Allow the students about ten to fifteen minutes to play. **The ray box must remain in a fixed position.** However, there are no restrictions on the placement or angle at the mirror. Make sure all students have equal opportunity to play.

4. Distribute a second plane mirror, and challenge the students to find as many ways as possible to get the light into all six of the pockets (one pocket at a time) using both mirrors. Instruct the students that the ray box must remain in a fixed position. Students may place one of the mirrors wherever needed and alter its angle, but the second mirror must be aligned along the edge (anywhere along either side or either end) of the pool table and cannot be angled. Allow the students about ten minutes to complete this challenge.

5. Discuss the concept of the reflection of light with the class. Use the following questions to help guide the discussion:
a) What object did we use in the pool game to change the direction of the beam of light?
b) What term do we use when a beam of light is able to bounce off something and change direction?
c) What other objects could have been used, other than the mirror, to reflect the beam of light?
d) Name ways that we could apply what we learned about light while playing Ray Box Pool to an everyday life situation (for example, using objects that reflect light on clothing when biking, in-line skating, or exercising; using reflective materials on road signs and lane markers; playing Laser quest; focussing beams from T.V. remotes; angling mirrors to reflect light at or away from objects; making periscopes and kaleidoscopes).

6. Extension Activity
Geometric experiments using mirrors to flip various shapes could be introduced at this time. Most math text books have sets of experiments about flips laid out and ready for students to explore.

Part D: The Law of Reflection (40 mins)

1. Before beginning this activity, examine BLM 8.5.3, Reflection - Teacher Information so that the Law of Reflection is understood.

2. Organize the students so that they are working in pairs or in small groups. It is probably preferable if the students work in the same groups as before. Have a ray box, a plane mirror, a pencil, a ruler, and a protractor ready for distribution to each group. Give a copy of both **BLM 8.5.4** and **BLM 8.5.5** to each group and instruct the students to use the INSITE method of inquiry to develop and test a hypothesis that compares the angle of incidence and the angle of reflection. Instruct the students to use the "Identify", "Narrow", and "Investigate" sections of **BLM 8.5.5** as a sample of how to use the INSITE method. They do not need to respond to any of the questions asked in the "Identify" and "Narrow" sections. The students will be required to complete the "Hypothesis", "Investigate", "Test", and "Examine" sections of **BLM 8.5.5**.

3. Teachers may want to have students submit **BLM 8.5.4** and **BLM 8.5.5** for evaluation. Evaluation criteria might include: use of ruler and pencil, lines labelled - normal, incident ray, reflected ray, use of arrows on rays, angles measured and labelled, hypothesis clearly stated, test results examined and discussed, conclusions drawn and explained, etc.

****Note that if these are being evaluated, then students should be given the criteria before they begin the task***.

4. Discuss with the students the law of reflection. (The law of reflection states that the angle of incidence is equal to the angle of reflection.) Ask the students to suggest possible real life applications for the law of reflection. For example, the placement of mirrors for surveillance/security purposes or the angle of mirrors used in shoe stores.

5. Extension Activity
Have the students use **BLM 8.5.6** to examine and explain the ways light reflects off a flat uncreased piece of aluminium foil and a piece of aluminium foil that has been crinkled. Discuss the students' results and conclusions when they have completed **BLM 8.5.6**.

Part E: Reflections Using Concave and Convex Mirrors (40 mins)

1. Prior to this lesson, get five or six people (it could be students, but the class would respond better if you used staff) to help you make a video. Give each volunteer a spherical concave/convex mirror (see step 4 below) and allow them a few minutes to practice making faces. When they are ready use the video camera to record a ten second shot of each volunteer's reflected image (shoot over the subject's shoulder and zoom in on the mirror). The odder/more humourous the reflected image the better.

2. Connect the video camera to a television so the class can view the tape. Invite the students to play "Whose Face Is It Anyway?". Play back the tape and have the students try to guess who is making the face in the mirror. Pause the playback between each taped subject to give the students a chance to guess who it is.

3. Distribute a spherical concave/convex mirror or a large stainless steel serving spoon to each student in the class. Have the students examine their own reflection in the spoon. Instruct the students to examine their reflection using both sides of the spoon.

4. Based on their observations, ask students to discuss how curved mirrors affect the reflection of images. Ensure students understand that curved mirrors can be classified as either concave or convex (a concave mirror has the reflecting surface on the inside of the curve and a convex mirror has the reflecting surface on the outside of the curve). Concave and convex mirrors can be classified as either cylindrical (cut from a cylinder) or spherical (cut from a sphere).

Part F: The Properties of Curved Mirrors (30 mins)

1. Have the students work with a partner. Distribute a rectangular prism, a concave mirror, a convex mirror, and **BLM 8.5.7** to each pair. Have the students use the mirrors to create reflected images of the rectangular prism, and have them record their observations in their Science and Technology journals.

2. Discuss the properties of reflected images using concave and convex mirrors. Identify real life devices that use concave and convex mirrors. Demonstrate the students' responses using curved mirrors. Review and discuss the terms divergence and convergence as they relate to concave and convex mirrors. Concave mirrors make images close to the mirror appear enlarged and images farther from the mirror appear smaller and inverted. Convex mirrors make images appear smaller and farther away than they actually are and provide a wider field of view than concave mirrors. Some examples of concave and convex mirrors are: a telescope and vehicle rear view mirrors. A telescope collects light from distant object such as a star and reflects that light off a concave mirror and one or more plane mirrors so that we can see the image. Rear view mirrors on the passenger side of cars and a section of the driver side rear view mirror on buses are in fact convex mirrors that allow drivers to see other vehicles on the road more easily. Ask students if they have ever seen the phrase, "objects in this mirror are closer than they appear" on a car mirror. Ask them why they think it only appears on the passenger side mirror.

Adaptations

Resources

BLM 8.5.1	blm 8.5.1.cwk
BLM 8.5.2	blm 8.5.2.cwk
BLM 8.5.3	blm 8.5.3.cwk
BLM 8.5.4	blm 8.5.4.cwk
BLM 8.5.5	blm 8.5.5.cwk
BLM 8.5.6	blm 8.5.6.cwk
BLM 8.5.7	blm 8.5.7.cwk

chart paper

ray boxes

magnetized cards (light filters) for ray boxes

plane mirrors

rulers

protractors

stainless steel serving spoons

spherical concave mirrors

spherical convex mirrors

cylindrical concave mirrors

cylindrical convex mirrors

Notes to Teacher

Ray boxes must be treated carefully. Remind students not to scratch the surface of the mirrors.

Activities with ray boxes (and light in general) work best in darkened rooms.

The experiments that call for ray boxes can be done using high powered flashlights and home made filters rather than ray boxes. However, these experiments are best done with ray boxes. There are a few complications in the manner in which flashlights are designed that will make it more difficult to use them compared to ray boxes.

Gather a number of large stainless steel serving spoons, either your own or ones that the students bring in before you begin Part E.

Most of the plane mirrors available from educational suppliers are made from a piece of reflective plastic. One of the advantages of these plastic mirrors is that they are flexible. This can come in very handy when studying convex and concave mirrors because the plastic mirrors can be bent to take on the shape of cylindrical concave and convex mirrors. Of course care needs to be taken when bending these plastic mirrors that one does not apply too much force or try to bend them too far.

Plane Mirror Terms

Point of Incidence is the point where normal intersects the reflective surface

Incident ray is the path of the light beam from the light source to the point of incidence

Reflected ray is the path of the reflected light beam from the point of incidence

Angle of Incidence is the angle between the incident ray and normal

Angle of Reflection is the angle between the reflected ray and normal

The **Law of Reflection** states that the angle of incidence is equal to the angle of reflection

Teacher Reflections

Description

Students will investigate the properties of light as they relate to lenses, prisms and refraction. They will explore what happens when light encounters a transparent object and the rays of light are not perpendicular to the face of the object (refraction). Students will explore and examine the differences in the refraction created by lenses and prisms.

Expectations

8s82 – explain the function and purpose of combinations of multiple lenses or lenses and mirrors in optical systems (e.g., the source and one or more reflectors or lenses in cameras, periscopes, telescopes);
8s77 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as incidence, reflection, refraction, wavelength, frequency when describing the properties of light);
8s65 – identify the properties of visible light through experimentation;
8s71 – identify ways in which the characteristics of mirrors and convex and concave lenses determine their use in optical instruments (e.g., in a camera, a telescope, binoculars, a microscope);
8s70 – investigate how objects or media refract, transmit, or absorb light (e.g., non-luminous objects are seen when reflected light enters the eye; stars are seen when transmitted light enters the eye);
8s69 – describe qualitatively how visible light is refracted;

Groupings

Students Working As A Whole Class
Students Working In Small Groups

Teaching / Learning Strategies

Demonstration
Direct Teaching
Experimenting

Assessment

The Science and Technology Journal Assessment Rubric (**BLM 8.UW.5**) should be used to assess their journal entry. **BLM 8.UW.5** should be used to assess **BLM 8.6.8.**

Assessment Strategies

Exhibition/demonstration
Performance Task
Questions And Answers (oral)
Learning Log

Assessment Recording Devices

Anecdotal Record
Checklist
Rubric

Teaching / Learning

Part A: An Introduction to Lenses (40 minutes)

1. Review what happens when light encounters opaque objects. Discuss the terms reflection and absorption. Next, review what happens to light when it encounters a transparent object. Recall that all of the light hitting a transparent object passes (or is transmitted) through the object. Hold up a square or rectangular glass plane and a double convex glass lens. Tell the students that the two objects are made of the same transparent material. Ask the students to identify the only difference between the objects (shape).

2. Have a number of centres around the room to accommodate groups of four or five students. Each centre should have at least 2 of each of the following lenses: simple convex, simple concave, double convex and double concave. Have the lenses drawn on the board and the names of the lenses beside each of the diagrams.

3. Tell the students they will be experimenting with the lenses at each of the stations to determine what happens to objects as they are viewed through a single lens or lenses in combination. Name each of the

lenses (review the terms from the reflection subtask). Discuss the association between the lenses and how they make objects appear. Hand out **BLM 8.6.1** "Working With Lenses". Briefly review the investigation with students. Have them to record their observations in their Science and Technology journals. Tell them they will be expected to discuss their observations in the next lesson. Warn the students to be careful when handling the lenses. They are fragile.

Part B: An Introduction to Refraction (60 minutes)

1. Review the kinds of lenses used in Part A. Have the students generalize their observations about each lens. Remind students that all of the lenses are transparent which means all of the light from an object is passing through the lens. Discuss with the students that something other than reflection or absorption of light is occurring.

2. Ask the students to respond to the following question: "What is happening to the light as it passes through the lenses?" At the conclusion of this discussion hold up the glass plane and the double convex glass lens used in Part A. Reaffirm that the only difference between objects is their shape. Remind students that light travels in straight lines. Use the first page of **BLM 8.6.2**, "Refraction: The Bending of Light" as an overhead. Point out that the light rays are approaching each lens perpendicular to the face of the lens. Look at the bottom diagram. Ask students what happens when light hits a glass plane (rectangular prism). A window is a practical example of a glass plane. Discuss the fact that the light passes straight through, so they see exactly what is on the emergent rays on the other side of the plane (rectangular prism).

3. Ask the students to recall what they saw when they viewed an object through a double convex lens. Discuss the fact that the objects appeared bigger than they actually were. Ask them to recall what they observed when they viewed objects through lenses other than a glass plane (rectangular prism). Develop the generalization that "objects appear different or changed when viewed through a lens that is not a plane.

4. Examine the top diagram (double convex lens). Through discussion, have the students draw the following conclusions:
- the lens is transparent so we know all the light rays pass through the lens
- the object does not appear to be the same when viewed through the lens so the light rays do not pass straight through

5. Examine the two diagrams. Ask the students, "Since the light rays approach both lenses perpendicular to the surface, what accounts for the difference in the way the images appear?" (The rays hit the surface of each lens at different angles because the surfaces have a different shape. The rays hit the rectangular prism at 90 degrees and pass straight through. However, the rays hit the curved surface of the double convex lens at angles other than 90 degrees, which changes the path of the rays and alters or changes the image. Use the analogy of a ball hitting a flat wall straight on, versus hitting a curved wall. The path of the ball represents the path of a light ray.)

6. Tell the students that in Part C the class will be trying to determine the following, "Does the angle at which light rays hit a transparent lens affect the way an image is viewed?"

7. Review the I.N.S.I.T.E. model with the students. Use the I.N.S.I.T.E. model as the basis for the following "teacher demonstration". Employ a question and answer format.

I. Identify the problem (draw out from students)

Does the angle at which a ray of light hits a transparent lens affect the path of the ray as it passes through the lens?

N. Narrow the problem

What materials will we need? -- ray box and a rectangular prism (teacher tells the students)
What are the variables in the problem? -- the angles at which the beam of light from the ray box hits the prism.
--the thickness of the transparent object (students answer)
How can we see if the path of light changes? -- visually or measurement (students answer)

S. State the Hypothesis

A ray hitting a transparent object (lens) at 90 degrees (perpendicular to the face of the object) will pass straight through the object. If a ray hits a transparent object (lens) at an angle other than 90 degrees, the path of the ray will change.

I. Investigate and Gather Information/ Test the Hypothesis and Record Observations

Teacher Demonstration

Tape a rectangular prism vertically to the board. Place a ray box with a single beam on the board perpendicular to the prism so the light beam hits the prism at 90 degrees. Ask the students to predict what will happen when the ray box is turned on. Turn on the ray box. Light passes straight through the prism.

Turn off the ray box. Change the position of the ray box by rotating it lower so the light beam hits the prism at approximately 45 degrees. Remind students that in the previous investigation the light rays approached the double convex lens and the plane (rectangular prism) at the same angle (90 degrees), but the angle at impact was different because the surfaces are different. Allowing the light ray to strike the rectangular prism at approximately 45 degrees, essentially duplicates the way the light rays hit the convex lens. Recalling what happened when the light rays passed through the lens, ask the students to predict what will happen to the path of the light ray as it passes through the prism.

Turn on the ray box. The path of the beam changes when it encounters the prism. Describe it as a "bending" of the light.

Repeat the procedure at different angles. This will further reinforce the conclusion.

E. Examine the Results and Write a Conclusion

Discuss the conclusions with the students. (When light encounters a transparent object other than at 90 degrees (perpendicular) then light is "bent". As the the size of the angle increases, the degree of refraction increases.)

8. Introduce the term Refraction and define it as the "bending" of light.

9. Discuss the variable not used in this experiment (thickness) and tell the students that they will examine whether thickness has an effect on refraction in a later lesson.

10. Hand out page 2 of **BLM 8.6.2**, "Refraction: The Bending of Light" to each student and have them fill in the emergent rays on the other side of the prisms. Have the students label both the incident rays and the emergent rays.

11. Have the student write a journal entry describing what they learned during this lesson. Remind them that labelled diagrams are an effective way of enhancing their entries.

Part C: Converging and Diverging Rays (40 minutes)

1. Set up eight stations in the classroom. At each station include a thick and a thin single concave lens, a thick and a thin double concave lens, a thick and a thin single convex lens, a thick and thin double convex lens and a ray box. Hand out blackline masters, "Refraction of Light Through a Lens" (**BLM 8.6.3**) and "Refraction" (**BLM 8.6.4**). Briefly review sections I (Identify), N (Narrow) and S (State) so students understand the purpose of the investigation. Ensure that each group has the materials listed in I (Investigate) then review the procedures with students. Students are to:
- project light rays at each lens and observe what happens as the rays pass through and emerge from the lens;
- complete each of the diagrams on **BLM 8.6.3** illustrating their observations by drawing the path of the "emergent" rays.

NOTE: Remind students to use only a single lens, not a combination of lenses.

2. To conclude the investigation, students complete sections T (Test) and E (Examine).

3. As a class confirm all of the findings. Discuss the terms converge and diverge as they apply to refracted rays. Have the students label each diagram on **BLM 8.6.3** using the terms converge and diverge to describe how the light rays are refracted. Introduce and explain the terms incident rays and emergent rays and have the students label the diagrams with these terms. Allow students to share their conclusions. Through discussion develop a conclusion acceptable to the class. Encourage students to modify their individual conclusions to ensure they are clear and accurate. Have the students hand in their sheets for evaluation at the end of the class. Use the rubric for the I.N.S.I.T.E. method (**BLM 8.uw.3**).

