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Light imitates art • Lesson 1 • Do you see what I see?

**Lesson 1**

**Launch**

**Year 5**

**Lesson 1**

**Launch**

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# Lesson overview

This lesson introduces the sequence content—exploring light, how it is transferred, and what happens when its path is interrupted by different objects—and context—how light can be used for artistic, decorative, and celebratory purposes.

## Key learning goals

Students will:

* identify what they think they know about light, how light travels and how it helps people to see.
* recognise that light is used and manipulated by humans for many purposes.

Students will represent their understanding as they:

* represent their current understanding of light using arrows, images and words.
* use arrows to identify the movement of light.
* ask questions about light.

## Assessment advice

In the launch phase, assessment is diagnostic

Take note of:

* students’ ideas about the different aspects of light.
  + See the embedded professional learning [*Students’ conceptions and alternative conceptions* in the Elicit step of this lesson.](https://primaryconnections.org.au/teaching-sequences/year-5/light-imitates-art/lesson-1-do-you-see-what-i-see?utm_source=docx&utm_medium=lesson1&utm_campaign=LIA)

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Materials to create a word wall or class glossary
* Demonstration copy of **My thoughts Resource sheet** and/or**In the dark Resource sheet**
* Demonstration copy of **Creatively light Resource sheet**
* Optional: Gallery of other art works that rely on light, such as those created each year for light festivals such as Vivid, Lightscapes, Illuminate etc. See the embedded professional learning *Adapting to your context—Community Light Festivals* for links to sources where these can be located.
* A darkened room or space and/or a shoe box or similar to create a peek box
* At least one torch. You may have several of varying lumens for demonstration purposes.

**Each student**

* Individual science journal (digital or hard-copy)
* **My thoughts Resource sheet** and/or **In the dark Resource sheet**

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| **Lesson Routine** | **Estimated time** |  |
| Elicit | Variable | Whole class, Individual |
| Experience and empathise | 15 minutes | Whole class, Individual |
| Anchor and Connect | 20 minutes | Whole class |
| Question | 15 minutes | Whole class |

# Launch

## Elicit • What do we think we know?

The following two activities are designed to elicit students’ current ideas about light, including how it helps people to see, how it travels, how shadows are formed, when light might reflect and refract. You might consider doing either or both activities, depending on the needs and experiences of your students.

See the embedded professional learning on *Student conceptions and alternative conceptions*below for specific details about the conceptions addressed in each activity and how student learning is developed over the course of the sequence, to support you to make decisions about which activity to use.

Explain to students that, over the course of the sequence, they will undertake investigations about light, but that before they begin these, they will write and draw to show what they currently think they know about light.

**My thoughts**

Individually, students complete each question on the **My thoughts Resource sheet**. Students cut along the dotted lines, so that each response is separated onto its own slip of paper. Responses can be anonymous, or students can put their name on each slip.

* Remaining anonymous is a good way to elicit prior knowledge in a non-judgemental way. It can encourage students to answer in more detail, as it removes the anxiety of being incorrect.
* Identifying students’ responses allows students the opportunity to compare their responses at the end of the sequence and consider how their ideas have changed.

Determine which approach is most suitable for your students.

Collate each question into separate piles.

Using question 1, *What things give us light?*, model how to sort and categorise responses, highlighting how to use key words and statements that are the same or similar and statements that are similar.

In collaborative teams, students sort and categorise the responses to one of the other questions, grouping together similar responses.   
Divide some/each pile of questions in half to have enough for each team if required.

Teams report back to the class on what they found. Record this in the class science journal.

Reserve the answers for *What things give us light?* to be referred to again in Lesson 2.

**In the dark**

Using the **In the dark Resource sheet**, students respond ‘Yes’, ‘No’, or ‘I’m not sure’ to each statement presented.

Using a demonstration copy of the **In the dark Resource sheet**, create a cumulative tally of student responses in the class science journal.

Where students have given different responses, for example where some have voted that the owl could be seen because it is white and others voted it would not be, discuss each idea and why students might think different things.

Consider inviting individual students to share the reasoning for their decision if appropriate. You might also do this by asking them to record their thinking using words and images in the individual science journals.

NOTE: Students might re-visit this task at the end of the learning sequence, comparing their responses and explaining their ideas.

## Experience and empathise • No light

Design a light deprivation experience for students. You might:

* create a darkened room or space (such as under a blanket-covered table) for students to enter. Ask them to describe what (if anything) they can see around them, how well they can see it, and why they think this is.
* create a ‘peek box’—a box with a small hole cut into the side that contains a small familiar object. It should be designed so that when students place their eye/face against the hole, light cannot enter the box. Ask students to describe what, if anything, they can see inside the box.

A white box with a hole in the middle

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As a class discuss the light deprivation experience.

**Potential discussion prompts**

* *What could you see inside the room/space/box?*
* *How well could you see it?*
* *Why do you think you could not see anything/much?*
* *What would happen if there was no light at all?*
* *What would you need to do so that you would be able to see more clearly/easily?*
  + *Students will likely offer that having light in the room/space/box will help them to see more clearly and easily.*
* *Why do you think the light will help you to see more clearly/easily?*
* *Can you think of any places/experiences that are really dark?*
  + *Late at night, in a cave, in a room with thick curtains and light off, photography dark room, bank vault, underground etc.*

Introduce a light into the dark room/space/box by:

* using a lamp or a large torch.
* giving students an individual torch.
* making another small hole in the box through which you can shine a torch directly into it, and onto the object inside.

Discuss what students can see with an added light source.

**Potential discussion prompts**

* *What could you see once you had a source of light?*
* *How well could you see?*
* *Would more/brighter light help you to see more clearly?*
* *Why do you think that?*
* *How did the light get to the room/space/box? Where did it come from?*

If students mention that they could see shadows formed in the beam of the lamp/torch, pursue this line of questioning further. If not, there is no need to introduce it at this stage.

**Potential discussion prompts**

* *Why do you think you were able to see shadows in the light?*
* *What causes a shadow?*
* *Can we always see shadows?*
* *When can we see/not see them?*
* *Are shadows always the same size? Shape? Definition/darkness?*

## Anchor and Connect • How do humans use light?

Students identify some of the ways/reasons that humans use light. Record these in the class science journal.

Refer to any celebratory or artistic uses of light that students have identified. If none have been identified, **pose the question**: *In what ways to people use light as part of their celebrations? Or creatively/artistically?*

As is appropriate for your context and students, discuss:

* religious and cultural events that use light as a key part of their observance/celebration.
* local light festivals. Many of these are held in cities and regional centres across Australia where artworks, sculptures and light shows are displayed. See the embedded professional learning *Adapting to your context—Community light festivals* for links to sources where these can be located.
* the role that light, shadows, reflections etc. play in illusions such as repeated reflections, fun house mirrors, shadow puppetry etc.

