4.1 Mirror, mirror

Lesson outcomes

At the end of this activity students will be able to:

- draw ray diagrams to record where light rays travel when they reflect off mirrors
- manipulate light beams with mirrors and predict outcomes using the law of reflection
- describe the different uses of convex and concave mirrors
- explain the difference between a real image and a virtual image.

What ideas might your students already have?

Some students will have the misconception that light comes from all objects, rather than being reflected off them. Most students will be aware of the lateral inversion of plane mirrors, but not really consider how it occurs.

Key vocabulary

Mirror, plane, concave, convex, angle of incidence, angle of reflection, law of reflection, converge, diverge, diminished, magnified, erect, inverted, ray diagram, object, real image, virtual image.

Equipment list:

Each GROUP will require:

- Activity one: A4 white paper, heavy block of wood, marble, ruler
- Activity two: A4 white paper, a plane mirror and stand, light box and power supply, protractor.
- Activity three: A4 white paper, a plane mirror, concave mirror, convex mirror, light box and power supply.
- Activity four: A4 white paper, a plane mirror, concave mirror, convex mirror.

Each STUDENT will require:

- ***Notebook.***

Things to consider

- Students will require a Scootle Student login PIN to access the Scootle digital resources Optics and images: plane mirrors (L1487) and Optics and images: curved mirrors (L1488). For information on how to create a Learning Pathway and a Student login PIN see General Information – Scootle Resources.
- All aspects of the hands-on activities are re-emphasised in the digital activities.
- In addition to the concave and convex mirrors supplied by scientific supply companies you might like to assemble a shaving mirror, makeup mirror and car rear view mirror to show examples of curved mirrors in daily use.
- A fun extension activity that emphasises how concave mirrors invert images can be viewed at https://www.youtube.com/watch?v=h6NqaDxi2KY

Lesson plan:

Step 1: Introduce the activity by asking students why we use mirrors?

Step 2: Invite students to carry out the hands-on inquiries into the ricochet marble and mirrors. If they have not used the ray boxes before you may wish to explain the filters and safety precautions.

Step 3: During the activity, circulate and encourage students to record their observations accurately. One of the objectives of this lesson is drawing accurate ray diagrams.

Step 4: Summarise the hands-on inquiries. Introduce the terms converging and diverging to describe the reflected rays in the concave and convex mirrors.

Step 5: Invite students to capture a real image of the outside world by aiming a concave mirror at the window and placing a sheet of white paper in front of the mirror.

Step 6: Introduce the **Student Digital** activities which help to consolidate the learning to date.

Suggested question/s:

- How can we explain reflection?
- Do all mirrors behave the same way?
- Do they produce the same image?

4.2 Does light travel in straight lines?

Lesson outcomes

At the end of this activity students will be able to:

- describe refraction
- draw a ray diagram involving lenses
- explain that reflection and refraction occur at a boundary
- describe the critical angle and total internal reflection.

What ideas might your students already have?

Students should know that the speed of light is constant but they may not know this is medium specific.

Key vocabulary

Light, media, refraction, converging rays, diverging rays, angle of refraction, speed, vacuum, refractive index, mirage, normal, critical angle, total internal reflection, optical fibre.

Equipment list:

Each GROUP will require:

- Activity 1: A4 white paper, a rectangular block (glass or plastic), single beam splitter, light box and power supply.
- Activity 2: A4 white paper, a convex lens, a concave lens, multiple beam splitter, light box and power supply.

Each STUDENT will require:

- ***Notebook.***

Things to consider

- You will need to perform this investigation in a darkened room.
- You may wish to have a wooden ruler and large beaker of water on your front bench to allow the students to see the image in the *Science by Doing* **Student Guide** is not faked.
- The hands-on inquiries and the digital activities can be delivered separately and you may wish to set the digital as a homework exercise.
- If you have a laser pointer and an empty PET soft drink bottle you could demonstrate how light shows total internal reflection through a water stream as illustrated in the **Student Guide**.

Teacher content information:

The focus of this lesson is refraction and it also allows students to develop their ray diagram skills. Common practice in drawing in the beam of light is to use very small pencil crosses to indicate the beam and then use a ruler to complete the diagram after the equipment is out of the way.