Part D: How Light Refracts (30 minutes)

1. Review refraction with the students. Pose the question, "Why do you think the refraction, the 'bending of light' occurs?". Discuss possible answers with the students. Come to the conclusion that refraction occurs when light passes through a medium of different density and the beam of light is hitting on an angle other than perpendicular. Discuss the term medium and relate it to the use of the lenses (light through air and glass/plastic). Ask the students what they think happens to light when it enters a denser medium (it slows down) and a less dense medium (it speeds up). Tell them that it is the slowing down and speeding up of light through the different medium that causes refraction to occur.

2. Distribute the blackline master, "How Will Light Refract" (**BLM 8.6.5**). Tell the students they are to use a single beam on the raybox to by draw the emergent ray for each diagram.

3. Display a chart paper copy of **BLM 8.6.5.** Select a student to fill in the emergent ray for each diagram.

4. As a whole class, discuss the findings. Ask the students to describe any patterns they see in the direction of the refraction.

Part E: Science and Technology Journal Entry (30 minutes)

1. Have the students make a journal entry to record what they learned about reflecting and refracting light. Tell the students that they are not to use any of their notes. Remind them to use correct terminology. When labelling diagrams, they should include brief written explanations in their own words if they are unable to recall the correct term.

Part G: The Water Drop Challenge: Extension Activity

1. As a final challenge extension activity, have students complete **BLM 8.6.6**, "The Water Drop Challenge".

The teacher notes are found on **BLM 8.6.7**.

Adaptations

Resources

- **BLM 8.6.1** blm 8.6.1.cwk
- **BLM 8.6.2** blm 8.6.2.cwk
- **BLM 8.6.3** blm 8.6.3.cwk
- **BLM 8.6.4** blm 8.6.4.cwk
- **BLM 8.6.5** blm 8.6.5.cwk
- **BLM 8.6.6** blm 8.6.6.cwk
- **BLM 8.6.7** blm 8.6.7.cwk
- **ruler**
- **ray boxes**
- **simple and double concave lenses**
- **simple and double convex lenses**
- **optical bench (optional)**
- **eye dropper**
- **beaker or water container**
- **newspaper**
- **a rectangular prism**
- **a glass plane**

Notes to Teacher

Background Information

A lens is a curved transparent device that causes light to refract as it passes through. Lenses have a wide variety of uses, depending on their size and shape. Human eyes are an everyday example of refraction in lenses. While reading, light is reflected off the page, travels to your eyes, and refracts when it enters the lens of each eye. Why does this happen?

Scientists discovered that the speed of light differs in different transparent materials. The denser the material is, the slower light travels as it passes through. When light travels from air into
denser glass, it slows down. The change in speed causes the light to change direction. The same thing happens, for the same reason, if you are running on the beach and then run into the water. The water is denser than air and slows you down.

Two common lenses are concave and convex . A convex lens is thicker in the middle than at the outside edge. It causes light rays to come together. A concave lens is thinner in the middle than at the outside edge, It causes light rays to spread apart. Combining more than one lens provides people with many interesting optical devices.

Teacher Reflections

Description
By studying the visible light range of the Electromagnetic Spectrum, the students will investigate how colour is perceived. They will also investigate Additive and Subtractive Colour Theories.

Expectations
8s68 – identify colours as different wavelengths of light and explain why objects appear to have colour;
8s74 – describe the effect of colour filters on white light using the subtractive theory.
8s73 – explain colour vision using the additive theory;
8s77 – use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as incidence, reflection, refraction, wavelength, frequency when describing the properties of light);
8s79 – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., prepare a brochure informing the public of the risks of a specific type of electromagnetic radiation).

Groupings
Students Working As A Whole Class
Students Working Individually
Students Working In Small Groups

Teaching / Learning Strategies
Demonstration
Direct Teaching
Experimenting
Homework
Learning Log/ Journal

Assessment
The Science and Technology Journal Assessment Rubric (**BLM 8.uw.3**) should be used to assess their journal entry.

Assessment Strategies
Exhibition/demonstration
Learning Log
Observation
Questions And Answers (oral)

Assessment Recording Devices
Anecdotal Record
Checklist

Teaching / Learning
Part A: Colour and the Electromagnetic Spectrum (40 minutes)

1. Begin by reviewing what happens when light encounters transparent, translucent, and opaque objects. Review transmission, refraction and reflection. Review the fact that light can also be absorbed and converted into heat (back side of mirror - subtasks).

2. The colour of light emitted by the sun, or by a flashlight is white. However, when this "white light" encounters a translucent or opaque object, colours are perceived. Discuss this phenomenon with students. Establish the fact that if a colour other than white were emitted from the sun then every object we see would be that colour.

3. Pose the question to the students, "Why do we perceive colour when white light passes through a translucent or transparent object (lens)?"

4. Conduct the following demonstration to illustrate how a prism refracts light. This demonstration is best conducted by the teacher because finding the correct angle of incidence in order to create a colour spectrum can be a time consuming process for students. Prior to the lesson, set up the ray box and prism so you are

sure a colour spectrum will be produced when the classroom lights are turned off. After viewing the demonstration the following is discussed:
- white light is actually a combination of all the colours of the visible spectrum
- the colours are created by the refraction of light.

Ask the students if it is possible to explain our perception of colour only by means of refraction of light. Tell the students in the next lesson that they will be examining why we perceive colour, but for the moment, they will examine the colours of light.

5. Use an overhead of **BLM 8.2.1** (from Subtask 2) to review the electromagnetic spectrum. Through question and answer, reconfirm the following with students: as we move through the spectrum from low frequency to high frequency, light waves increase in energy and frequency (number of cycles of a wave per second).

6. Although the students have studied the electromagnetic spectrum in a previous subtask, this is an appropriate time to introduce the unit of measurement for frequency and wavelength because it will help students develop a better understanding of why there are different colours in the visible spectrum. Refer to the teacher information on **BLM 8.7.1**. Emphasize the following points in your discussion.
- visible light is one part of the electromagnetic spectrum
- it is the wavelength and frequency of light waves that determine the characteristics of light in the entire spectrum
- within the visible spectrum, colours are distinguished by wavelength, and amplitude determines brightness

Identify the colours in the visible spectrum (ROY G BIV). Note that the colours are measured in nanometers, and listed in order of wavelength from shortest to longest. Refer to the colours and identify the wavelength (in nanometers) of each colour.

7. Tell the students that the human eye is "attuned" to the colours of the visible spectrum and is able to distinguish between colours. A more detailed discussion of the function of the rod and cone cells in the eyes may occur here, but it is more important for students to understand that the rod and cone cells are parts of the human eye which allow us to detect light and distinguish colours.

Part B: Why Objects Have Colour (40 minutes)

1. Prepare the students for the lesson by reviewing the facts established in Part A:
-white light radiates from a source (e.g., our Sun)
-white light is a combination of all of the colours of the visible spectrum
-we can separate the colours of the spectrum by refraction, but refraction cannot explain why translucent and opaque objects have colour

2. Ask the question, "If refraction cannot explain why translucent and opaque objects have colour how do we perceive objects as having colour?"

3. Hold up a coloured object (choose a primary colour). Ask the students if the object is a light source?(no). Remind the students that we have only seen coloured light as emitted from a light source, so there must be another explanation as to why the object has colour.

4. Discuss what happens to light when it encounters a transparent object (it passes through or it is refracted). Ask the students what happens to light that encounters a translucent object. Some light passes through, some is refracted, and the rest is reflected, refracted or absorbed. Ask the students what happens to light that encounters an opaque object. It is either reflected or absorbed.

5. Ask the rhetorical question, "How does this relate to colour?" Select a student wearing an article of clothing in a primary colour; a red shirt for example. Ask the students if the shirt refracts light (no, because it is opaque). Therefore, we can eliminate refraction as the reason the shirt is red. Ask the students to identify the two remaining possibilities (the light is reflected or absorbed) and ask them to make a scientific guess to explain what might be happening.

6. Using a question and answer technique, develop the following explanation:
- white light containing all the colours of the visible spectrum encounters the shirt
- our eyes detect the colour red, which means red light is being reflected and all the other colours are being absorbed.

7. Create a general statement (i.e.. "When we look at an object we see a colour because that colour is reflected from the object, while all the other colours are absorbed."

8. Conclude the discussion of colour by making reference to the fact that there are different colours of "red". Ask the students if they can relate this to wavelength and the visible spectrum. They should be able to state that as the frequency of the waves increases or decreases the properties of the light change. The colour red for example has its own spectrum. As the frequency of the light within the "red spectrum" changes, we see different colours of red.

9. Have the students make a science and technology journal entry to record what they learned during this lesson. Encourage them to include any interesting ideas, questions or observations. Remind them that diagrams are an effective way of communicating information.

Part C: Combining Colours (40 minutes)

1. Have colour filters/paddle filters available for students. Tell the students that they have just learned about the theory behind our perception of colour. Tell them that you want them to explore different colour combinations by viewing objects through the filters or paddle filters. The filters can be used singly or in combination.

2. After the twenty minutes, ask the students to share their observations. Record the observations on the blackboard. Ask them if there were any surprises (i.e.. unexpected colours, etc.). Again, record these observations on the board. It should soon become apparent that when the filters were used, the students perceived colours which were not the same as the actual colour of the object, or the colour of the filter.

3. Distribute copies of blackline master "Perceiving Light" (**BLM 8.7.2**). Display an overhead of **BLM 8.7.2** and review how the absorption and reflection of light determines our perception of colour. From the information recorded on the blackboard, choose a "surprise" or an "unexpected" colour result. For example, "When I looked at Tom's red shirt through the green filter, it looked yellow." If there are enough filters available, have all of the students confirm this observation. Take a red filter and place it on the overhead. Have a student explain why red light is being projected. (White light hits the filter. All colours except red are absorbed. Red light passes through the filter and is projected/perceived). Place a green filter over the red filter. A yellow colour should be projected. Distribute blackline master "Combining Light" (**BLM 8.7.3**) to students, and display an overhead of **BLM 8.7.3**. Using the overhead have the students explain what is happening when we look at the shirt through the combined filters (red and green). Record this information on the overhead in the boxes provided, then have the students copy the information onto their sheets. Teacher explanations are provided on the "Combining Light - Teacher Version" blackline master (**BLM 8.7.4**).

Part D: The Additive Colour Theory (40 minutes)

1. Review the reason why part of the electromagnetic spectrum is visible. Simply put, the human eye is

"attuned", or sensitive to the range of the spectrum which has a wavelength between roughly 380 to 780 nanometers. Because of this sensitivity, this part of the spectrum is visible. The variations in wavelength (for colour) and amplitude (for brightness) in this part of the spectrum create what we perceive as colour.

2. Hand out the blackline master entitled, "Additive Colour Theory Investigation" (**BLM 8.7.5**). Following the procedures on the blackline master, the students will use colour filters or paddles and flashlights to add coloured light together to see what colours are produced.

3. After the students have experimented with the lights and filters, reconvene the class and discuss the findings. The teacher answers version can be found on **BLM 8.7.6**.

4. The process of adding colours of light together to produce other colours is called the additive colour theory. This theory applies only to the mixing of light and not the mixing of pigment. The additive light theory is the more difficult of the two theories for students to understand. The primary colours of light are blue, red and green. The secondary colours of light are yellow, cyan (turquoise), and magenta (bright pink). Yellow is produced when you mix green and red light. Cyan is produced when you mix blue and green light. Magenta is produced when you mix blue and red light. When all three primary colours of light are present in any form you produce white light. Example, cyan and red will produce white since cyan is actually green and blue light combined.

Adaptations

Resources

BLM 8.7.1	blm 8.7.1.cwk
BLM 8.7.2	blm 8.7.2.cwk
BLM 8.7.3	blm 8.7.3.cwk
BLM 8.7.4	blm 8.7.4.cwk
BLM 8.7.5	blm 8.7.5.cwk
BLM 8.7.6	blm 8.7.6.cwk
white paper	1
coffee filters	3
glue	1
construction paper	1
light source (flashlight or ray box)	1
colour filters (cellophane & tissue paper will work)	1
projection screen or white wall	1

water soluble markers package

Notes to Teacher

The quantity of resources will determine the size of your groups for the Additive Colour Theory Investigation. It can be done as a teacher demonstration with your whole class. With responsible students, you could divide your class in half and allow students to lead a demonstration. Each group ideally should have three light sources (ray boxes or flashlights).

Teacher Reflections

Optics
Energy and Control An Integrated Unit for Grade 8

Description
Students have had an opportunity to learn what happens when light is reflected and refracted and have developed a basic understanding of other properties of light. In this subtask, students will research optical devices which make use of the properties of light they have studied. Each student will make a presentation to the class based on the research.

Expectations
8s79 – communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., prepare a brochure informing the public of the risks of a specific type of electromagnetic radiation).
8s70 – investigate how objects or media refract, transmit, or absorb light (e.g., non-luminous objects are seen when reflected light enters the eye; stars are seen when transmitted light enters the eye);
8s82 – explain the function and purpose of combinations of multiple lenses or lenses and mirrors in optical systems (e.g., the source and one or more reflectors or lenses in cameras, periscopes, telescopes);
8s83 – compare the automatic functions of the human eye to functions in an automatic camera (e.g., focusing power, adaptation to brightness);

Groupings
Students Working In Pairs
Students Working In Small Groups

Teaching / Learning Strategies
Issue-based Analysis
Model Making
Research

Assessment

Assessment Strategies
Performance Task
Observation
Self Assessment

Assessment Recording Devices
Anecdotal Record
Rating Scale

Teaching / Learning
1. Review with the students what has been studied about the properties of light. List this information on the board, an overhead, or chart paper.

2. Tell students that based on our knowledge of the properties of light, optical devices have been developed to perform functions that the eye is not normally capable of performing. These devices, in general, change the way objects are viewed "by the naked eye". They are designed to perform a specific functions.

3. On the board, overhead, or chart paper create a new list entitled "Optical Devices". Have the students generate a list of optical devices which "change the way objects are normally viewed". Start the list with a magnifying glass. Have the students brainstorm to add to the list. Objects may include:

- cameras
- video cameras
- microscopes
- binoculars
- telescopes
- glasses/bifocals/contact lenses
- film projectors
- overheads
- televisions
- night vision goggles
- one way glass

(*note that in the Grade 4 energy unit a periscope and kaleidoscope have already been made/studied)

4. Tell students they must choose an optical device to research. They may select one from the list generated by the class, or they may choose one of their own after consulting with the teacher. They will be required to present the device and their research findings to the class. Distribute **BLM 8.8.1** "Optical Devices Research Assignment". Review the information on **BLM 8.8.1** to ensure students understand the components of the assignment.

5. Tell the students that they will have only one in-school period to do the research for their presentation and that the following class will be the presentation of their device. As this is not the culminating activity, it is imperative that the students find the information quickly, and develop a short effective presentation. The presentation should be short (approximately 5-10 minutes) and should include the elements listed in **BLM 8.8.1**.

6. Try to arrange for Internet time to allow students to gather the necessary information for their projects. It may be an opportune time to arrange for library or computer-class time. If students elect to create a WordPerfect Presentations multimedia slideshow, computer-skills classes focusing on the use of the software package should occur prior to this lesson. If possible, prior arrangements with other subject area teachers, or block timetabling around this activity would be beneficial.

The presentations of the optical devices will be extended into the culminating activity periods. Two or three students will present prior to each of the periods allotted for the culminating subtask.

Adaptations

Resources

BLM 8.8.1	blm 8.8.1.cwk
convex lenses	1
disposable cameras	1

Notes to Teacher

The Research and Presentation Assignment on Optical Devices

Students should be able to quickly locate information on optical devices and use the knowledge they have gained about the properties of light to understand how these devices function in a system. The assignment is not designed to extend beyond the allotted time.