Use one of these examples as a jumping off point for discussions about how light is used as a form of art and celebration.

Show students examples of how light has been used in these instances.

The **Creatively light Resource sheet** provides examples of light, reflection, shadow etc. being used in a creative manner.

You might prefer to create your own gallery of image to suit your school or community context. If so, ensure that the sample encompasses the different aspects of light that will be explored during the unit, including the formation of shadows, reflection of light/reflective surfaces changing the direction light is travelling, filtering wavelengths to ‘alter the colour’ of the light visible.

Discuss the examples viewed, both in terms of what the students might know about the scientific concepts being demonstrated, and the artistic expression of each.

**Potential discussion prompts**

* *Why do you think light is used as a means of celebration? Artistic expression?*
* *Why do people enjoy these events?*
* *What are your experiences at such events?*
* *What can you see in each sculpture/artwork?*
* *Where is the light coming from?*
* *How is it being used in the sculpture/artwork?*

Discuss with students how they will use their learning about light to create their own light sculpture/artwork at the end of the sequence.

Determine who their audience will be to share their designs/artworks and the best mode of sharing them.

## Question • What do we want to know?

## Use the [question formulation technique](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/question-formulation-technique?utm_source=docx&utm_medium=lesson1&utm_campaign=LIA), with the gallery of light sculptures as the stimulus, to support students to generate questions they might want/need the answers to in order to create their own ‘light sculptures’ at the end of the sequence.

## Reflect on the lesson

You might:

* begin a [word wall](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-word-wall?utm_source=docx&utm_medium=lesson1&utm_campaign=LIA) or [glossary](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-glossary?utm_source=docx&utm_medium=lesson1&utm_campaign=LIA) of relevant words and images that students will likely use throughout the sequence.
* begin a [TWLH chart](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-twlh-chart?utm_source=docx&utm_medium=lesson1&utm_campaign=LIA) about light. Use the questions generated using the QFT as the W section of the chart.

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**Year 5**

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Light imitates art • Lesson 2 • How does light help us see?

**Lesson 2**

# Lesson overview

Students identify sources of light and investigate how light is transferred and helps us to see.

## Key learning goals

Students will:

* identify primary sources of light.
* explain how light helps people to see.
* identify that light travels in a straight line.

Students will represent their understanding as they:

* create a data table naming and explaining sources of light.
* categorise sources of light as natural and man-made.
* use arrows to identify the path that light travels.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* students’ identification and categorisation of sources of light. Are they able to identify sources of light? Can they differentiate between natural and man-made light, or light that is being transferred vs another form of energy being transformed into light energy?
* students’ descriptions of how light helps us to see. Have students identified that light comes from a source outside the box to illuminate inside the box? Have they identified that light needs to reach the eye for them to see? Have they identified that light bounces off an object before travelling to the eye?
* students' ray diagrams. Have they used straight lines and arrows to show the direction light was moving? Do they show the light rays bouncing off objects and thus changing direction?

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Materials to add to a word wall or class glossary
* Demonstration copy of **Sources of light** **Resource sheet**(or create your own)
* Shoe box or similar to create a demonstration peek box, or use the one created in lesson 1

**Each group**

* Scissors
* An object small enough to place inside the peek box
* Tape/Blu-tac to secure the item in place
* A torch

**Each student**

* Individual science journal (digital or hard-copy)
* **Sources of light Resource sheet** (or create their own)

SAFETY NOTE: Remind students never to look directly at a source of light, or intentionally shine a light into the eyes of others. This includes torches, the Sun, and laser pointers. Looking directly at sources of bright light can cause permanent and irreversible eye damage.

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Reorient | 5 minutes | Whole class |
| Question | 5 minutes | Whole class |
| Investigate | 15 minutes | Collaborative team |
| Integrate | 15 minutes | Whole class |
| Question | 5 minutes | Whole class |
| Investigate | 15 minutes | Collaborative team, Individual |
| Integrate | 25 minutes | Whole class |

# Inquire

## Re-orient

Review student responses to the question “What things give us light?” from Lesson 1.

## Question • How do we see light?

**Pose the question:** *How do we see light?*

Discuss what happens if we shut our eyes.

**Potential discussion prompts**

* *What do we see when we shut our eyes? Can you see light? Or colour?*
* *What do we see if we are blindfolded?*
* *What do we need our eyes for?*
* *What can we see if our eyes are open but there is no light?*
* *What do we mean when we use the word 'light'? Can it refer to more than one thing?*
  + The word 'light' might be used to describe the source, or things that emit light (turn the light on), the effects (the light is shining on the wall) or as a scientific concept where light is an entity that can travel.
  + Students might also identify other uses of the word 'light', for example as an opposite to heavy, or as a description in relation to colour.

**Pose the question**: *What are sources of light? How might sources of light be categorised?*

## Investigate • What things give us light?

Students work in collaborative teams to identify and record sources of light on the **Sources of light Resource sheet**, as well as three ideas they have about that source of light. They may use examples identified in Lesson 1 or add new ideas to the list. Remind students that, in this instance, we are using the term ‘light’ in terms of things that allow/introduce light into a space or area.

Brainstorm the types of things students might write about in the ideas column, modelling an example to show how they might complete the investigation. See the sample table below for ideas.

## Integrate • Categorising sources of light

Students share the sources of light they identified and the ideas they had about each one. Discuss and record each source of light and related ideas in the class science journal using a demonstration copy of the **Sources of light Resource sheet**.

Create a mind map in the class science journal with sources of light in the centre, and two branches, one titled ‘natural’ and the other ‘artificial’. Discuss the terms, noting that artificial light involves human manipulation in some form. As a class, categorise the sources of light as natural or artificial, recording each source on the mind-map with any relevant accompanying notes.

Discuss how fire could be considered both natural, because it can occur on its own due to natural processes, and artificial, because humans have learned to used specific resources to create fire when they want/need to.

Discuss what students think about the origin of the sources of light.

**Potential discussion prompts**

* *Where do you think the object/source is 'getting its light from'?*
* *Does the object source emit its own light, or is the light coming from somewhere else?*
* *Does the object/source constantly provide light? Can it be switched off or otherwise made to not emit light?*
* *Would it still be a source of light if all other sources were switched off or blocked out?*
* *Could it be a source in the middle of the night?*
* *Is the Moon a source of light?*
* *Is the Moon a source of light in the middle of the day?*
* *Does the Moon emit its own light?*
  + The Moon does 'provide' light when it is dark, but it is not the source of that light. The source of the Moon's light is the Sun. When the Moon can be seen at night, the Sun is on the opposite side of Earth. The Sun’s rays are reflected off the surface of the Moon, illuminating it and providing some light at night.
* *Does the Moon always produce the same amount of light? (New moon vs full moon.)*
  + The position of the moon relative to the Earth and Sun affects how much light can reflect of it. That's why the Moon appears as different shapes/sizes in the sky.
  + A full moon occurs when the largest surface area of the Moon is facing the Sun, and therefore reflecting sunlight off a larger surface. The size of the Moon's surface area lessens each day as the positions of the Sun, Earth and Moon change. This is what causes the appearance of crescent, quarter, gibbous and new moons. A new moon occurs when there is not surface area of the Moon facing the Sun, so it cannot reflect its rays.