Another key idea here is that both reflection and refraction occur at a boundary. In the digital activity, students monitor the intensity of the beam so that they become aware that not all light is refracted.

You may wish to read about Snell's law for your own background knowledge or to extend the students. For further reading about this see - http://www.physicsclassroom.com/class/refrn/u14l2b.cfm and the video - http://www.youtube.com/watch?v=yfawFJCRDSE

Lesson plan:

Step 1: Explain that the class will look at whether light travels in straight lines. What ideas do students have about this?

Step 2: Form small groups to carry out the hands-on activities.

Step 3: During each activity, circulate and address any issues with equipment set up and encourage students to be accurate with their drawing.

Step 4: Present the **Student Digital** and explain refraction using the wave animation. Ask students to recall how water waves similarly change direction when they enter shallow water. Discuss the analogy of the car driving into the beach sand.

Step 5: Explore the **Student Digital** activities and invite students to share their observations through a class discussion.

Suggested question/s:

- Does light travel in straight lines?
- Does light travel in a straight line as it passes through objects?
- Is the ruler bent?
- Does the shape of the lens matter?
- How does a mirage work?
- What did you notice about the path the light took?
- Can you link the investigation to the image of the ruler in water?
- In the digital activity what do you notice about the red and black lines?
- Why do people spearfishing aim below fish to catch them?

4.3 The world of colour

Lesson outcomes

At the end of this activity students will be able to:

- describe white light as a mixture of component colours
- describe how to add different colours of light to make certain colours
- explain how we use our three types of cone cells and our brain to sense and perceive colour.

What ideas might your students already have?

Students may have the misconceptions:

- light is nothing
- darkness is an entity
- light comes from the eyes to the object.

Key vocabulary

Colour blindness, dispersion, absorption, apex, camouflage, colour, emission, radiation, ultraviolet, visible, cyan, magenta.

Equipment list:

Each GROUP will require:

- Activity A: light box and power supply, a triangular prism, red filter, A4 white paper.
- Activity B: light box and power supply, set of coloured filters, range of coloured cards or objects.

Each STUDENT will require:

- ***Notebook.***

Things to consider

- You may wish to limit the exploration of coloured objects to a set of four, or you may wish to bring in a range of clothing to broaden the activity from the cards that come with the ray box sets.
- You may be aware of colour-blind students and they might like to share what this means. In addition, the art department may have resources to complement the activity.
- You may wish to use electrical discharge tubes to show light from elements or include a hands-on flame test activity to see how chemicals produce coloured light.

Teacher content information:

- Dispersion is the scientific term for the spreading out of white light as it passes through an optically denser medium than air. Light of different wavelengths refracts by varying amounts causing a rainbow effect.
- The eye's retina is made up of cones and rods. Each cone is sensitive to one region of the electromagnetic spectrum, either red, blue or green. In addition, there are rods which are sensitive to the intensity of the light. Your cones do not work in low intensity light, hence your vision becomes black and white in dimly lit rooms. There are excellent summary videos available on YouTube.

When a ray of white light is shone through the apex of a glass prism the light disperses and the shorter wavelength violet refracts more than the longer wavelength red. The primary colours red, green and blue can be added to make the following colours:-

a. Purple (magenta) = red + blue
b. Yellow = red + green
c. Aqua (cyan) = green + blue
d. White = red + green + blue

For further reading about soap films and the interference effect that produces the colour go to http://www.nuffieldfoundation.org/practical-physics/soap-film

Lesson plan

Step 1: Introduce the activity with a ***Think-Pair-Share*** about 'What is colour?' From these ideas you can tailor the rest of the material.

Step 2: During the activity, circulate and pose questions to the groups to explain what they are doing. Encourage them to explore outside the bounds of the activity.

Step 3: Conclude the hands-on activities with a large scale version of the white light spectrum if you have the resources (glass prism and slide projector) or a class discussion on seeing in colour.

Step 4: Present the two videos to the class that explain how we see colour. Introduce the ***Notebook*** activities as a ***Predict-Observe-Explain*** activity.