Teacher Reflections

Description

The topic of optics contains many properties which can be demonstrated in ways that appear "amazing". Students will work in pairs or individually to create an "optical illusion" that incorporates the concepts studied in the optics unit. Each illusion will be presented to the class members who will use their knowledge of optics and light to explain how each illusion was created. The class will then present their illusions, as a show, to other classes.

Expectations

8s65	– identify the properties of visible light through experimentation;
8s75	– formulate questions about and identify needs and problems related to the properties and behaviour of light (e.g., interactions between light and different materials), and explore possible answers and solutions (e.g., predict and demonstrate how various liquids will refract a light beam and describe the angle of refraction);
8s76	– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;
8s79	– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., prepare a brochure informing the public of the risks of a specific type of electromagnetic radiation).
8s62	• demonstrate an understanding of the properties of visible light and the properties of other types of electromagnetic radiation, including infrared and ultraviolet rays, X-rays, microwaves, and radio waves;
8s63	• investigate the properties of visible light, including the effects of reflection and refraction, and recognize how these properties are used in optical devices;
8s64	• describe ways in which different sources of visible light and the properties of light, both natural and artificial, are used by humans for different purposes.

Groupings

Students Working In Pairs

Teaching / Learning Strategies

Advance Organizer
Demonstration
Oral Explanation
Inquiry

Assessment

Assessment

Students will be assessed:
- on their ability to explain the science behind their own optical illusion and the illusions of their classmates
- using the design rubric
- using the presentation checklist

Assessment Strategies

Exhibition/demonstration
Performance Task
Classroom Presentation

Assessment Recording Devices

Rubric
Checklist

Teaching / Learning

1. Ask the students to think about the experiments and activities on light that have been completed during the unit. Review the properties of light and optics using a concept web. See Notes to Teacher for suggestions.

2. Read the opening paragraph on **BLM 8.9.1** with students. Emphasize that because illusionists and magicians use science to create illusions, there is always an explanation for how they work.

3. Ask the students to think about the experiments and activities done throughout the optics unit and ask how these demonstrations of the properties of light could be turned into an illusion. Brainstorm a list of possible "illusions" based on the activities already done. See Notes to Teacher for possible answers.

4. Invite the students to design their own demonstration using one or more property of light and present it as an illusion. Students should work in pairs and should follow the S.P.I.C.E. Method of design as outlined at the beginning of this document on **BLM 8.uw.4**. Blackline Master 8.9.1 (**BLM 8.9.1**) will be used as an organizer for the illusion activity.

5. Read through the design rubric and presentation rubric with the students to ensure that the criteria for the activity are clear.

6. Review the timelines for the project. The students will have approximately 4 in-class periods to research, design, test and practice their illusion. During the fifth class, students will present their illusions to their classmates. Following this, a presentation, in the form of a show, will be made to at least one other class.

Adaptations

Resources

BLM 8.9.1	blm 8.9.1.cwk
BLM 8.9.2	blm 8.9.2.cwk
BLM 8.9.3	blm 8.9.3.cwk

Notes to Teacher

1. A review of the properties of light might include:

a) Light travels in straight lines and its intensity decreases with distance from its source.
b) Light reflects from a plane mirror according to the law of reflection.
c) Light is refracted by transparent materials.
d) Light is a form of energy
e) The visible light spectrum is made up of different colours
f) Visible light is only one part of the electromagnetic spectrum.

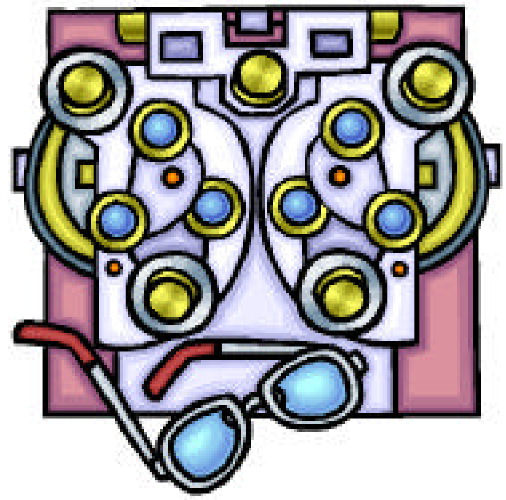
It may be necessary to remind students of the various activities in the optics unit that covered each property.

2. Samples of activities that could become an illusion would be:

- using mirrors to make an object appear / disappear
- using phosphorescent paint to highlight an illusion
- using light and shadow to make an object appear / disappear
- bouncing light and /or images off mirrors etc.
- home-made cameras, telescopes or other optical devices
- backwards writing or mirror images
- card tricks using mirrors
- changing the colours of light by mixing light and/or pigments
- using curved mirrors to reverse images, distort images

Students should be encouraged to come up with their own design for an illusion, based on one or more properties of light. If some students find this very difficult, building on one of the lessons from the Optics unit is recommended.

Teacher Reflections



Appendices

Optics

Energy and Control

Resource List:

Black Line Masters:

Rubrics:

Unit Expectation List and Expectation Summary:

Optics
Energy and Control An Integrated Unit for Grade 8

Blackline Master / File

- ☐ **BLM 8.UW.1** — **Unit**
  blm 8.uw.1.cwk
- ☐ **BLM 8.UW.2** — **Unit**
  blm 8.uw.2.cwk
- ☐ **BLM 8.UW.3** — **Unit**
  blm 8.uw.3.cwk
- ☐ **BLM 8.UW.4** — **Unit**
  blm 8.uw.4.cwk
- ☐ **BLM 8.UW.5** — **Unit**
  blm 8.uw.5.cwk
- ☐ **BLM 8.1.1** — **ST 1**
  blm 8.1.1.cwk
- ☐ **BLM 8.2.1** — **ST 2**
  blm 8.2.1.cwk
- ☐ **BLM 8.2.2** — **ST 2**
  blm 8.2.2.cwk
- ☐ **BLM 8.3.1** — **ST 3**
  blm 8.3.1.cwk
- ☐ **BLM 8.3.2** — **ST 3**
  blm 8.3.2.cwk
- ☐ **BLM 8.3.3** — **ST 3**
  blm 8.3.3.cwk
- ☐ **BLM 8.4.1** — **ST 4**
  blm 8.4.1.cwk
- ☐ **BLM 8.5.1** — **ST 5**
  blm 8.5.1.cwk
- ☐ **BLM 8.5.2** — **ST 5**
  blm 8.5.2.cwk
- ☐ **BLM 8.5.3** — **ST 5**
  blm 8.5.3.cwk
- ☐ **BLM 8.5.4** — **ST 5**
  blm 8.5.4.cwk
- ☐ **BLM 8.5.5** — **ST 5**
  blm 8.5.5.cwk
- ☐ **BLM 8.5.6** — **ST 5**
  blm 8.5.6.cwk
- ☐ **BLM 8.5.7** — **ST 5**
  blm 8.5.7.cwk
- ☐ **BLM 8.6.1** — **ST 6**
  blm 8.6.1.cwk
- ☐ **BLM 8.6.2** — **ST 6**
  blm 8.6.2.cwk
- ☐ **BLM 8.6.3** — **ST 6**
  blm 8.6.3.cwk
- ☐ **BLM 8.6.4** — **ST 6**
  blm 8.6.4.cwk
- ☐ **BLM 8.6.5** — **ST 6**
  blm 8.6.5.cwk
- ☐ **BLM 8.6.6** — **ST 6**
  blm 8.6.6.cwk
- ☐ **BLM 8.6.7** — **ST 6**
  blm 8.6.7.cwk
- ☐ **BLM 8.7.1** — **ST 7**
  blm 8.7.1.cwk
- ☐ **BLM 8.7.2** — **ST 7**
  blm 8.7.2.cwk
- ☐ **BLM 8.7.3** — **ST 7**
  blm 8.7.3.cwk
- ☐ **BLM 8.7.4** — **ST 7**
  blm 8.7.4.cwk
- ☐ **BLM 8.7.5** — **ST 7**
  blm 8.7.5.cwk
- ☐ **BLM 8.7.6** — **ST 7**
  blm 8.7.6.cwk
- ☐ **BLM 8.8.1** — **ST 8**
  blm 8.8.1.cwk
- ☐ **BLM 8.9.1** — **ST 9**
  blm 8.9.1.cwk
- ☐ **BLM 8.9.2** — **ST 9**
  blm 8.9.2.cwk
- ☐ **BLM 8.9.3** — **ST 9**
  blm 8.9.3.cwk

Optics

Energy and Control An Integrated Unit for Grade 8

Media

- ☐ **an Optics video** — **ST 1**

Material

- ☐ **10 gauge insulated copper wire** — **ST 2**
- ☐ **a lamp (without shade)** — **ST 2**
- ☐ **Batteries (9V or D cell)** — **ST 2**
- ☐ **chart paper** — **ST 4**
- ☐ **chart paper** — **ST 5**
- ☐ **coffee filters** — **ST 7**
  3
  per person
- ☐ **construction paper** — **ST 7**
  1
  per person
- ☐ **flashlight** — **ST 2**
- ☐ **flashlight bulb** — **ST 2**
- ☐ **flashlight bulb holder** — **ST 2**
- ☐ **flashlights** — **ST 4**
- ☐ **glue** — **ST 7**
  1
  per person
- ☐ **ray box** — **ST 2**
- ☐ **white paper** — **ST 7**
  1
  per person

Equipment / Manipulative

- ☐ **a glass plane** — **ST 6**
- ☐ **a rectangular prism** — **ST 6**
- ☐ **beaker or water container** — **ST 6**
- ☐ **colour filters (cellophane & tissue paper will work)** — **ST 7**
  1
  per group
- ☐ **convex lenses** — **ST 8**
  1
  per group
- ☐ **cylindrical concave mirrors** — **ST 5**
  per group
- ☐ **cylindrical convex mirrors** — **ST 5**
  per group
- ☐ **disposable cameras** — **ST 8**
  1
  per group
- ☐ **eye dropper** — **ST 6**
- ☐ **light source (flashlight or ray box)** — **ST 7**
  1
  per group
- ☐ **magnetized cards (light filters) for ray boxes** — **ST 5**
  per group
- ☐ **newspaper** — **ST 6**
- ☐ **optical bench (optional)** — **ST 6**
  per class
- ☐ **plane mirrors** — **ST 5**
  per group
- ☐ **projection screen or white wall** — **ST 7**
  1
  per class
- ☐ **protractors** — **ST 5**
  per person
- ☐ **ray boxes** — **ST 5**
  per group
- ☐ **ray boxes** — **ST 6**
  per group
- ☐ **ruler** — **ST 6**
  per person
- ☐ **rulers** — **ST 5**
  per person
- ☐ **simple and double concave lenses** — **ST 6**
  per group
- ☐ **simple and double convex lenses** — **ST 6**
  per group
- ☐ **spherical concave mirrors** — **ST 5**
  per group

- ☐ **spherical convex mirrors** **ST 5**
  per group
- ☐ **stainless steel serving spoons** **ST 5**
  per group
- ☐ **water soluble markers** **ST 7**
  package
  per group

Classifying Sources of Light

Classify: to group based upon similarities
Characteristics: a characteristic is a typical or noticeable quality of someone or something
Criteria: a standard, rule, or test on which a judgment or decision can be based.

Look at the following 15 sources of light listed on the bottom of this page. Your group will classify the items based upon certain characteristics or criteria.

1. Look at all of the items on the list.

2. Discuss ways to classify the items. You must use a minimum of two groups or categories.

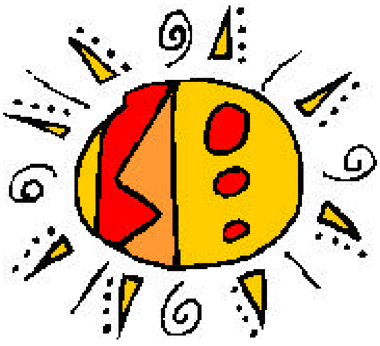
3. Choose the categories you wish to use. Create the required number of columns on chart paper. Put a heading on each column to identify the categories. Copy each item on the list into the correct column.

EXAMPLE:

How to Classify
List of items: water, rocks, a table, juice, a necklace
Possible groups/categories
SOLIDS: rocks, a table, a necklace
LIQUIDS: water, juice

LIST OF LIGHT SOURCES

a light bulb
a campfire
the sun
a forest fire
a flashlight
stars
a glow in the dark sticker
headlights on a car
a firefly
the northern lights
fireworks
a lit candle
propane barbeque flames
a glow in the dark tube necklace
a fluorescent light tube



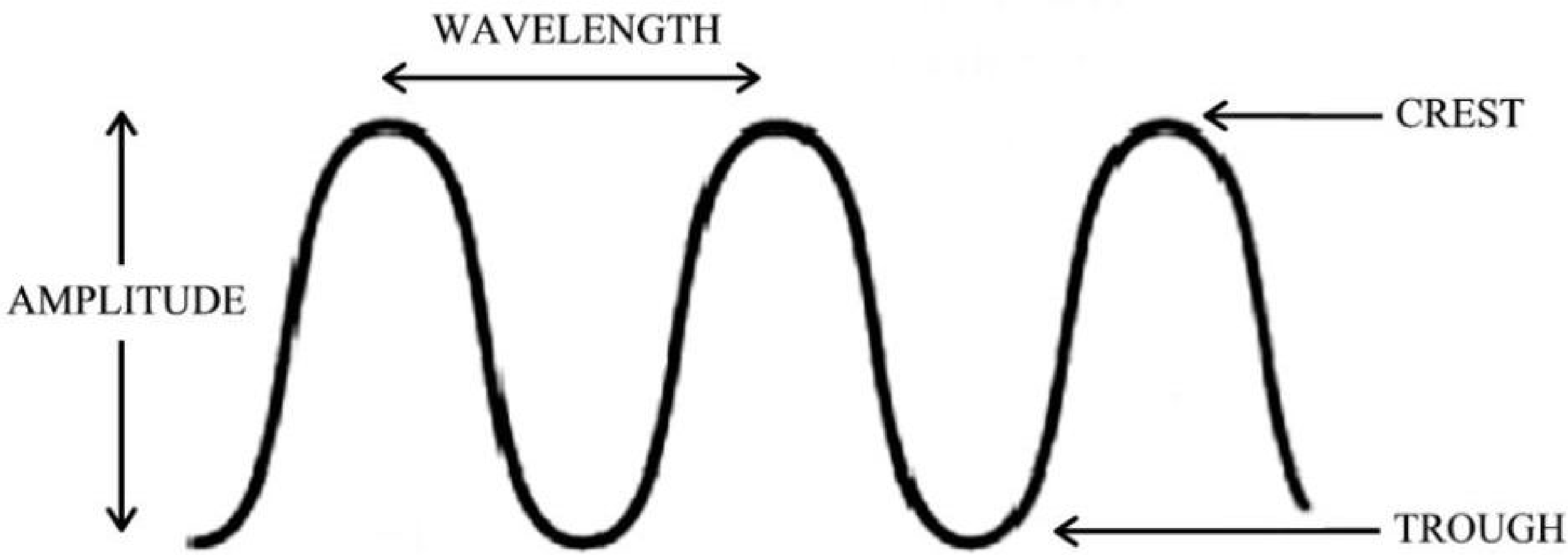
The Electromagnetic Spectrum

Lower < Frequency > Higher

Radio Waves	Infrared Rays	Visible Light	Ultraviolet Rays	X – Rays	Gamma Rays	Cosmic Rays

Longer < Wave Length > Shorter

Looking at Waves



Visible Sources of Light

a campfire

stars

a flashlight

headlights on a car

a television screen

a fluorescent light tube

a glow in the dark sticker - natural

a light bulb

a firefly

fireworks

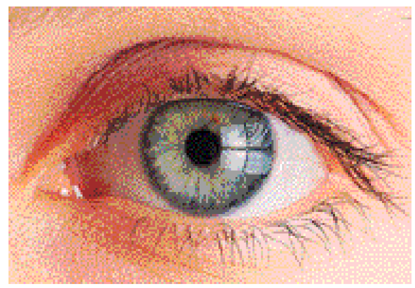
the sun

a lit candle

a forest fire

propane barbeque flames

a glow in the dark tube necklace



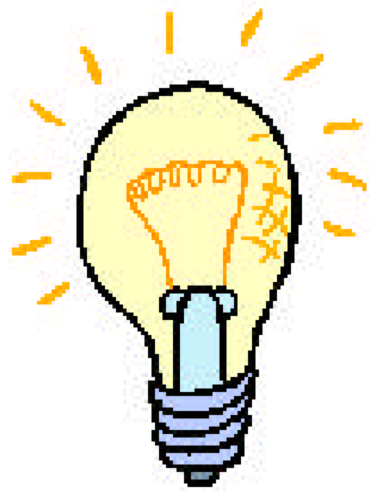
1. Sort these objects into various groups (categories) considering HOW these objects produce light.