NOTE: Students will have explored concepts relating to day and night in Year 2, and will encounter it again in Year 6. It is not necessary at this stage for them to have a full understanding of the relative position of the Sun, Earth and Moon, or the Moon's phases. They simply need to be aware that the Moon is not actually a source of light.

Optional: Categorise the sources of light in other ways, for example, sources where light is its primary purpose, such as a lamp, or light bulb, and sources where light is produced as a secondary outcome, such as a toaster.

Optional: Discuss how light is often accompanied by heat. Students will have learned concepts related to heat energy in Year 3. Introduce that idea that both heat and light are forms of energy. Discuss what students know about energy. This will be revisited later in the lesson, and again in Lesson 4.

## Question • How do I see it?

Explain to students that now they have identified some sources of light, they are going to investigate how light helps us to see. Referring to any similar student questions asked during Lesson 1**, pose the question:***How does light help us to see?*

## Investigate • The path of light

If the peek box was used in Lesson 1, reintroduce it and ask students what to recall when they looked into the viewing window: they could not see any of the objects inside of it until the ‘side door’ was created and light was shone through it.

If the peek box was not used in Lesson 1, introduce a partially completed peek box (with a viewing hole, but no light window) and ask students to predict what they will see when they look in through the viewing hole.

Allow students the opportunity to look into the viewing hole to see if they can see anything inside the box, and describe how well they can see it.

**Potential discussion prompts**

* *Do you think you will be able to see an object that is inside this box? Why? Why not?*
* *What might you do to be able to see it better?*
* *What might you do to see the object better if you could not remove the lid?*

Students work in teams to create their own peek boxes containing an item of their choosing, exploring how peek boxes work and how they might alter the box to be able to see the object inside without removing the lid.

To be able to see the object, students will need to create a hole or ‘light window’ to introduce light into the box. Shining a torch through this light window will illuminate the object inside the box, showing students that it is the light reflecting off the object that helps them to see it.

**Discuss:**

* where the light window might be placed for best results e,g. directly beside or above the object they're trying to see, so the most light will reach it.
* why it would be unsafe to place the light window directly behind the object—this would cause the light from the torch to shine directly into students’ eyes, which is unsafe and can cause eye damage

After creating their peek box in teams, students individually draw a diagram to represent what they did to the box to get light to shine into it. The diagrams should include the source of light and where it is coming from and moving to.

Undertake a gallery walk to share/discuss what students have drawn to show the path of the light from its source to help them to see the object inside the box.

It is likely that some students will use arrows to show the direction they think the light is traveling. Draw attention to this and discuss why they have used lines. Once the use of lines to show the path of light has been established, focus on any diagrams that use arrow heads on those lines to show the direction of light, and establish why this is helpful.

If students have not used arrow heads, then ask if they think the inclusion of arrow heads would be helpful for this diagram and why.

**Potential discussion prompts**

* *Which diagrams showed the movement of light the most clearly?*
* *Why do you think that?*
* *Why do you think arrows can be helpful to show the movement of light?*

## Integrate • Building a shared understanding

Display a pre-prepared, incomplete diagram showing a peek box with its viewing window, light window and an object inside.

A white rectangular object with black text

Description automatically generated

An incomplete peek box diagram.

Through questioning and discussion, determine that the light travels from the torch to the object in the box, then ‘bounces’ off this object towards the viewing window, allowing the object to be seen by the viewer. You could also hold this discussion as part of the gallery walk.

**Potential discussion prompts**

* *When the peek box only had a viewing window, could you see the object inside the box?*
* *Was it easy or difficult to see the object? Could you see the colours or the design on the object?*
* *Why do you think that was happening?*
* *Did adding the light window to the peek box make it easier to see the colours or the designs on the object inside (before you shone the torch in through the light window)?*
* *Why/why not?*
* *What extra details could you see on the object inside the peek box better once you shone the torch in through the light window?*
* *Where was the light traveling to?*
  + *It shone on the object inside the box.*
* *How do you know that?*
  + *The object was lit up really brightly. The light window was at the end of the box where we placed the object.*
* *Did the light get to your eye?*
  + *Yes, but it wasn’t shining at our eye directly, but shining on the object, and bouncing off that object to our eyes.*
* *How did the light help you see the object?*
* *How could we show where the light came from and where it went?*
  + *We used arrows.*

Once consensus has been reached that the light travelled towards the object, then bounced off it and towards our eyes so it could be seen, complete the drawing in the class science journal. Emphasise the use of the arrow heads to accurately show the paths of the light.

A diagram of a light source

Description automatically generated

Work sample of a completed peek box diagram.

Introduce the term ‘ray diagram’ and discuss what they are used for: to show the path and direction that light is travelling.

Students then generalise their understanding (thus deepening it) by drawing a ray diagram to represent how light moves to help us to see other objects, for example how they can see objects lit up by the sun, or by lights in a room.

Ask students what other word they might use to describe the way that light moves when it reaches an object, other than ‘bounces off’. If required introduce the word ‘reflect’, and through discussion determine that this is the best word to describe what happens when light ‘bounces off’ an object.

Further support students to generalise their understanding by making connections to their past learning about the transfer of heat energy, and/or the transfer of energy in a food chain.

**Potential discussion prompts**

* *Have you used arrows to represent the movement of something in a scientific diagram in the past?*
  + Students have likely used diagrams to represent the transfer of heat in Year 3, and may have used them to represent the transfer of energy in a food chain in Year 4.
  + If students are not able to name a past example of using arrows to represent the movement of something in a scientific diagram in the past, you might ask them to consider what happens when they hold a mug/cup of something hot on a cold day, and how they would represent the movement of heat from the warm contents of the mug/cup to their hands, or how they might represent what happens when the heat of their hand melts an ice-cube.
* *Why do you think we use arrows to represent both the movement of light, and the movement of heat (or other form or energy students may have identified)?*
  + Light and heat are both forms of energy, so scientists use the same symbols to represent their movement.
  + Students may not be able to articulate why light and heat are represented by the same symbols, and they are not expected to at this year level. However, you might introduce the idea that light and heat are both forms of energy, and ask students to name other sources of energy they are familiar with. They may identify electricity, batteries, or even food as sources of energy.
* *Scientists use the term ‘transfer’ to describe the movement of light (and other forms of energy). Could you use the word ‘transfer’ to explain how the light was travelling from its source and helping you to see the object in the box?*
* *When people talk about light being transferred, or moving, what terms do they use?*
  + Some examples are shining, glowing, travelling, being emitted etc.