Step 5: If you have time, have the students explore their colour vision through online colour blind tests (e.g. http://colorvisiontesting.com/ishihara.htm).

Suggested question/s:

- How does light allow us to see in colour?
- Do blue objects look blue in red light?
- Do red objects look red in green light?
- How do you get an object to appear orange?
- How do other animals see in colour?

Follow up:

Students could design a role play explaining how colour is seen.

They could write a short story about 'The day my cones weren't working'.

4.4 Eye defects

Lesson outcomes

At the end of this activity students will be able to:

- identify eye defects
- determine the lens type that will correct an eye defect.

What ideas might your students already have?

Students might associate glasses with 'being smart'; a loosely linked myth due to straining eyes through reading in dim light.

Key vocabulary

Cornea, aqueous humour, iris, pupil, lens, vitreous humour, retina, optic nerve, rods, cones, bifocal lens, multifocal lens, cataracts, concave, convex, glaucoma, hyperopia (long-sighted or far-sighted), myopia (short-sighted or near-sighted), presbyopia.

Equipment list:

Each STUDENT will require:

- ***Notebook.***
- Internet access.

Things to consider

- Some students may be sensitive about their vision, whereas others may have family stories to share, such as a relative that went blind through German measles etc.
- There is an opportunity to explore globalization and community awareness here through supporting organisations such as the Fred Hollows Foundation (https://www.hollows.org/au/home)
- You may wish to watch the videos as a class and then let students explore the ***Notebook*** activity individually.

Teacher content information:

Our eyes are remarkable organs. They detect the light around us and send signals to the brain, where we interpret the information. The iris allows the pupil to expand and contract depending on light levels and the combination of the cornea and lens focusses the image (due to refraction as media changes). The retina is at the back of the eye and is made of rods and cones. Colour vision was covered in **Activity 4.3**. This activity allows students to revisit their understanding of lenses and their properties.

When a ray of white light is shone through the apex of a glass prism the light disperses and the shorter wavelength violet refracts more than the longer wavelength red. The primary colours red, green and blue can be added to make the following colours:-

- myopia – near sightedness; cornea and lens focus in front of the retina, needs a concave lens to correct.
- hyperopia - far sightedness; cornea and lens focus behind the retina, needs a convex lens to correct.
- presbyopia – age related disorder preventing the lens from changing shape easily, bifocal or multifocal lenses are needed.

- glaucoma – disease where the optic nerve is slowly destroyed. (http://www.glaucoma.org.au/)
- cataracts - cloudiness of the lens.

The answers to the ***Notebook*** tasks are:-

Reading between the lines Vision problems identified and their correction					
Person	Focus at a distance?	Focus at middle distance?	Focus up close?	Lens needed to fix vision	Vision problem
Alf	YES	YES	YES	None	None
Carol	NO	NO	YES	Concave	Myopia
Bob	YES	NO	NO	Convex	Hyperopia
Di	YES	YES	NO	Convex	Hyperopia

1. How does a lens fix each vision problem?

Short sightedness means the light rays focus before the retina. A concave lens will fix this and make the light rays focus on the retina.

Long sightedness means the light rays focus behind the retina. A convex lens will fix this and make the light rays focus on the retina.

2. How can you quickly check if someone has a vision problem?

Test their ability to read an eye chart at different distances.

Lesson plan

Step 1: Introduce the activity by projecting a vision letter chart (e.g. https://en.wikipedia.org/wiki/Snellen_chart#/media/File:Snellen_chart.svg) and asking students for their ideas about its purpose. Have them identify the control variables needed to assess vision.

Step 2: Invite the students to explore the information about eye diseases and follow the onscreen instructions.

Step 3: During the activity encourage students to ***Notebook*** their thoughts and draw diagrams where appropriate.

Step 4: Conclude with a class discussion of their results.

Suggested question/s:

- Why do you get long sighted as you age?
- What are cataracts?
- How do glasses help?

Follow up:

- Homework investigation of family members' eyesight or producing a leaflet on an eye disease.
- Check out the **Find out more** section that explains why goggles help us see under water.