2. Name the groups (categories) by giving each a title that best describes the grouping or the reason the items belong to the group.

3. Make a rough draft on the bottom or back of this sheet.

4. Copy a final draft onto chart paper for presentation.

VISIBLE SOURCES OF LIGHT



1. [ ]
a firefly

2. [ ]
a fluorescent light tube

3. [ ]
a campfire
stars
a flashlight
headlights on a car
a light bulb
fireworks
the sun
a lit candle
a forest fire
propane barbeque flames

4. [ ]
a television screen a glow in the dark sticker

5. [ ]
a glow in the dark tube necklace

Incandescence

Any object that emits visible light because it is heated to a high temperature is incandescent. Examples of this are candles and any form of fire. Even objects that we don’t normally view as a light source are incandescent if they produce light. A stove element or the element inside of a toaster are good examples of this.

Bioluminescence

Fireflies sparking on a summer's evening. Jellyfish glowing in night waters. These are examples of bioluminescence - light emitted by living organisms. Unlike incandescent light, which is caused by heat, the light produced by luminous animals and plants results from a biochemical reaction to oxygen.

Chemiluninescence

Emission of light as a result of a chemical reaction at environmental temperatures.

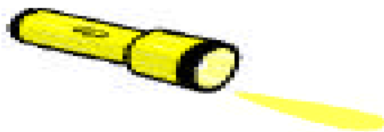
Fluorescence

Emission of light caused when ultraviolet light is absorbed by particles which emit light. The most common example of fluorescence is a fluorescent light tube. An electric current causes mercury vapor inside a light tube to produce ultraviolet radiation which is absorbed by a thin layer of phosphor. When phosphor absorbs ultraviolet radiation, it glows; that is it produces light.

Phosphorescence

Similar to fluorescence but in this case, phosphorescent materials absorb ultraviolet radiation or visible light and are able to emit light (glow) for a longer period of time after the light source which it is absorbing energy from, is removed.

Shining Light at Various Objects



Object	Result

PROPERTIES OF LIGHT AND THE RAY BOX

Nothing we know of travels faster than light. Light travels at 300 000 km/s. Light particles at the atomic level are known as photons. Bundles of photons are known as rays. Bundles of rays are known as beams.

1. Turn on the ray box. Do not look directly into the light coming from the ray box. Do not shine the light from the ray box in anyone's eyes! Hold a piece of coloured construction paper, in the landscape position, upright directly in front of the ray box. Slowly move the paper away until it is about 30 cm from the ray box.

2. Locate the focus knob. Adjust the focus knob by slowly turning it all the way in both directions (clockwise and counter clockwise). Do not over turn the focus knob!

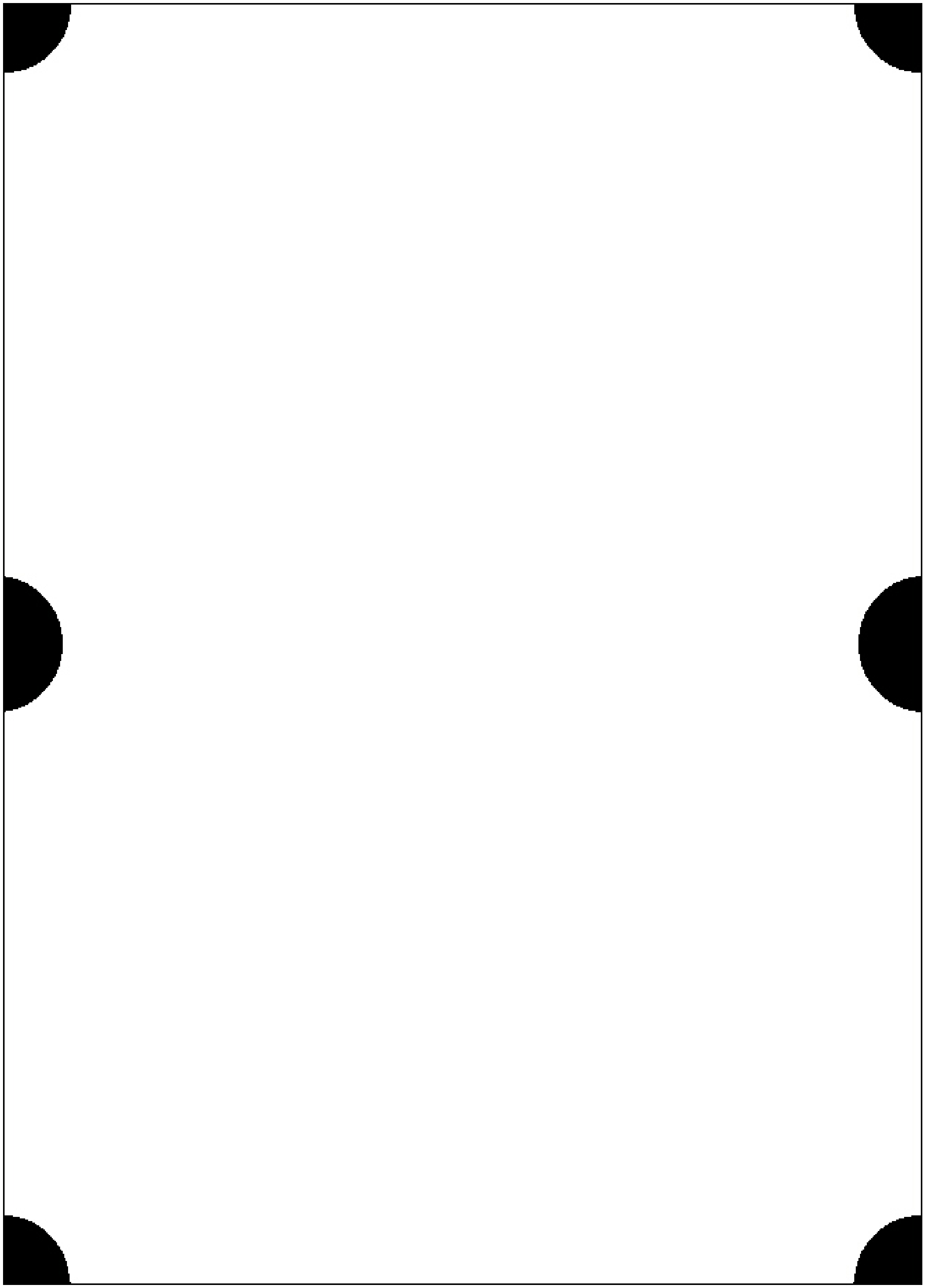
3. Locate the light filters (magnetized cards) that come packaged with the ray box. There is usually a set of five magnetized cards (one cross shaped filter, one five beam filter, one three beam filter, one narrow beam filter, and one wide beam filter). Remove the protective transparent film from one of the filters and place it over the front panel of the ray box. Adjust the focus knob on the ray box and observe what happens. Record your observations below. Repeat for each of the magnetized cards until all have been tested. Replace the protective transparencies after using the filters.
   Note: Your ray box may differ from the type described here. The point of this exercise is to familiarize yourself with the parts and function of a ray box.

How does light travel?

What does the focus knob on the ray box do?

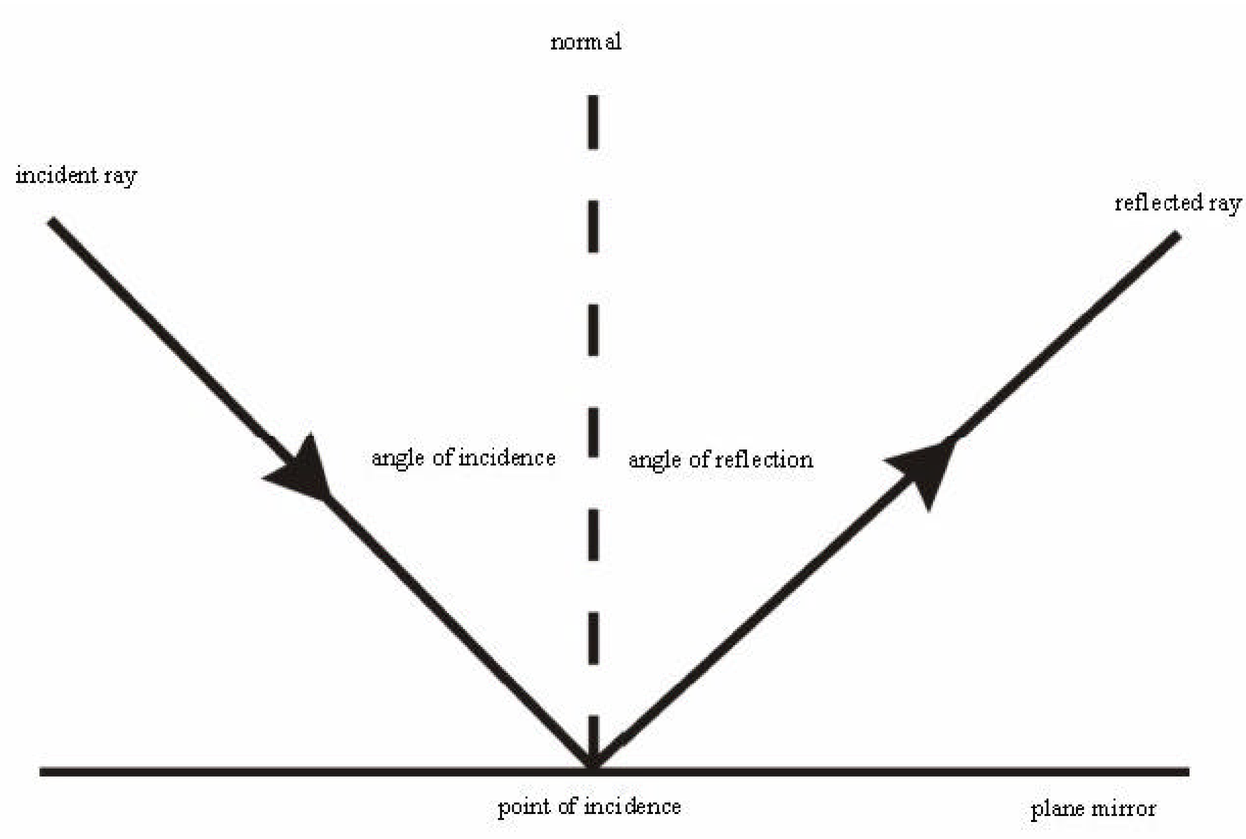
Look up the works converge and diverge in the dictionary. What do you think the terms convergence and divergence mean with respect to light? Illustrate convergence and divergence using a simple diagram on the back of this sheet.

THE POOL TABLE



REFLECTION- Teacher Information

Look at the figure below. Notice the use of a single arrow to show the path of the light beam before and after the reflection. The point where normal intersects the reflective surface is called the **point of incidence**. The path of the light beam from the light source to the point of incidence is called the **incident ray**. The path of the reflected light beam from the point of incidence is called the **reflected ray**. The angle between the incident ray and normal is called the **angle of incidence**. The angle between the reflected ray and normal is called the **angle of reflection**.



THE LAW OF REFLECTION

Use the **INSITE** method to develop and test a hypothesis that compares the angle of incidence and the angle of reflection.

I: Identify the problem

Is there a difference between the angle of incidence and the angle of reflection?

N: Narrow the problem

What type of materials will be needed? What are the variables in the problem? What factors should be kept constant to ensure a fair test? What is the angle of incidence? What is the angle of reflection? How do we measure the angle of incidence? How do we measure the angle of reflection? How are the angle of incidence and the angle of reflection the same? How are the angle of incidence and the angle of reflection different?

S: State the hypothesis

In your opinion, what is the the answer (solution) to the problem. Remember this is a scientific guess.

I hypothesize that:

I: Investigate and gather information

On **BLM 8.5.3**, read the information about the angle of incidence and the angle of reflection and examine figure 3.

Materials: a ray box, a plane mirror, a pencil, a ruler, and a protractor.

Variables: angle of light beam.

Constants: position of mirror, intensity of light beam, normal, and point of incidence.

Procedure (plan of investigation):

. Set up the ray box to emit a single focussed beam of light (use the narrow light filter).

. Using Figure 1 on **BLM 8.5.5** align the ray box as instructed, so it emits a light beam that hits the point of incidence. Using a ruler draw the incident ray and the reflected ray. Using a protractor, measure and record the angle of incidence and the angle of reflection.

. Using Figure 2 on **BLM 8.5.5** align the ray box as instructed, so it emits a light beam that hits the point of incidence. Using a ruler draw the incident ray and the reflected ray. Using a protractor, measure and record the angle of incidence and the angle of reflection.

. Using Figure 3 on **BLM 8.5.5** align the ray box as instructed, so it emits a light beam that hits the point of incidence. Using a ruler draw the incident ray and the reflected ray. Using a protractor, measure and record the angle of incidence and the angle of reflection.

. Using Figure 4 on **BLM 8.5.5** draw, without the aid of the ray box, an incident ray and a reflected ray so the angle of incidence equals 62 degrees.

T: Test the hypothesis

Follow the procedure above to test your hypothesis.

E: Examine the results and write a conclusion

Examine the results of your investigation. Write a conclusion that outlines what you learned when you tested your hypothesis. In your conclusion write a statement about the law of reflection.