**Optional:** Conduct a gallery walk to examine and discuss these new ray diagrams.

**Optional:**Allow students time to amend their original peek box diagrams as required.

## Reflect on the lesson

You might:

* add new words and images to the [word wall](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-word-wall?utm_source=docx&utm_medium=lesson2&utm_campaign=LIA) or [glossary](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-glossary?utm_source=docx&utm_medium=lesson2&utm_campaign=LIA).
* add to the W and H sections of the [TWLH chart](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-twlh-chart?utm_source=docx&utm_medium=lesson2&utm_campaign=LIA). Students should focus on what they have **L**earned, and link it to the evidence they collected in the lesson that shows **H**ow they know they learned that. For example: *"I learned that* *without light you will not be able to see anything. I proved this when I looked into the peek box before it had a light window. I could not see inside it. But when I added the light window and shone a torch into it, I could see what was inside the box."*
* discuss how the learning from this lesson will be relevant to building their light sculptures/artworks at the end of the sequence, including:
  + sources of light that they can use.
  + considering where they will place the light so it travels in the intended direction and enables viewers to see the elements they have created.

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**Year 5**

**Lesson 1**

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Light imitates art • Lesson 3 • Can we change the direction light is travelling?

**Lesson 3**

# Lesson overview

Students consolidate the idea that light travels in straight lines, and that the direction of light is changed when it hits a reflective surface.

## Key learning goals

Students will:

* recognise that light travels in a straight line, until it is interrupted.
* investigate to find out what happens when light makes contact with a reflective surface.
* identify the properties of a reflective surface.
* identify that the path of light can change direction under specific conditions.

Students will represent their understanding as they:

* contribute to class consensus discussion to explain the evidence collected.
* identify that light travels in a straight line, until it is interrupted by something, in this case a reflective surface.
* draw a ray diagram to show the path that light travels, and how this is altered after it reaches a reflective surface.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* the materials students select to attempt to change the direction of the light beam. Do they immediately identify that reflective surfaces will change the direction light is travelling?
* students’ ray diagrams. Are they able to represent the change in direction of light once it hits a reflective surface? Do their ray diagram include arrows to show the direction the light is travelling before and after it meets the reflective surface?

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Materials to add to a word wall or class glossary
* Demonstration copy of the **Shining light** **Resource sheet**
* Demonstration copy of the **Around the corner Resource sheet**
* Spray bottle filled with water
* Torch
* 2 x sheets of A4 paper, rolled into tubes. Ensure that one tube is slightly smaller in diameter so that the end of one can fit inside the other.

**Each group**

* A small object
* A pile of books or similar to create an obstruction
* Torch
* Access to materials students might test to see if they can change the direction of the beam of light. These materials **must** include reflective surfaces such as mirrors or foil and should also include clear plastic (hard and soft), white paper/cloth etc.
* Safety note
* Remind students never to shine the beam from a torch or other light source directly into their eyes. Light could damage the eye if shone directly or reflected from a very shiny surface into the eye. Encourage students to view light reflecting from a surface or object.

**Each student**

* Individual science journal (digital or hard-copy)
* **Around the corner Resource sheet** (or create their own)

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Reorient | 5 minutes | Whole class |
| Question | 10 minutes | Whole class |
| Investigate and Integrate | 15 minutes | Whole class |
| Question | 5 minutes | Whole class |
| Investigate | 15 minutes | Collaborative teams |
| Integrate | 20 minutes | Whole class |

# Inquire

## Re-orient

Review the activities and the ray diagrams created in the last lesson.

**Potential discussion prompts**

* *Why could we not see the object in the box originally?*
  + There was no light to reflect from the object to our eyes.
* *What did we need to do so that we could see the object in the box?*
  + Let some light into the box to shine on the object and reflect to our eyes.
* *What was the best position for the torch to be in for us to be able to see the object clearly?*
  + Angled toward the object we were trying to see, so it could shine off it.
* *What helps us to see?*
* *What are ray diagrams?*

## Question • Where the light shines

Point a torch at a specific spot in the classroom and ask students to predict where the light from the torch will shine once the torch is turned on. Repeat by pointing the torch in another direction.

Using the **Shining Light Resource sheet**, display the images showing sunlight shining in straight lines, for example through mist in the early morning or through trees in a rainforest. Ask students to describe how the light is depicted.

Pose the question: How can we show that the light is travelling in a straight line?

## Investigate and Integrate • See the rays

Students predict what they think they will see when water is sprayed from a spray bottle into the beam of light being shone from a torch.

With the help of students, darken the room and demonstrate what happens. Discuss.

**Potential discussion prompts**

* *What did you see in the light of the torch?*
  + You can see the water droplets—they shine in the beam of the torch and you can see the beam itself more easily.
* *What does the shape of the beam of light look like? How big is it? Does it stay the same size?*
  + The beam starts out the width of the torch but gets wider and ‘spreads out’ the further away from the torch it gets.
* *Can you see where the beam of light ends?*
  + You can tell where the beam ends because you can see water droplets falling, but they doesn’t shine/sparkle when they're not in the beam of light from the torch.
* *If you had to draw the beam of light coming from the torch, what would you draw?*
* *Where is the light being transferred from and to?*

You might like to ask students to represent this independently. Otherwise, draw a single, agreed-upon representation in the class science journal.

Next, show students a paper tube. Ask them to predict what they think they will observe when a torch is placed at one end of the tube and turned on. Use the P and R sections of a PROE table (Predict, Reason, Observe, Explain) technique to record student predictions and reasoning.

Complete the demonstration, discuss if their predictions were correct, and complete the O and E sections of the PROE.

Insert the end of a second paper tube into the first, taking care to make sure it is straight, to create one long tube. Repeat the prediction and demonstration process described above. Compare what happened with one tube, and when a second one was attached: you should still see light shining out of the end of the tube, the tube will simply be longer.

Finally, manipulate the second tube so that it becomes crooked, and again repeat the prediction/demonstration/comparison process. You will not be able to see light shining from the end of the tube this time, as the light rays will be blocked by the bend in the tube.

**Potential discussion prompts**

* *Could we see the light shining through both tubes in the final demonstration?*
  + No,
* *Why not?*
  + In the final demonstration the second tube was crooked/not straight, so the light couldn’t get through to shine out of the end of the tube.
* *Why couldn’t the light get through?*
  + It was blocked by the bend in the tube.
* *What happens to the light?*
  + It can’t shine straight through anymore, because it is blocked by the paper/cardboard. The light bounces off the paper and back towards the torch.

Jointly construct an explanation to answer the question: *How can we show that the light is travelling in a straight line?*For example, *“When we shine a light through a straight tube, the light can be seen travelling through the tube and shining out the other side. When we add a bend to the tube, the light cannot be seen coming out the other side. This is because the light is travelling in a straight line, it cannot ‘bend’ around the corner/curve created in the bent tube."*

## Question • Can it be bent?

Pose the question: Can we change the direction the beam of light is travelling? How might we do this?