RAY DIAGRAMS

Figure 1

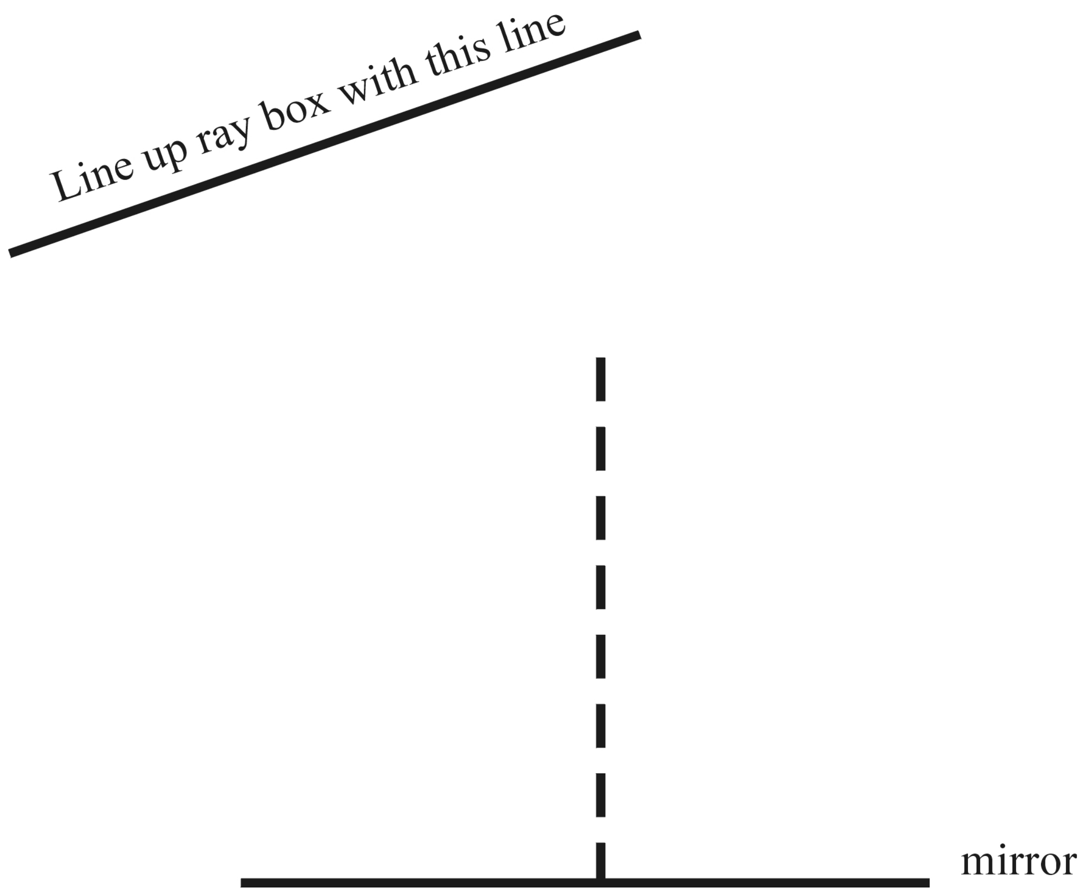


Figure 2
Figure 3

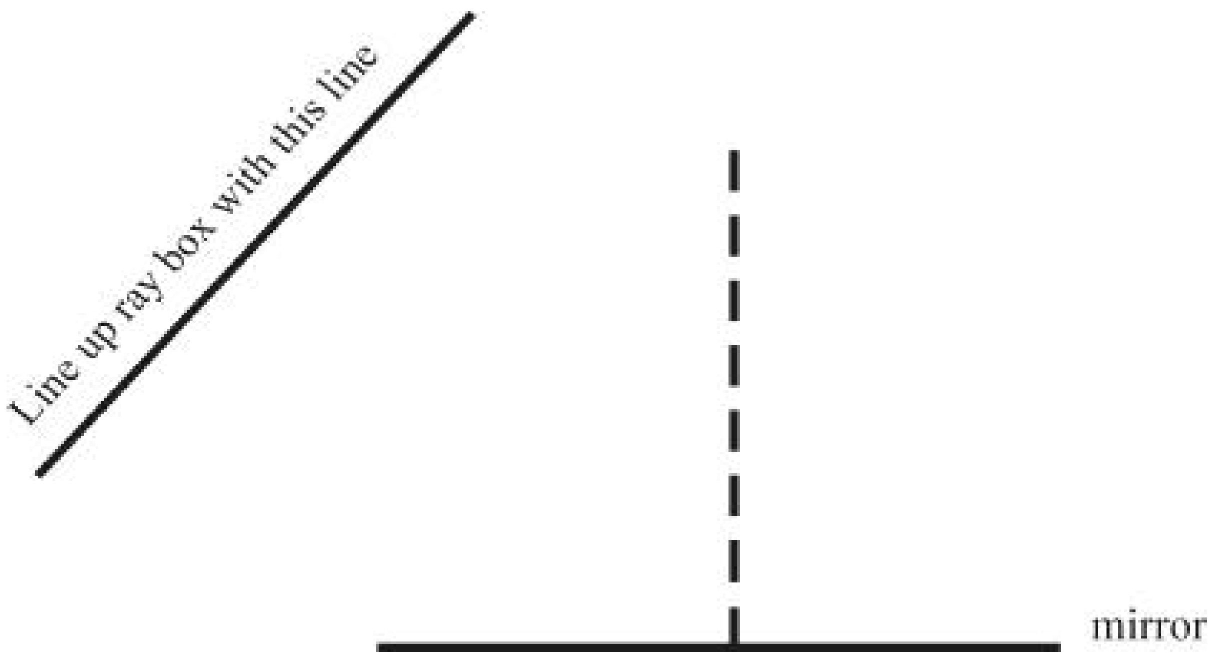
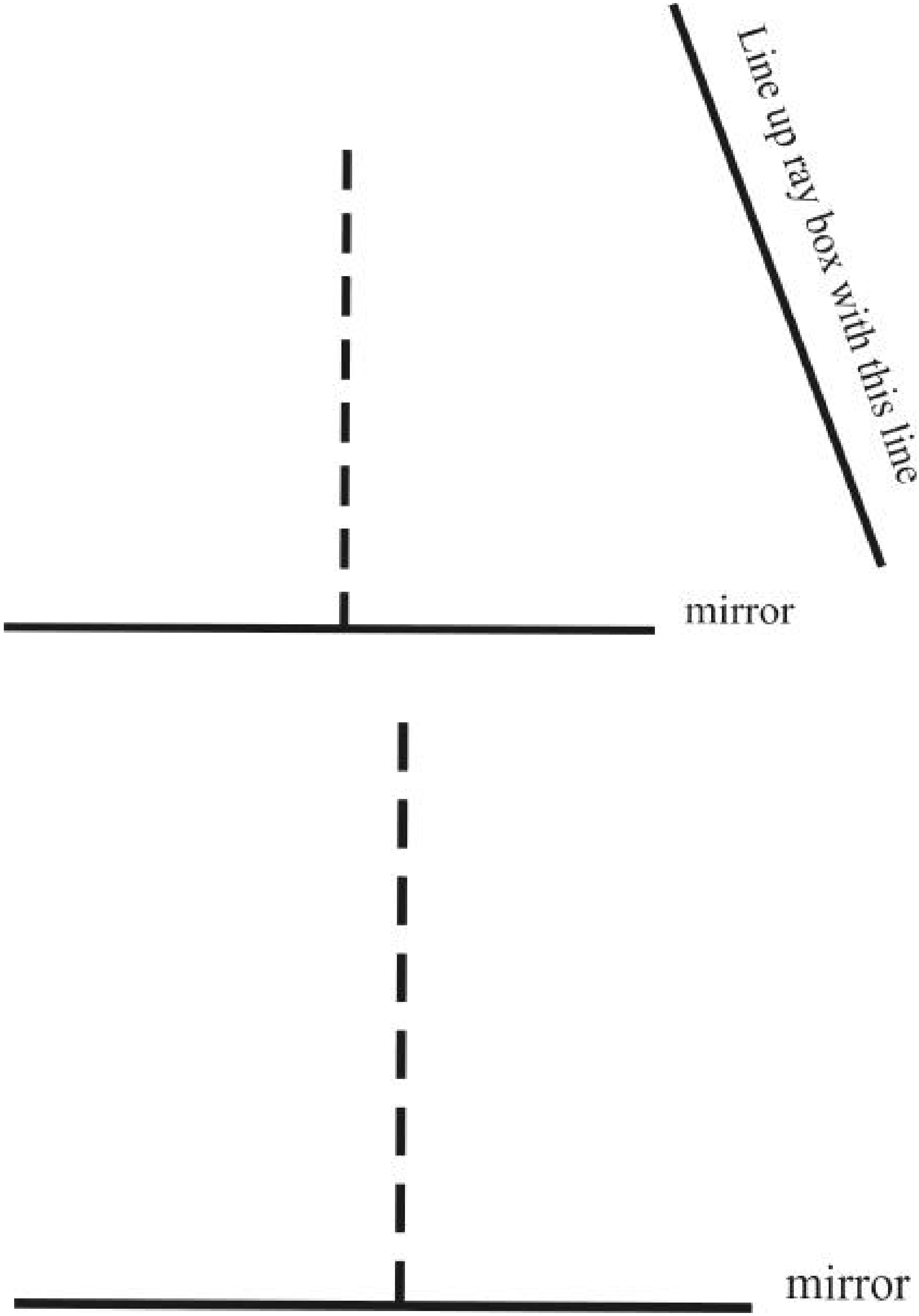


Figure 4



ANGLES OF REFLECTION

Use the **I.N.S.I.T.E.** method to examine and explain the differences in the ways that light reflects off a flat un-creased piece of aluminum foil and a piece of aluminum foil that has been crinkled.

Identify the problem

Narrow the problem

State the hypothesis

Investigate and gather information
Study the appearance of frosted glass or stucco ceilings. Research questions: What is diffuse reflection? What is indirect lighting?

Materials:
- a light source (ray box, flash light, etc.)
- two sheets (pieces) of aluminum foil

Variables:

Constants:

Procedure:

. Crumple one sheet of the aluminum foil.
. Un-crumple the sheet of aluminum foil and stretch it so it is flat. Do not smooth out the crinkles.
. Keep the other sheet of aluminum foil smooth and flat. Do not crinkle or crease the second sheet in any way.
. Using the light shine a beam of light on the smooth sheet of aluminum foil. Move the light around so it reflects off the different areas. Make observations about the quality of the reflection and the angle of reflection of the light beam.
. Next, shine a beam of light on the crinkled sheet of aluminum foil. Move the light around so it reflects off different areas of the sheet. Make observations about the quality of the reflection and the angle of reflection of the light beam.

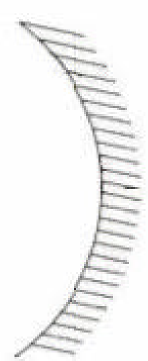
Test the hypothesis
Follow the procedure above.

Examine the results and write a conclusion
Examine the results of your investigation. Write a conclusion that outlines what you learned when you tested your hypothesis. In your conclusion make a generalization about the reflection of light off smooth, flat surfaces and rough, uneven surfaces.

PROPERTIES OF CURVED MIRRORS

OBJECT	IMAGE IN CONCAVE MIRROR		IMAGE IN CONVEX MIRROR	
Rectangular Prism	Size as compared to real object (bigger, smaller or the same)	Orientation compared to real object (upright or inverted)	Size as compared to real object (bigger, smaller or the same)	Orientation compared to real object (upright or inverted)
Object close to mirror				
Object far from mirror				

Name two devices that use concave mirrors and two that use convex mirrors . Describe how the mirrors function to achieve the desired affect in each device.

Concave Mirrors	Convex Mirrors
	

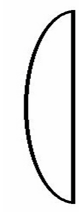
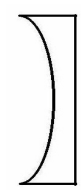
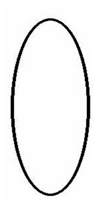
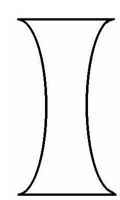
Use the word FUN below and reflect its image using:

-a plane mirror
-a 45 degree angled plane mirror
-a concave mirror close to image
-a concave mirror far from image
-a convex mirror close to image
-a convex mirror far from image

FUN

Working with Lenses

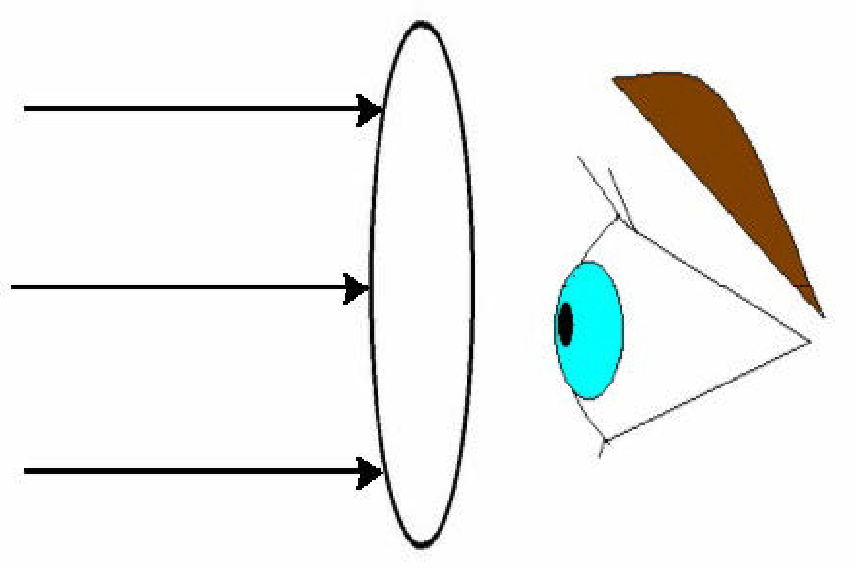
Record what happens to images when viewed through each of the lenses shown below.

Simple Convex 	
Simple Concave 	
Double Convex 	
Double Concave 	

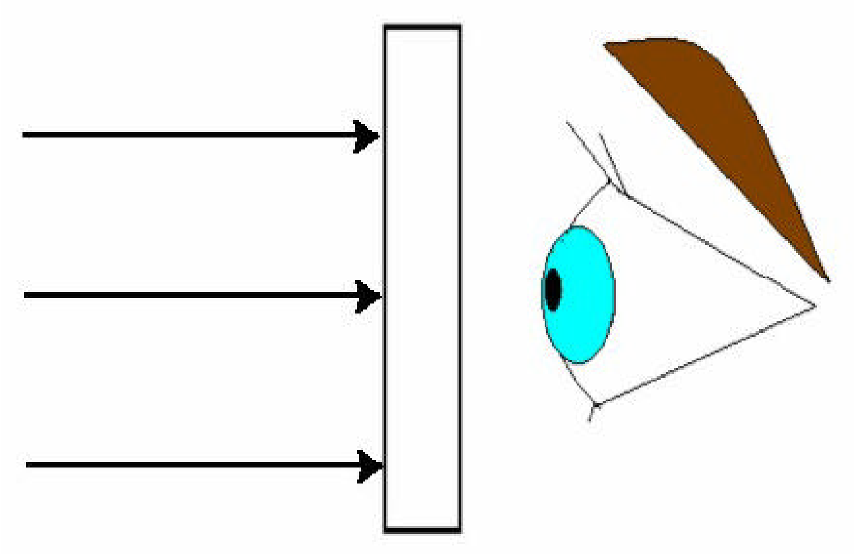
Did you try any lenses in combination? Identify the combination you used and describe your observations.

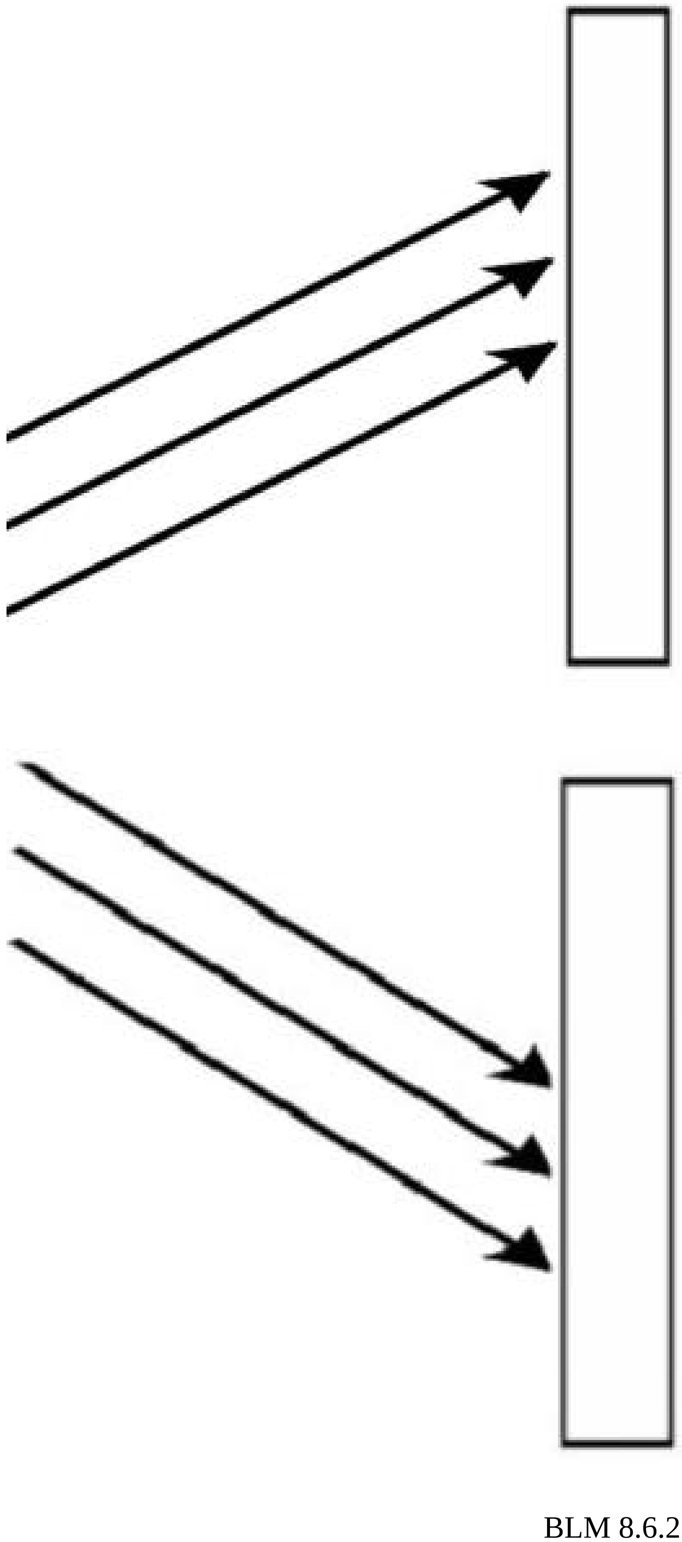
Refraction: The "Bending" of Light

Lens
Double Convex Lens
"Image Changed"