You can relate this to the demonstration by asking students if there was something they could do to the bent tube to make sure the light still shone out the other end.

## Investigate • Around the corner

Using **Around the corner Resource sheet**, students will work in collaborative teams to investigate how they might change the direction of a beam of light.

Show students a diagram or set-up of the investigation, showing a pile of books at the centre, a torch placed near one corner of the pile, and an object near the diagonally opposite corner:

A black and white picture of objects

Description automatically generated

An example to demonstrate to students how to set up the investigation. Note the position of the observer.

Challenge students to get the beam of light around the corner to shine on the object, so that the observer can see the beam of light clearly. Students should set up the investigation on a surface they can draw on, such as a large sheet of paper, or a table (where whiteboard markers can be used and erased).

Turn on the torch and discuss the difference between the ambient light hitting the object, and having the beam of light directed at the object. Observers are aiming to see the direct beam of light hitting the object.

You might allow students to wrestle with this task for a short period before providing prompts. When a group's discussion has become un-productive (i.e., students are no longer discussing ideas and possibilities and have become frustrated) consider providing enabling prompts such as pointing them in the direction of a resource table where there are reflective surfaces, among other objects such as white and coloured paper to choose from.

Alternatively, introduce the resource table immediately.

A yellow arrows pointing to a mirror

Description automatically generatedOnce they have managed to get the beam of light around the corner, students trace the beam of light onto their drawing surface, following it from the torch to the mirror, and then from the mirror to the object, labelling the location of the observer, mirror, object, obstruction, and light ray. This, in effect, creates a ray diagram that represents what they experienced during the investigation. They will return to this diagram after the integrate discussion.

## Integrate • Reflections

Share students’ methods for getting the light to shine around the corner onto the object. Through this discussion determine which surfaces made it easiest to change the direction of the beam of light, and what these surfaces all have in common: the mirrors, foil and, less so, the clear plastic, which are all shiny and smooth.

If students haven’t offered it themselves, introduce the term ‘reflective’ as a way to describe these properties.

Discuss that reflective surfaces allow light to ‘bounce off’ them easily. They are typically smooth and shiny, and we can see ‘reflections’ in them—although sometimes we have to look at them at just the right angle for this to happen.

Discuss the reflective surfaces the students used in the investigation and how easily you can see a reflection in them. For example, a mirror is the most reflective, and you can see your reflection in it easily. The clear plastic needs to be held a certain way for you to see reflections in it. You can see your reflection in the shiny side of the foil, but it is not clear and often looks distorted. The dull side of the foil is less clear, but you can see colours reflected back at you. The reflections are sometimes clearer the closer you get to the foil (you can demonstrate this with your hand).

List other surfaces that might have reflective properties, such as glass and water.

Students return to the ray diagram they created earlier, where they traced the beam of light from the torch to the mirror and then to the object. They measure the angles created by the beam of light coming into the mirror, and the reflected ray coming from the mirror to the object. Compare these two angles and discuss what students notice about them—the two angles should be equivalent.

**Optional:** Explore how mirrors work. See the below embedded professional learning on *Mirrors* for suggestions.

Students draw a ray diagram in their science journals to show the beam of light travelling from the torch, reaching the mirror, reflecting off the mirror and changing directions towards the object. They should include any information on angles if they were measured.

### Reflect on the lesson

You might:

* add new words and images to the [word wall](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-word-wall?utm_source=docx&utm_medium=lesson3&utm_campaign=LIA) or [glossary](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-glossary?utm_source=docx&utm_medium=lesson3&utm_campaign=LIA).
* add to the W and H sections of the [TWLH chart](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-twlh-chart?utm_source=docx&utm_medium=lesson3&utm_campaign=LIA).
* discuss how the learning from this lesson will be relevant to building light sculptures at the end of the sequence:
* It will help students to determine the path the light will take from its source.
* It will help students determine how to change the path of the light to make it go in a direction of their choosing.

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**Year 5**

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| To read the most recent version of this task, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://primaryconnections.org.au/teaching-sequences/year-5/light-imitates-art/lesson-4-what-happens-light-when-it-hits-non-reflective-surface](https://primaryconnections.org.au/teaching-sequences/year-5/light-imitates-art/lesson-4-what-happens-light-when-it-hits-non-reflective-surface?utm_source=docx&utm_medium=lesson4&utm_campaign=LIA) |

Light imitates art • Lesson 4 • What happens to light when it hits a non-reflective surface?

**Lesson 1**

**Lesson 4**

# Lesson overview

Students investigate to find out how light interacts with translucent, transparent and opaque material.

## Key learning goals

Students will:

* identify materials as transparent, translucent or opaque.
* define ‘transparent’, ‘translucent’ and ‘opaque’.
* identify and define shadows, including the umbra and penumbra.
* explain how shadows can change shape and size.

Students will represent their understanding as they:

* categorise materials as transparent, translucent or opaque.
* draw a ray diagram to show the formation of a shadow.
* contribute to discussions to define and explain how shadows are formed and manipulated.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* students’ descriptions and definition of a shadow.
* students’ ray diagrams—are they accurately representing the direction the light is travelling? Do they show the light hitting the object and how a shadow is formed? Have they included arrows to indicate the direction of travel?

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Materials to create a word wall or glossary
* 2 torches
* Demonstration copy of **Passing through Resource sheet**
* Demonstration copy of **I can see the light Resource sheet**
* Demonstration copy of **Shadow masters Resource sheet**
* Objects to create a shadow for demonstration purposes
* Demonstration copy of **Umbra and Penumbra Resource sheet**
* A dark coloured object, such as a piece of black paper/cardboard, a book with a dark coloured cover, etc.

**Each group**

* A selection of materials for students to test, which are:
  + transparent, e.g. cling wrap, certain plastic containers, food wrappings, glass, cellophane
  + translucent, e.g. baking paper, tissues/tissue paper, frosted glass/plastic, sheer fabric
  + and opaque, e.g. most things that can be easily sourced in the classroom, including paper, books, pencil cases, digital devices, erasers, desks
* Torch
* 3 opaque objects, one with straight edges, one with curved edges and one of their choosing (see lesson steps for suggestions)

**Each student**

* Individual science journal (digital or hard-copy)
* **Passing through Resource sheet** (or create their own)
* **Shadow masters Resource sheet**

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Reorient | 5 minutes | Whole class |
| Question | 5 minutes | Whole class |
| Investigate | 15 minutes | Collaborative team |
| Integrate | 15 minutes | Whole class |
| Question | 5 minutes | Whole class |
| Investigate | 20 minutes | Collaborative team, Whole class |
| Integrate | 25 minutes | Whole class |

# Inquire

## Re-orient

## Review the previous lesson. Discuss what happened when the light hit the bend in the tube of paper, what happened when it hit the reflective surface, and how these actions were different.