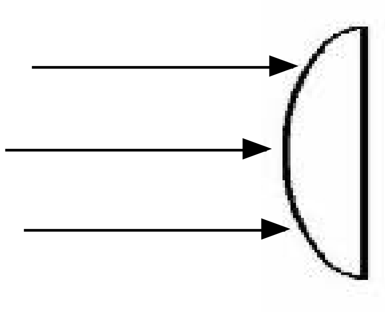
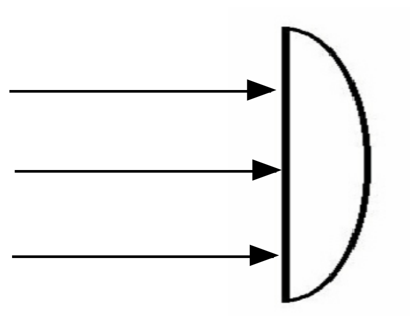
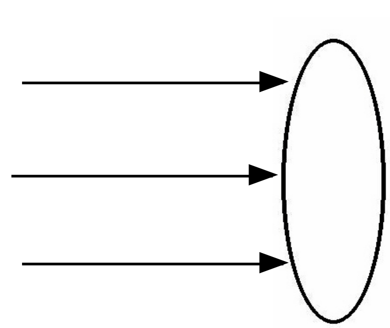
Lens
Rectangular Prism
"Image Stays the Same"

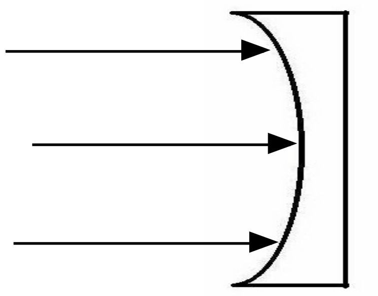
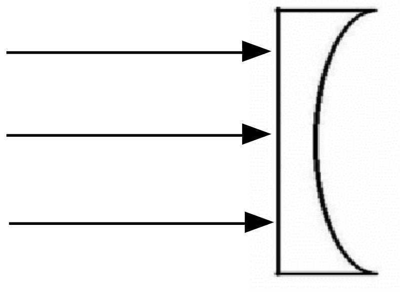
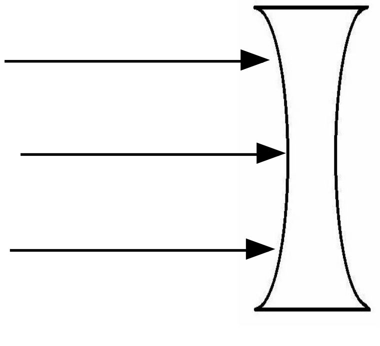




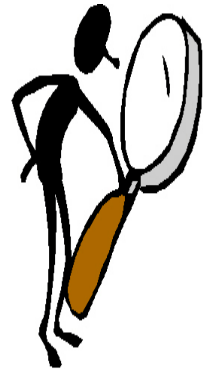
BLM 8.6.2

<u>Refraction of Light Through a Lens</u>

LENS	
simple convex lens	
simple convex lens	
double convex lens	

LENS	
simple concave lens	
simple concave lens	
double convex lens	

REFRACTION



Use the **INSITE** method as laid out below to develop and test a hypothesis that examines how the shape of transparent objects affects the way light travels.

I: Identify the problem

How does the shape of a transparent medium, such as a lens, affect the way light is refracted?

N: Narrow the problem

What type of materials will be needed? What are the variables in the problem? What factors should be kept constant to ensure a fair test? What is the angle of incidence? What is the angle of emergence? When are the angle of incidence and the angle of emergence the same? How can we describe the way in which the rays of light emerge from the transparent media?

S: State the hypothesis

Make a scientific guess as to what you believe is a solution to the problem above.

I hypothesize that:

I: Investigate and gather information

Review the findings from activities in **BLM 8.6.1** and **BLM 8.6.2**.

Materials: a ray box, a simple convex lens, a simple concave lens, a double convex lens, a double concave lens, a rectangular prism

Variables: shape of the lenses

Constants: position of lenses, position of the ray box, intensity of light beam, distance from the ray box to the lenses,

Procedure (plan of investigation):

- Set up the ray box to emit three focused beams of light (use the narrow light filter).
- Align the ray box to be perpendicular to the axis of the rectangular prism. Emit three light beams, the centre beam encountering the prism as close to the centre of the prism as possible so that all light beams pass straight through the prism without any refraction occurring. This setup position will now be the constant for all of the testing of the lenses in the experiment. The lenses will replace the rectangular prism, but will remain perpendicular to the ray box, and will have the centre beam encountering the centre of the lens.

- Look at the diagrams on **BLM 8.6.3**. Align the ray box so the three light beams hit each prism as illustrated. Observe what happens to the path of the light rays as they pass through and “emerge” from each prism. Using a ruler, draw the three emergent rays on each diagram to illustrate your observations.

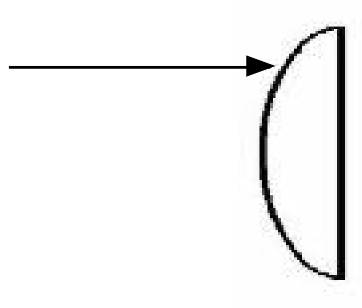
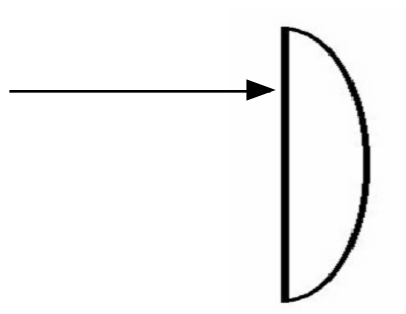
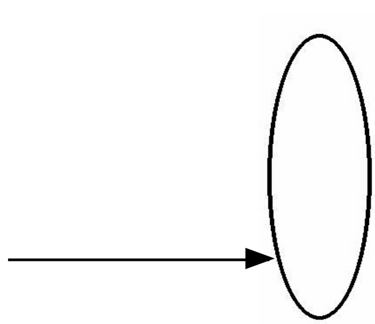
T: Test the hypothesis and record observations

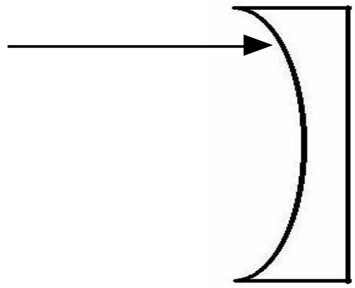
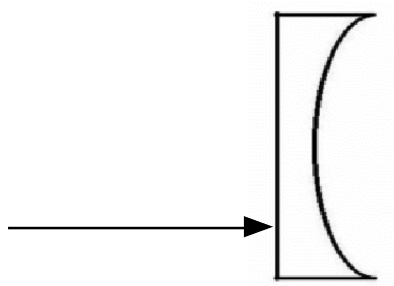
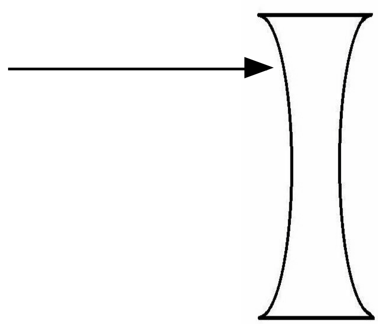
Follow the procedure above to test your hypothesis. Make a chart that summarizes your observations.

E: Examine the results and write a conclusion

Examine the results of your test. Write a conclusion that outlines what you learned in the investigation and testing of your hypothesis. In your conclusion write a statement which uses the terms converge (to come together) and diverge (to move apart).

<u>How Will Light Refract?</u>

LENS	
simple convex lens	
simple convex lens	
double convex lens	

LENS	
simple concave lens	
simple concave lens	
double convex lens	

The Drop of Water Challenge!

Materials:
- eye dropper
- beaker with water
- newspaper

Place a drop of water on a small letter on a piece of newspaper. What do you observe?

What property of light causes this to occur? ___________________________________

In the space below, draw an labeled diagram which explains this phenomenon.

The Drop of Water Challenge! Teacher Notes

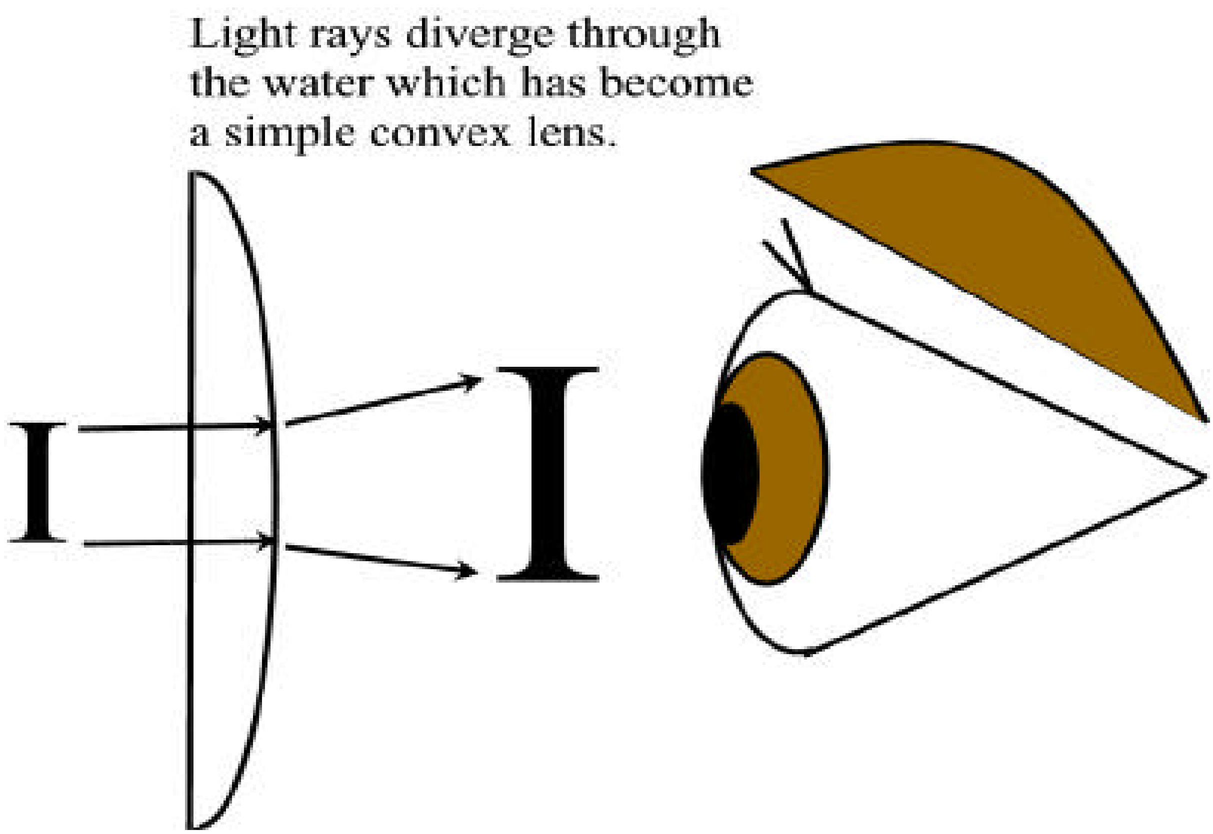
Materials:
- eye dropper
- beaker with water
- newspaper

Place a drop of water on a small letter on a piece of newspaper. What do you observe?

The letter appears to be larger than the other letters surrounding it. It is "magnified".

What property of light causes this to occur? Refraction

In the space below, draw a labeled diagram which explains this phenomenon.



Wavelength and the Visible Spectrum- Teacher Information

The visible spectrum contains numerous colors that are distinguished by wavelength and amplitude; wavelength determines color and amplitude determines brightness. Of these colors, the human eye can distinguish about 10 000. The visible spectrum, however, is often identified by the seven prominent colors we see in the rainbow. In 1666, Isaac Newton named these colors red, orange, yellow, green, blue, indigo, and violet, which are often referred to by the mnemonic acronym ROY G BIV.

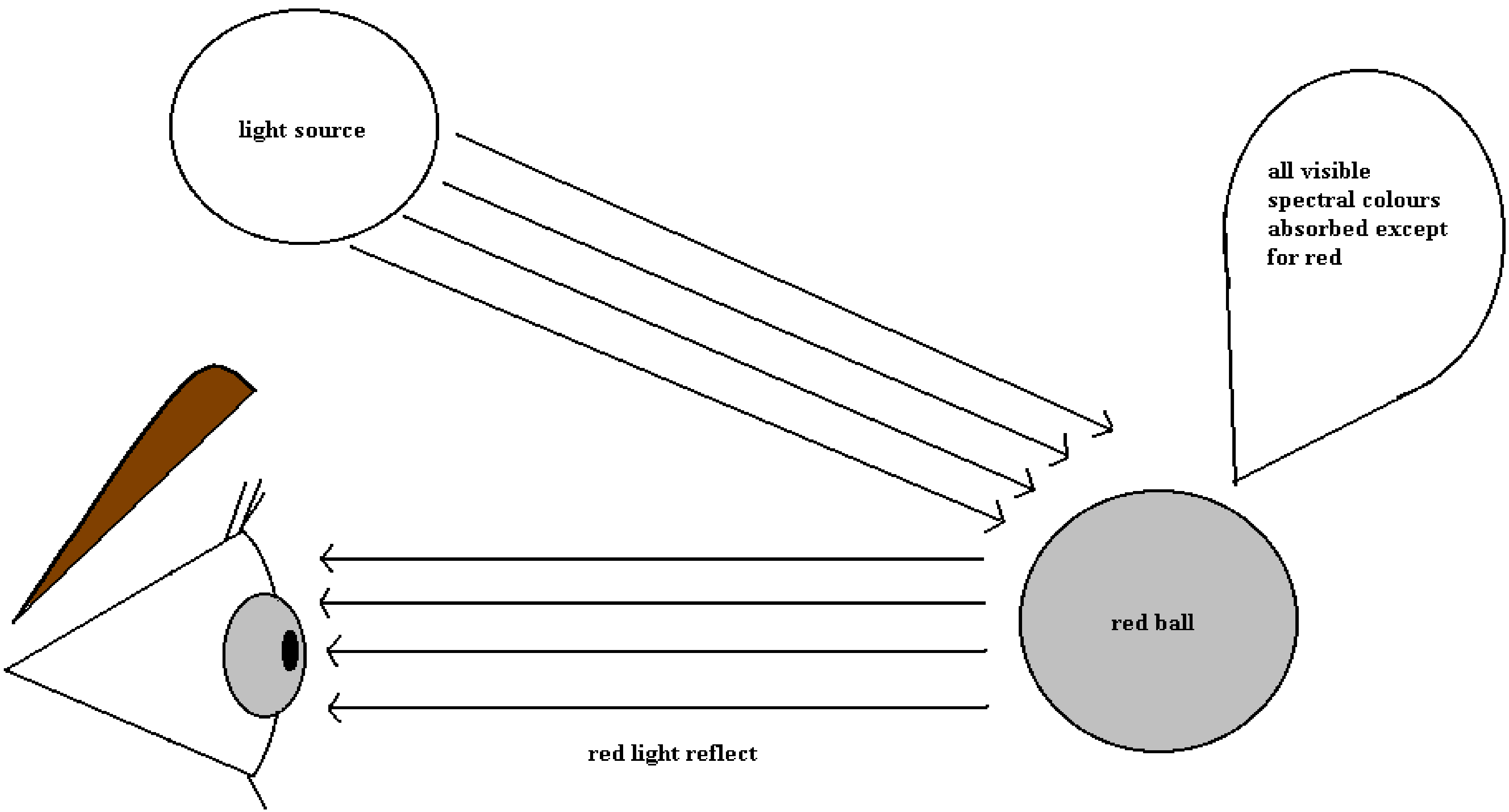
More commonly, however, the spectrum is arranged in order of wavelength, shortest to longest, and divided into segments identified as (note a nanometer, nm, is 1/1 000 000 000th of a meter):

violet (380-450nm)
blue (450-490nm)
green (490-560nm)
yellow (560-590nm)
orange (590-630)
and red (630-780)

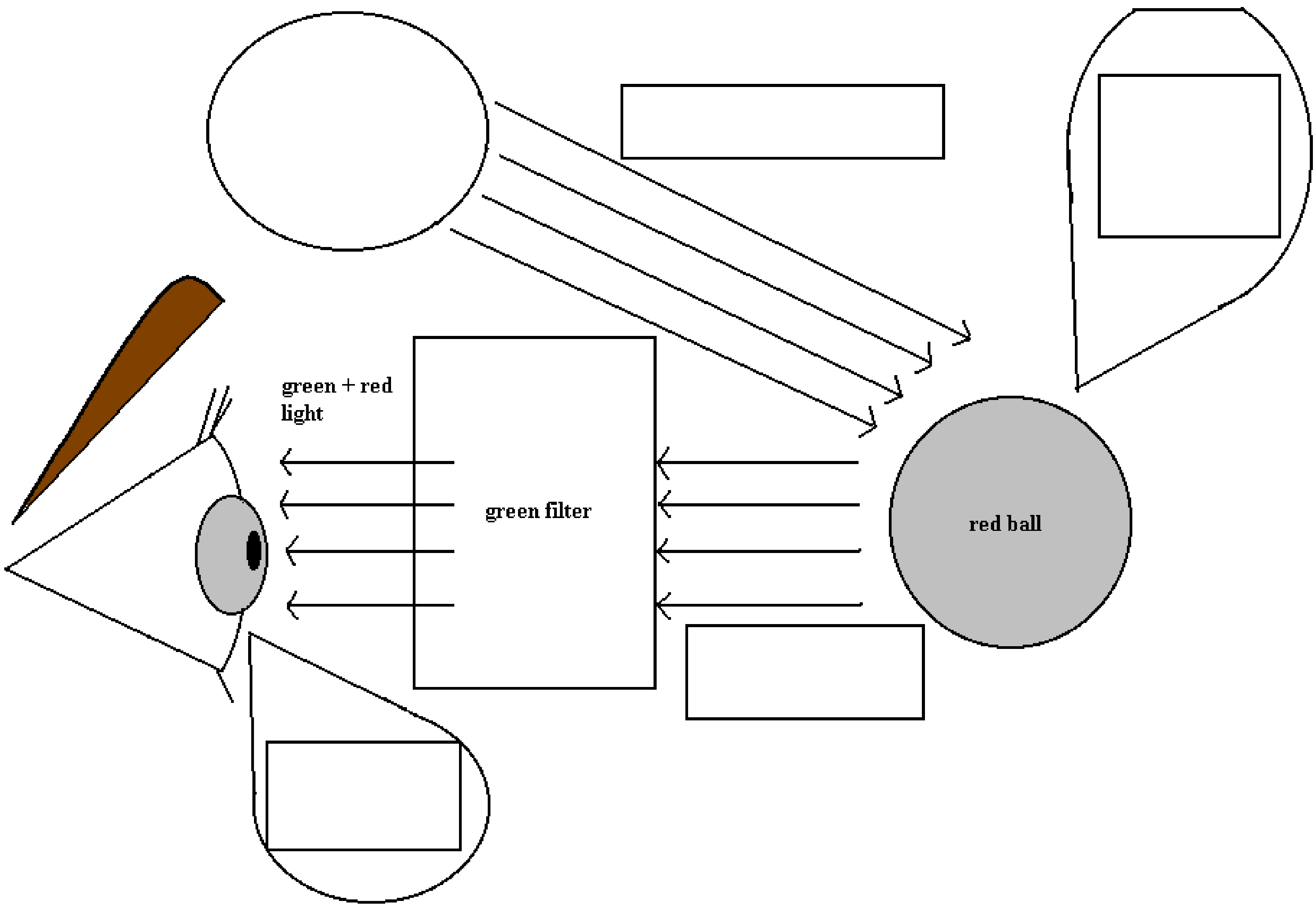
Wavelengths as Colour
Light that the human eye can detect as colour is a very small portion of the entire range of radiant energies referred to as the electromagnetic spectrum. Between infra-red rays and ultra violet rays is the visible light spectrum (aka the rainbow). Each of the six colours of the rainbow has a slightly different wavelength. A wavelength is considered the distance between the top of one wave and the top of the next.

Red has the longest wavelength, lowest frequency and the lowest energy. Violet has the shortest wavelength, highest frequency, and highest energy.
The combination of these light waves produces white light, which is what we see from the Sun and from most artificial light sources. A breakdown of the individual colors themselves is only visible under certain circumstances. This occurs naturally in a rainbow; it also occurs when white light is refracted through a prism. In fact, it was by experimenting with a prism in 1666 that Newton conclusively proved that what we see in these refractions are the constituent colors of white light; that is, that white light is not homogeneous (as had been previously supposed), but a composite of myriad-colored wavelengths.

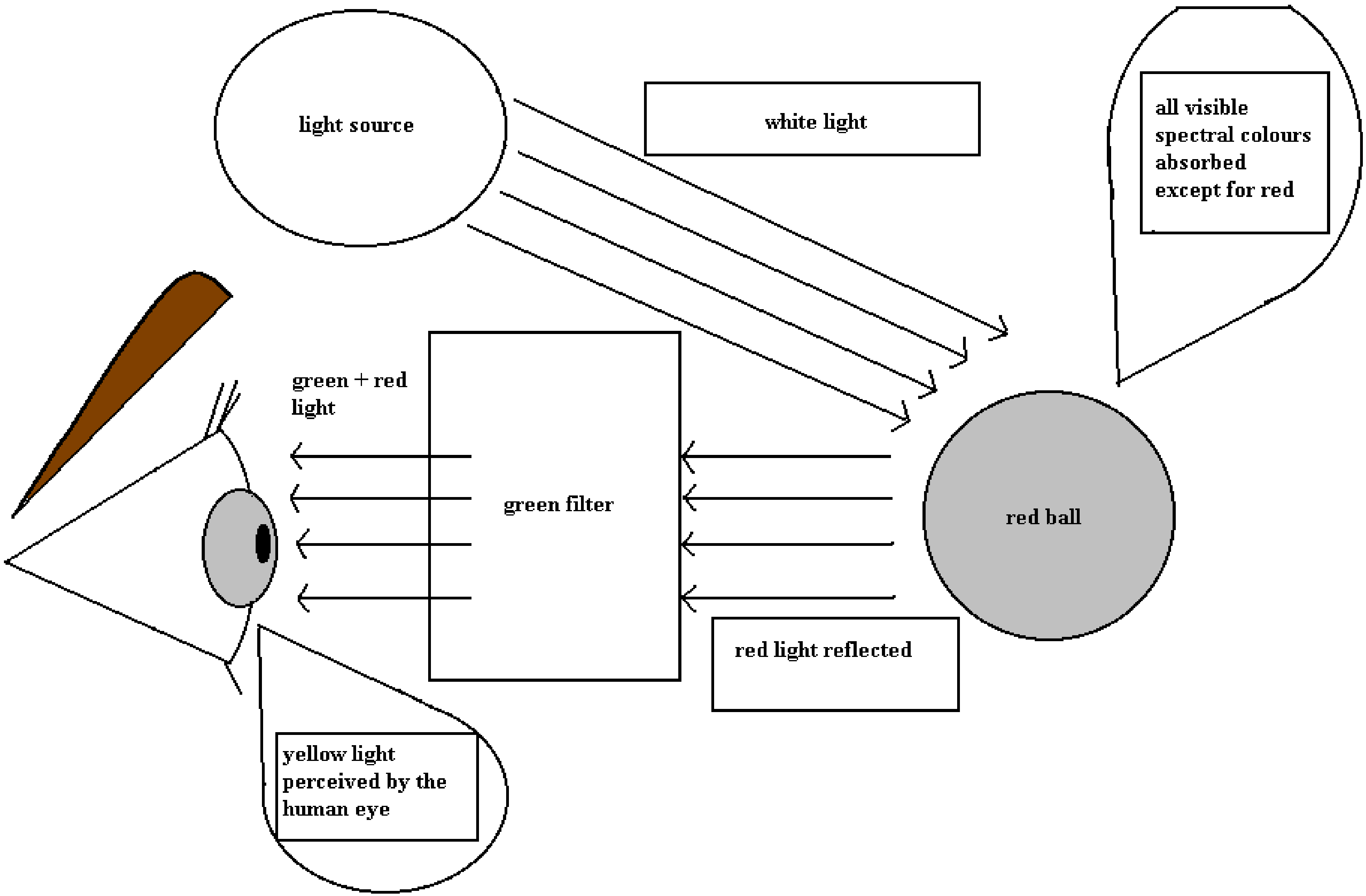
Perceiving Light



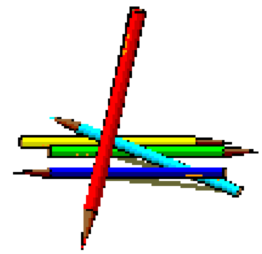
Combining Light



<u>Combining Light: Teacher Version</u>



Additive Colour Theory Investigation



Name:____

Predictions and Observations

First Colour	Second Colour	Prediction (use pencil crayon)	Result (use pencil crayon)
red	green		
blue	green		
red	blue		
yellow	cyan		
cyan	green		
magenta	yellow		
green	cyan		
blue	yellow		

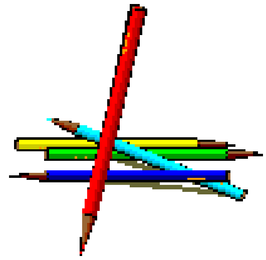
Procedure:

1. Working in groups set up your investigation area.
2. Cover your light sources with colour filters.
3. Experiment with your materials until you get the brightest possible light on the white screen.
4. Shine all three colours on your screen. Overlap all three beams.
5. Try different colour combinations of lights.
6. Record your observations on the chart above.

Conclusions (on a separate sheet of paper)

1. Make a Venn diagram below showing what each combination of colours will produce.
2. How does your diagram help to explain why sunlight appears white?

Additive Colour Theory Investigation



Name: **TEACHER VERSION**

Predictions and Observations

First Colour	Second Colour	Prediction (use pencil crayon)	Result (use pencil crayon)
red	green	**varies**	**yellow**
blue	green	**varies**	**cyan**
red	blue	**varies**	**magenta**
yellow	cyan	**varies**	**white**
cyan	green	**varies**	**white**
magenta	yellow	**varies**	**white**
green	cyan	**varies**	**white**
blue	yellow	**varies**	**white**

Procedure

1. Working in groups set up your investigation area.
2. Cover your light sources with colour filters.
3. Experiment with your materials until you get the brightest possible light on the white screen.
4. Shine all three colours on your screen. Overlap all three beams.
5. Try different colour combinations of lights.
6. Record your observations on the chart above.

Conclusions

1. Make a Venn diagram below showing what each combination of colours will produce.
2. How does your diagram help to explain why sunlight appears white?

Answers to the question may vary but should include some of the following information:

Sunlight is white because it is a combination of the three primary light colours, red, blue and green.

Optical Devices Research Assignment

We know that light travels in straight lines from a source. We have learned that it can be transmitted, reflected, refracted or absorbed when it encounters various media. We have also studied white light and spectral colours. Based upon the study of light, optical devices have been developed which make use of the properties of light. These devices are used to perform or enhance functions that the eye is not capable of performing.

Examples of Optical Devices:

Your assignment is to research one of the optical devices listed above (or choose one of your own in consultation with your teacher), and create a presentation which will include the following elements.

Required Elements:

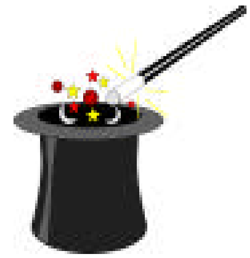
1. A cross section diagram of the optical device with all parts labeled
2. A diagram which reveals how the optical device functions as a system with light.
3. A description of how the device functions as a system.

The presentation of your research to the class will include the following:

1. A 5 to 10 minute oral presentation of your material
2. Handout notes for all students of no more than 2 photocopied sheets (your teacher will photocopy a single double sided page for you)
3. A visual aid which could be:
- a multimedia presentations file
- prepared overhead transparencies
- mounted diagrams and descriptions on Bristol board

STUDENT ACTIVITY SHEET FOR " OPTICS - SEEING IS BELIEVING"

People have been fascinated by the study of optics for many years. Magicians and illusionists have used that fascination and their understanding of light and the properties of light to create amazing illusions. Whether it is making whole buildings "disappear" or pulling a rabbit out of a hat, illusionists have relied on mirrors, light, colour and the human eye to entertain.



Your task is to design an illusion which uses one or more property of light. The illusion will be presented to your classmates who will try to explain how the illusion worked. You will also present the illusion as part of a traveling show to the students in other grades.

Each team will be assessed on:

1. The criteria in the Presentation Rubric
2. The criteria in the Design Rubric
3. The completion of the organizer

Use the following template to create the "Design Organizer" elements on separate sheets of paper.

Design Organizer

Student Name:
Partner's Name:
Date Started:
Presentation Date:

Challenge: To design and perform an illusion incorporating one or more properties of light.

A. Possible Ideas (list at least 3)

Illusion:
Property being Used:
Pros / Cons:

B. Description of Illusion Chosen (one to two paragraphs)
C. Materials Needed (a complete list of materials)
D. Work Plan (extensive notes and labeled diagrams)

Design Rubric for "Seeing is Believing"

CRITERIA	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
Identifying the Problems Related to the Task	-Identifies and describes the design challenge with limited clarity - Explores a few possible solutions - Demonstrates limited understanding of the task	-Identifies and describes the design challenge with partial explanations - Explores some possible solutions - Demonstrates limited understanding of the task	-Identifies and describes the design challenge with considerable explanations - Explores considerable possible solutions - Demonstrates general understanding of the task	-Identifies and describes the design challenge using complete and precise explanations - Thoroughly explores all or almost all possible solutions - Demonstrates a thorough understanding of the task
Planning	-Outlines limited steps to complete the plan	-Outlines some steps to complete the plan	-Outlines the steps to complete the plan in a detailed manner	-Outlines the steps to complete the plan in a complex and thorough manner
Following a Plan	-Outlines limited steps to complete the plan -Selects a few appropriate materials and equipment for the illusion -Tests the design and makes minimal modifications for improvement	-Outlines some steps to complete the plan -Selects some appropriate materials and equipment for the illusion -Tests the design and makes some modifications for improvement	-Outlines the steps to complete the plan in a detailed manner -Selects most of the appropriate materials and equipment for the illusion -Tests the design and makes several modifications for improvement	-Outlines the steps to complete the plan in a complex and thorough manner -Selects all or almost all of the appropriate materials and equipment for the illusion -Tests the design and makes extensive modifications for improvement
Communicating	-Records limited correct, complete data - Uses limited appropriate science and technology vocabulary	-Records some correct, complete data - Uses some appropriate science and technology vocabulary	-Records considerable correct, complete data - Uses considerable appropriate science and technology vocabulary	-Records with great detail, all or almost all data in a clear and organized manner - Uses appropriate science and technology vocabulary extensively

PRESENTATION CHECKLIST FOR “SEEING IS BELIEVING”

Science and Technology

Criteria	Limited	Somewhat	Usually	Always
Student demonstrates and understands the property of light being demonstrated				
Materials, etc. are used appropriately and with skill				

Language Arts

Criteria	Limited	Somewhat	Usually	Always
Communicates to audience clearly and logically				
Uses appropriate tone, volume and pace when presenting illusion				
Performance has been planned and participants know their roles				

I.N.S.I.T.E. Method

Throughout this unit students will be involved in inquiry based learning and investigations.
The INSITE method, a problem solving model based on the principles of scientific inquiry, has been developed to help students conduct these investigations.