## Question • How dull!

Note that not all surfaces are reflective and ask students how they might describe the surfaces of other objects (dull, rough, dark, etc.).

Pose the question: What happens when light hits different surfaces? What will it do?

Examine some different materials that are available for students to test.

Students predict if they think the materials will let ‘lots of light’ or ‘some light’ or ‘no light’ through. Ask students to give reasons for their predictions.

Note: It is important to delineate between ‘material’ as what something is made of’, and an object. For example, a window is an object, but the material they are made from is typically glass, with a metal, plastic or wooden frame. Where possible students should be encouraged to list the specific material rather than the object. This is because transparency, translucency and opaqueness are properties of materials and not objects. Students will be familiar with materials and their properties from past learning in chemical sciences in Foundation and Years 2 and 4.

## Investigate • Passing through

In collaborative teams, students use the **Passing through Resource sheet** to record a list of materials they will test and make a prediction as to how much light they think each material will let through.

They shine a light on each material to test it and record their observation by categorising the materials as letting ‘lots of light’, ‘some light’ or ‘no light’ through.

## Integrate • Transparent, translucent or opaque?

Share results as a class, grouping together materials according to how much light they let through.

Allow students to name each category.

If students do not offer them, introduce the terms (without definitions) ‘transparent’, ‘translucent’ and ‘opaque’. Ask students if they have heard these terms before, what they know about them, and which they would attach to each category.

Ask students if they can describe how clearly you can see objects through transparent, translucent and opaque materials.

Introduce the definitions for each of the above terms, and compare them to the students’ ideas:

Transparent: Light is transferred through the material in a straight line. You can see what is on the other side of the material clearly.

Translucent: Light is scattered as it travels through the material. Some light may be absorbed. You can see some things that are on the other side of the material, but they are not clear. Materials can have different 'levels' of translucence.

Opaque: Light cannot travel though the material. The path of the light will be blocked and a shadow will be formed. You cannot see through the material.

If groups have categorised the same materials differently, discuss how/why they made different decisions. Discuss if, when and why categorising the items differently might cause problems, and how scientists might go about ensuring that this doesn't happen: Scientists use/design and build specialised equipment and agree on universal standards to make sure that results are fair and not subject to personal opinions or ideas. For example, a light meter measures the amount of light in ‘lux’ units, and is an impartial, fair and accurate way to determine levels of light.

Record the names of the materials on a demonstration copy of the **I can see the light Resource sheet**. Invite students to name other materials/objects that could be added to each category. If required, discuss the material/object and reach a class consensus over which category it belongs in before adding it to the resource sheet.

## Question • Absorbing ideas

Focus on the list of opaque objects, and pose the question: What happens when light hits an opaque object?

Students share their ideas and predictions, based on the experience they have just had shining light on materials that have been classified as opaque.

## Investigate • Forming shadows

Explore students’ ideas and predictions and demonstrate what happens by shining a light on an opaque object so that a shadow is formed.

Once students have identified the shadow, explain that they are going to further explore shadows in the following investigation.

Using a demonstration copy of the **Shadow masters Resource sheet**, discuss:

What does a shadow look like (shape, colour)?

Will the shadow always be the same on any surface?

Does the shape of the object make a difference?

Does the edge of the object (straight, curved, soft, translucent) make a difference?

Discuss the objects the students might select to make shadows with: one with straight edges, one with curved edges, and one of their choosing. This third object might have soft edges, include opaque and transparent materials, have holes in it, or have movable parts.

Students select one object to draw ray diagrams (with arrows) to show the shadows that are formed.

Allow students time to complete their observations in collaborative teams, recording their observations and drawing their ray diagrams individually.

**Optional:** Students see if they can manipulate the shapes from the shadows into something else, for example manipulating a circle into a love heart, or outlining a shadow and adding lines and features to make it appear like an animal. Explore the work of Vincent Bal at the [Vincent Bal Shadowology YouTube channel](https://www.youtube.com/@Vincent_Bal/featured) for inspiration.

## Integrate • Light and heat energy

Before beginning the Integrate discussion, set up a torch so that it is shining directly onto an opaque object—something dark, like a black piece of paper, will work most effectively. Focus as much of the beam of light as possible directly onto the paper, so that no (or very little) shadow is formed. Leave the torch switched on for the duration of the discussion, so that the object warms up. Draw students’ attention to what you have set up (without explaining why), informing them you will come back to it as the last part of the discussion.

Share and discuss what happened during the **Shadow masters** investigation.

**Potential discussion prompts**

* *What happened when you shone the light from the torch onto an opaque object?*
  + *A shadow was formed.*
* *What is a shadow?*
  + *A dark area behind an object.*
* *Why is it dark behind the object?*
  + *Because the light is blocked by the object, so the light can’t get behind it. Light passing the edges of the object defines the dark part.*
* *Can you explain what is happening?*
* *Can you change the shape of a shadow? How?*
* *How did the shape of the object affect the shadow?*
* *What was the third object you chose? Why did you choose that? What kind of shadow did it make? What was interesting about its shadow?*
* *Can we see any detail in the shadow (the colour or any patterns)?*
* *Is a shadow completely black?*
  + *No, not always. Sometimes a shadow has a dark section, and a lighter section.*
  + *Why do you think that is?*
* *Do you think transparent or translucent objects/materials will cast shadows? Why do you think that?*

Create a shadow using an object and asks students to describe what they observe or notice about the shadow formed. If necessary guide them to notice the ‘umbra’ (the inner darker part of a shadow) and ‘penumbra’ (the lighter part of a shadow)—using an object with lots of edges, protuberances or moving parts will create the best results. Also experiment with the angle of the light source before the demonstration to see which casts the most effective shadow for this purpose.

Discuss with students why they think that some parts of the shadow are lighter/darker.

Introduce the terms ‘umbra’ and ‘penumbra’, show students a diagram representing the phenomenon (as seen below), either using the demonstration copy of **Umbra and Penumbra Resource sheet** or drawing your own relevant to the object you are using to create the shadow.

A diagram of a ball and a ball

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A diagram demonstrating the umbra and penumbra of a shadow.

Allow students time and opportunity to discuss what the diagram is representing.

As required, prompt students with questions and comments to reach the conclusion that, because the light from a broad/wide/large source is travelling in more than one direction/angle, the main shadow (umbra) is formed where all light is blocked, and a second shadow (penumbra) is formed around the edges where only some of the light is blocked.

Draw students’ attention back to the beam of light you focused on the opaque object at the start of the discussion and discuss what is happening.

**Potential discussion prompts**

* *Where is the light shining?*
* *What is happening to the light as it hits the object/paper? Is a shadow being formed?*
  + No, because the beam of light is not wide enough to ‘get around’ the object/paper in order to make a shadow.
* *So, what is happening to the light? Where is it going?*
  + Students might express that the light is disappearing, or ‘going into’ the paper. This is acceptable at this point.