Identify the problem
Narrow the problem
State the hypothesis
Investigate and gather information
Test your hypothesis and record observations
Examine the results and write (communicate) conclusions

Identify the problem
The first step is for the students to identify the problem they will investigate or need to resolve.

Narrow the problem
The second step is to narrow the problem. At this stage the students will state the various questions (what, when, where, how, why, etc.) related to the problem.

State the hypothesis
The third step is to state the hypothesis. In this statement the students will make a scientific guess as to what they believe will be a solution to the problem.

Investigate and gather information
The fourth step is for the students to conduct a scientific investigation related to the hypothesis. Students will need to conduct research and gather information related to the problem and the questions they generated in the second step. Once the students have enough background they will create a plan of investigation to test their hypothesis. The students will need to consider all the possible variables and constants in order to carry out a fair test. Plans should include a list of materials they will need.

Test the hypothesis and record observations
The fifth step is for the students to follow their plan and carry out a fair test to confirm the validity of their hypothesis. Students will record their observations as they test their hypothesis. Students should be given opportunities to use a variety of recording devices such as charts, graphs, learning logs, or science journals.

Examine the results and write (communicate) conclusions
The sixth step is for the students to examine the results of their test and then write a conclusion (communicate a response) that outlines what they learned in the investigation and testing of their hypothesis. It is important that students examine their results and whether or not their hypothesis was valid before writing their conclusion. If their hypothesis was not valid the students may need to either develop a new hypothesis or create a new plan to test their hypothesis in order to gain different results. Students should examine what worked and why, what needs further research, and what needs further investigation. If their hypothesis was valid the students should state the solution to the problem in their conclusion and outline why it was a solution.

I.N.S.I.T.E. Method

I = Identify the problem

N = Narrow the problem

S = State the hypothesis

I = Investigate and gather information

T = Test the hypothesis and record observations

E = Examine the results and write (communicate) conclusions

Inquiry/I.N.S.I.T.E. Rubric

Criteria	Level 1	Level 2	Level 3	Level 4
Identifying the Problem and Stating the Hypothesis	- develops an unrelated hypothesis - shows limited understanding of the components of a fair test	- develops a simple hypothesis - shows some understanding of the components of a fair test	- develops an appropriate hypothesis - shows a general understanding of the components of a fair test	- develops an insightful hypothesis - shows a comprehensive understanding of all of the components of a fair test
Developing an Investigation	- applies a few of the skills and strategies to plan an investigation	- applies some of the skills and strategies to plan an investigation	- applies most of the skills and strategies to plan an investigation	- applies all or almost all of the skills and strategies to plan an investigation
Carrying Out the Test	- records data with limited accuracy	- records data with some accuracy	- records data with general accuracy	- records data with precision and accuracy
Explaining the Results	- the explanation of new learning contains many inaccuracies	- the explanation of new learning contains some inaccuracies	- the explanation of new learning is accurate	- the explanation of new learning is accurate and detailed

S.P.I.C.E. Model of Design

S - Situation

Observe the scene. Think about what has happened to create the problem.

P - Problems or Possibilities

Tell what the problem is, what you are required to do, what your restrictions are, and what the possible solutions to the problem might be.

I - Investigate/Ideas

Brainstorm as many solutions to the problem as possible. Think about materials, tools, and people.

C - Choose/Construct

Choose the best idea. Plan your design and build it. Test your design to make sure it works.

E - Evaluate

Look back at the problem and think about how well you solved the problem.

** Adapted from the SPICE model created by Geoff Day, University of Toronto, 1989.*

SCIENCE JOURNAL ASSESSMENT RUBRIC

CRITERIA	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4
Knowledge	i. demonstrates limited understanding of the topic ii. draws a few conclusions about new learnings	i. demonstrates some understanding of the topic ii. draws some conclusions about new learnings	i. demonstrates a general understanding of the topic ii. generally draws relevant conclusions about new learnings	i. demonstrates a comprehensive understanding of the topic ii. draws meaningful and insightful conclusions about new learnings
Communication	i. communicates information with limited clarity and accuracy ii. makes limited use of scientific and technological terminology	i. communicates information with some clarity and accuracy ii. makes some use of scientific and technological terminology	i. generally communicates information with clarity and accuracy ii. makes general use of scientific and technological terminology	i. communicates comprehensive information with clarity and accuracy ii. makes extensive use of scientific and technological terminology
Relating to the world outside the classroom	i. demonstrates limited understanding of how concepts relate to the world outside the classroom	i. demonstrates some understanding of how concepts relate to the world outside the classroom	i. demonstrates general understanding of how concepts relate to the world outside the classroom	i. demonstrates understanding of how concepts relate to the world outside the classroom and the implications of this relationship

Optics

Energy and Control An Integrated Unit for Grade 8

Selected **Assessed**

Science and Technology---Energy and Control

☐	**8s62**	• demonstrate an understanding of the properties of visible light and the properties of other types of electromagnetic radiation, including infrared and ultraviolet rays, X-rays, microwaves, and radio waves;	**1**
☐	**8s63**	• investigate the properties of visible light, including the effects of reflection and refraction, and recognize how these properties are used in optical devices;	**1**
☐	**8s64**	• describe ways in which different sources of visible light and the properties of light, both natural and artificial, are used by humans for different purposes.	**1**
☐	**8s65**	– identify the properties of visible light through experimentation;	**4**
☐	**8s66**	– compare the properties of visible light with the properties of other types of electromagnetic radiation, including infrared and ultraviolet rays, X-rays, microwaves, and radio waves;	**1**
☐	**8s67**	– describe how incandescent, fluorescent, and phosphorescent sources produce light;	**1**
☐	**8s68**	– identify colours as different wavelengths of light and explain why objects appear to have colour;	**1**
☐	**8s69**	– describe qualitatively how visible light is refracted;	**1**
☐	**8s70**	– investigate how objects or media refract, transmit, or absorb light (e.g., non-luminous objects are seen when reflected light enters the eye; stars are seen when transmitted light enters the eye);	**3**
☐	**8s71**	– identify ways in which the characteristics of mirrors and convex and concave lenses determine their use in optical instruments (e.g., in a camera, a telescope, binoculars, a microscope);	**2**
☐	**8s72**	– investigate and describe the laws of reflection of visible light (e.g., using a plane mirror);	**1**
☐	**8s73**	– explain colour vision using the additive theory;	**1**
☐	**8s74**	– describe the effect of colour filters on white light using the subtractive theory.	**1**
☐	**8s75**	– formulate questions about and identify needs and problems related to the properties and behaviour of light (e.g., interactions between light and different materials), and explore possible answers and solutions (e.g., predict and demonstrate how various liquids will refract a light beam and describe the angle of refraction);	**3**
☐	**8s76**	– plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions;	**1**
☐	**8s77**	– use appropriate vocabulary, including correct science and technology terminology, to communicate ideas, procedures, and results (e.g., use terms such as incidence, reflection, refraction, wavelength, frequency when describing the properties of light);	**7**
☐	**8s79**	– communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings, and oral presentations (e.g., prepare a brochure informing the public of the risks of a specific type of electromagnetic radiation).	**4**
☐	**8s80**	– describe how energy comes to earth as radiation in a range of wavelengths, some of which are visible;	**1**
☐	**8s81**	– identify ways in which the properties of reflection are used in everyday situations (e.g., cosmetology, rear-view mirrors in cars, security mirrors, night reflectors on jackets or bicycles);	**1**
☐	**8s82**	– explain the function and purpose of combinations of multiple lenses or lenses and mirrors in optical systems (e.g., the source and one or more reflectors or lenses in cameras, periscopes, telescopes);	**2**
☐	**8s83**	– compare the automatic functions of the human eye to functions in an automatic camera (e.g., focusing power, adaptation to brightness);	**1**
☐	**8s86**	– recognize that energy can be a significant cost in the manufacture and use of products or systems and explain how that determines its production (e.g., analyse the costs and benefits of producing and using solar panels).	**1**

Expectation Summary

Selected **Assessed**

Optics

Energy and Control An Integrated Unit for Grade 8

English Language

8e1	8e2	8e3	8e4	8e5	8e6	8e7	8e8	8e9	8e10
8e11	8e12	8e13	8e14	8e15	8e16	8e17	8e18	8e19	8e20
8e21	8e22	8e23	8e24	8e25	8e26	8e27	8e28	8e29	8e30
8e31	8e32	8e33	8e34	8e35	8e36	8e37	8e38	8e39	8e40
8e41	8e42	8e43	8e44	8e45	8e46	8e47	8e48	8e49	8e50
8e51	8e52	8e53	8e54	8e55	8e56	8e57	8e58	8e59	8e60
8e61	8e62	8e63	8e64	8e65	8e66	8e67			

French as a Second Language

8f1	8f2	8f3	8f4	8f5	8f6	8f7	8f8	8f9	8f10
8f11	8f12	8f13	8f14	8f15	8f16	8f17			

Mathematics

8m1	8m2	8m3	8m4	8m5	8m6	8m7	8m8	8m9	8m10
8m11	8m12	8m13	8m14	8m15	8m16	8m17	8m18	8m19	8m20
8m21	8m22	8m23	8m24	8m25	8m26	8m27	8m28	8m29	8m30
8m31	8m32	8m33	8m34	8m35	8m36	8m37	8m38	8m39	8m40
8m41	8m42	8m43	8m44	8m45	8m46	8m47	8m48	8m49	8m50
8m51	8m52	8m53	8m54	8m55	8m56	8m57	8m58	8m59	8m60
8m61	8m62	8m63	8m64	8m65	8m66	8m67	8m68	8m69	8m70
8m71	8m72	8m73	8m74	8m75	8m76	8m77	8m78	8m79	8m80
8m81	8m82	8m83	8m84	8m85	8m86	8m87	8m88	8m89	8m90
8m91	8m92	8m93	8m94	8m95	8m96	8m97	8m98	8m99	8m100
8m101	8m102	8m103	8m104	8m105	8m106	8m107	8m108	8m109	8m110
8m111	8m112	8m113	8m114	8m115	8m116	8m117	8m118	8m119	8m120
8m121	8m122								

Science and Technology

8s1	8s2	8s3	8s4	8s5	8s6	8s7	8s8	8s9	8s10
8s11	8s12	8s13	8s14	8s15	8s16	8s17	8s18	8s19	8s20
8s21	8s22	8s23	8s24	8s25	8s26	8s27	8s28	8s29	8s30
8s31	8s32	8s33	8s34	8s35	8s36	8s37	8s38	8s39	8s40
8s41	8s42	8s43	8s44	8s45	8s46	8s47	8s48	8s49	8s50
8s51	8s52	8s53	8s54	8s55	8s56	8s57	8s58	8s59	8s60
8s61	8s62 **1**	8s63 **1**	8s64 **1**	8s65 **4**	8s66 **1**	8s67 **1**	8s68 **1**	8s69 **1**	8s70 **3**
8s71 **2**	8s72 **1**	8s73 **1**	8s74 **1**	8s75 **3**	8s76 **1**	8s77 **7**	8s78	8s79 **4**	8s80 **1**
8s81 **1**	8s82 **2**	8s83 **1**	8s84	8s85	8s86 **1**	8s87	8s88	8s89	8s90
8s91	8s92	8s93	8s94	8s95	8s96	8s97	8s98	8s99	8s100
8s101	8s102	8s103	8s104	8s105	8s106	8s107	8s108	8s109	8s110
8s111	8s112	8s113	8s114	8s115	8s116	8s117	8s118	8s119	8s120
8s121	8s122	8s123	8s124	8s125	8s126	8s127	8s128	8s129	8s130
8s131	8s132	8s133	8s134	8s135	8s136	8s137	8s138	8s139	8s140
8s141	8s142	8s143	8s144	8s145	8s146	8s147	8s148		

History

8h1	8h2	8h3	8h4	8h5	8h6	8h7	8h8	8h9	8h10
8h11	8h12	8h13	8h14	8h15	8h16	8h17	8h18	8h19	8h20
8h21	8h22	8h23	8h24	8h25	8h26	8h27	8h28	8h29	8h30
8h31	8h32	8h33	8h34	8h35	8h36	8h37	8h38	8h39	8h40
8h41	8h42	8h43	8h44	8h45	8h46	8h47	8h48	8h49	8h50
8h51	8h52	8h53	8h54	8h55	8h56	8h57			

Geography

8g1	8g2	8g3	8g4	8g5	8g6	8g7	8g8	8g9	8g10
8g11	8g12	8g13	8g14	8g15	8g16	8g17	8g18	8g19	8g20
8g21	8g22	8g23	8g24	8g25	8g26	8g27	8g28	8g29	8g30
8g31	8g32	8g33	8g34	8g35	8g36	8g37	8g38	8g39	8g40
8g41	8g42	8g43	8g44	8g45	8g46	8g47	8g48	8g49	8g50
8g51	8g52	8g53	8g54	8g55	8g56	8g57			

Health & Physical Education

8p1	8p2	8p3	8p4	8p5	8p6	8p7	8p8	8p9	8p10
8p11	8p12	8p13	8p14	8p15	8p16	8p17	8p18	8p19	8p20
8p21	8p22	8p23	8p24	8p25	8p26	8p27	8p28	8p29	8p30
8p31	8p32	8p33	8p34	8p35	8p36	8p37	8p38	8p39	8p40
8p41									

The Arts

8a1	8a2	8a3	8a4	8a5	8a6	8a7	8a8	8a9	8a10
8a11	8a12	8a13	8a14	8a15	8a16	8a17	8a18	8a19	8a20
8a21	8a22	8a23	8a24	8a25	8a26	8a27	8a28	8a29	8a30
8a31	8a32	8a33	8a34	8a35	8a36	8a37	8a38	8a39	8a40
8a41	8a42	8a43	8a44	8a45	8a46	8a47	8a48	8a49	8a50
8a51	8a52	8a53	8a54	8a55	8a56	8a57	8a58	8a59	8a60
8a61	8a62	8a63	8a64	8a65	8a66				

Optics

Energy and Control **An Integrated Unit for Grade 8**

Analysis Of Unit Components

9 Subtasks
40 Expectations
77 Resources
89 Strategies & Groupings

-- Unique Expectations --
22 Science And Tech Expectations

Resource Types

0 Rubrics
36 Blackline Masters
0 Licensed Software
0 Print Resources
1 Media Resources
0 Websites
14 Material Resources
26 Equipment / Manipulatives
0 Sample Graphics
0 Other Resources
0 Parent / Community
0 Companion Bookmarks

Groupings

5 Students Working As A Whole Class
3 Students Working In Pairs
7 Students Working In Small Groups
3 Students Working Individually

Teaching / Learning Strategies

1 Advance Organizer
2 Brainstorming
1 Classifying
2 Collaborative/cooperative Learning
5 Demonstration
7 Direct Teaching
3 Experimenting
1 Homework
3 Inquiry
1 Issue-based Analysis
3 Learning Log/ Journal
1 Model Making
1 Oral Explanation
1 Research

Assessment Recording Devices

6 Anecdotal Record
3 Checklist
1 Rating Scale
5 Rubric

Assessment Strategies

1 Classroom Presentation
5 Exhibition/demonstration
6 Learning Log
5 Observation
4 Performance Task
2 Questions And Answers (oral)
1 Self Assessment