Turn off the torch and ask some students to feel the section of the paper that the beam of light was directed at. You will need to do this quickly, as the heat generated will rapidly begin to dissipate. Discuss.

**Potential discussion prompts**

* *What does the paper feel like where the beam of light had been shining?*
  + It was warm to the touch.
* *What do you think was happening?*
  + The light made the paper warm. The light turned into heat.
* *Scientists use the word ‘transfer’/‘transferred’ to describe what is happening when one form of energy turns into another. In this case, light turning into heat. Could you use the words transform/transformed to describe what happened to the light as it hit the paper?*

Through prompting and discussion, support students to come up with an explanation about what is happening in terms of the transformation of energy when light is absorbed by an opaque material.

**Potential discussion prompts**

* *Where does the light go when it hits an opaque material?*
  + The light can't get through the material, so it goes into the material, gets "soaked up", "sucked in", or absorbed.
    - Note that students might use everyday language to describe what happens. This language should be accepted as it will help students to understand what is happening, and then connected with the correct scientific terminology: being absorbed.
  + As the light is absorbed it turns into heat energy.
* If students have already learned about particles of materials in Year 5 Chemical sciences: *What do you think is happening to the particles that make up the opaque material? How are they behaving?*
  + The particles are vibrating faster and more strongly—that's why the material feels hotter.
* *Is light "hot"? If you held your hand in front of a torch would it feel warm straight away, or take some time to feel warm?*
  + When you hold your hand in front of the beam of a torch it doesn't feel hot, but if you left your hand there for a while it would eventually become warm. More light energy is absorbed and transformed into heat energy. This is why you feel hotter the longer you stand in the sun.
* *Why do you think that is?*
  + Visible light itself is not hot but is transformed into heat as it is absorbed. This is why you can put your hand in front of the beam of a torch and not feel heat, but if you left your hand there for a while it would eventually become warm then hot as more light energy is absorbed and transformed into heat energy.
* *Why do you think I chose to use a dark-coloured material for this demonstration?*
  + Dark colours get hotter more quickly.
* *Why would dark colours get hotter more quickly?*
  + They absorb more light, so there is more light energy to transform into heat energy. Light colours reflect more light, so there is less light energy being absorbed to turn into heat?
* *Where/when would you have to think about this in real life?*

Discuss other applications of this phenomenon—for example, light bulbs getting hotter the longer they are turned on. You might also discuss problems this might create and solutions that have been/could be designed for it, with a focus on safety considerations. For example, workers using torches for long periods would have to take care the top of the torch doesn't get too hot and burn them. Stage actors can also become hot under stage lights.

If students need to make corrections or add additional details to the ray diagrams drawn on their **Shadow masters Resource sheet**, allow them time to do this.

### Reflect on the lesson

You might:

* add new words and images to the [word wall](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-word-wall?utm_source=docx&utm_medium=lesson4&utm_campaign=LIA) or [glossary](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-glossary?utm_source=docx&utm_medium=lesson4&utm_campaign=LIA).
* add to the W and H sections of the [TWLH chart](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-twlh-chart?utm_source=docx&utm_medium=lesson4&utm_campaign=LIA).
* discuss how the learning from this lesson will be relevant to building light sculptures at the end of the sequence, including:
  + consideration of the materials students are using in their sculpture, how much light it will let through, and the shadows that will be formed.
  + the shapes of the shadows the sculpture might create.
  + the umbra and penumbra of the shadows.
  + how students might have to consider how the transformation of light into heat might impact their designs. Focus specifically on safety considerations here.

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**Year 5**

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| To read the most recent version of this task, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://primaryconnections.org.au/teaching-sequences/year-5/light-imitates-art/lesson-5-how-can-i-make-shadow-shorter-or-taller](https://primaryconnections.org.au/teaching-sequences/year-5/light-imitates-art/lesson-5-how-can-i-make-shadow-shorter-or-taller?utm_source=docx&utm_medium=lesson5&utm_campaign=LIA) |

Light imitates art • Lesson 5 • How can I make a shadow shorter or taller?

**Lesson 5**

# Lesson overview

Students consolidate the idea that the direction, angle and proximity of a light source to an object will affect the shadow that is formed.

## Key learning goals

Students will:

* plan, conduct and analyse the data collected in a fair-test investigation.
* make claims about how the proximity of a light source can affect the height of a shadow.
* make generalisations about other ways they might change the size and shape of shadows.

Students will represent their understanding as they:

* use equipment to measure and record their data.
* construct and use ray diagrams, and tables to describe the change in shadow length.
* communicate their understanding of their fair test investigation.

## Assessment advice

In this lesson, assessment is summative.

Students working at the achievement standard (science inquiry) should have:

* posed an investigable question.
* planned and conducted a repeatable investigation to answer this question.
* used equipment to observe, measure and record data with reasonable precision.
* constructed appropriate representations of this data, including a data table and graph.
* analysed the data to identify patterns.
* made a claim based on the data/evidence to answer their question.
* communicated their claim/s and evidence clearly.
* compared their methods and findings with others, determining sources of possible error, and where their claims correlate with those of others.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://primaryconnections.org.au/teaching-sequences/year-5/light-imitates-art?tabIndex=2) for further information.

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Materials to create a word wall or glossary
* Demonstration copy of the **Variables grid Resource sheet**
* Demonstration copy of the **Shadow height investigation planner Resource sheet**

**Each group**

* Grid paper marked at 0.5cm (preferably) or 1cm intervals to use as a measurement screen to measure the height of the shadow

OR

* Ruler or tape measure, to measure the height of the shadow, if the measurement screen above is not provided
* An easily moveable small object that will cast a defined shadow, for example a glue stick
* Torch
* Ruler or tape measure, to measure the distance of the object from where the first shadow is cast, and the increasing/decreasing 5cm intervals before casting a new shadow

**Each student**

* Individual science journal (digital or hard-copy)
* **Shadow height investigation planner Resource sheet** (or create their own)

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Reorient | 5 minutes | Whole class |
| Question | 10 minutes | Whole class |
| Investigate | 20 minutes | Collaborative team, Whole class |
| Integrate | 20 minutes | Whole class |

# Inquire

## Re-orient

Review the previous lessons and discuss what students have learned about shadows.

**Potential discussion prompts**

* *What is a shadow?*
* *How can you make a shadow?*
* *Why do shadows change in size?*
* *Are shadows always the same size as the object that makes them? Why or why not?*
* *Why can’t you see your face in a shadow?*

## Question • Shadow shapes

**Pose the question:***How can I make a shadow taller? Shorter? Wider? Thinner?*

Brainstorm student ideas and record them in the class science journal.

## Investigate • Changing shadows

Show students a transparent plastic bottle with a balloon, inflated to have an approximately 15 cm circumference, fitted over the opening.

Explain that in this investigation students will investigate what things affect the height of a shadow, and use the evidence they collect to make generalisations about how they can change the size and shape of a shadow.

Starting with the broad question “What things might affect the height of a shadow?” brainstorm potential variables using the **Variables grid Resource sheet.** Some examples of potential variables are:

* the distance from the light source to the object.
* the distance from the object to anything behind it.
* the angle of the torch.
* the height of the object.
* how powerful the light source is.

Model how to write a specific question for investigation using the question stem beneath the variables grid, selecting one variable to change (controlled variable), one way to measure the outcome of changing that variable (in this case the height of the shadow), and noting that for a test to be fair everything else must stay the same.

If your students are experienced and confident in conducting fair-test investigations you might allow them to select their own variable to change and create their own investigable question. For example: What happens to the height of a shadow when we change the angle of the beam of light shone on it? Alternatively, the class can all agree on a single question to investigate, e.g. What happens to the height of a shadow when I change the distance between the light source and the object?

If allowing students to select their own variables to change, be aware that each team will then need to undertake the investigation in a slightly different way.

Discuss fair testing principles, including why it is essential to only change one variable and leave everything else the same: to ensure that we find out the impact changing a specific variable has on the outcome. If multiple variables are changed there is no way of knowing which one made the impact and to what degree.

In collaborative teams, students plan and conduct a fair-test investigation to answer their question, using a small object that creates a defined shadow. They measure the height of the shadow cast against a measurement screen or wall, change their specific variable (for example, moving the torch closer/further to the object at 5cm intervals) and measure the new shadow's height.

Discuss how the students will record shadow height, such as by using a measuring screen placed against a wall behind the glue stick, or measuring the shadow with a ruler or tape measure. Discuss the potential for inaccurate measurements.

A group of objects on a surface

Description automatically generated

A demonstration of an investigation answering the question *What happens to the height of a shadow when I change the distance between the light source and the object?*

## Integrate • Discussing results

Using the [QCER framework](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/facilitating-evidence-based-discussions?utm_source=docx&utm_medium=lesson5&utm_campaign=LIA) as a guide, invite each team to share the results.

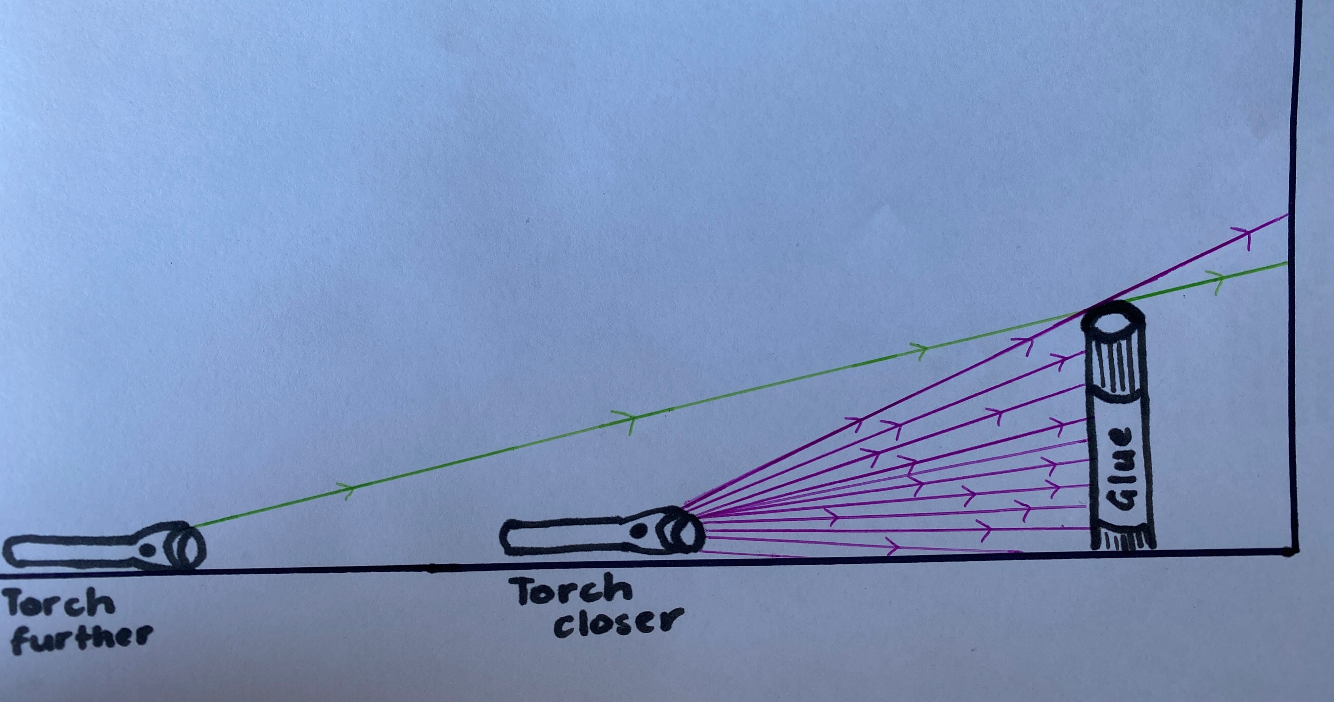
Reiterate the question that each team has answered and the variables they have tested.

Invite teams to make a claim to answer the question, using their evidence from their data tables and graphs to support their claim. For the example students might answer the question *What happens to the height of a shadow when I change the distance between the light source and the object?,*by saying*"the closer the light source is to the glue stick, the taller the shadow will be."*

Consider how much support your students will need to complete the Reasoning section of QCER, and if required, complete this step together, using discussion and ray diagrams to support students.

A ray diagram can be drawn to show that, when the light source is closer to the object, the rays of light travel past its edges at a much steeper angle, causing the shadow to be taller.

The further away from the object the light source is, the lesser the angle and shorter the shadow.



Work sample showing a ray diagram that demonstrates the change in shadow height as the light source is moved.

Support students to generalise what they have learned about changing shadow height into other ways they might change the shape of a shadow.

**Potential discussion prompts**

* *If shadows are taller when the light source is closer, how would we describe them when the light source is further away?*
  + The shadows are shorter/short.
* *When did the shadow have the most clear and defined edge? When the torch was closer or further away?*
  + The shadow was much more defined when the light source was further away. When it was closer the edges of the shadow were more 'fuzzy' and less defined.
* *When we moved the light source further away and the shadow got shorter, did it also make it wider? Did you notice that in your investigation?*
  + Model this again if students did not make observations of this during their investigation.
  + When the torch was closer/shadow was taller it was also a little bit wider than when the torch was further away and the shadow was more defined. The difference wasn't really big though?
* *Where might you position the light source to make a really wide shadow? Why do you think that?*
  + There are several suggestions that students might make in response to this. Consider testing out their suggestions as a demonstration, using what is learned from each test to inform where you might position the light source next.
  + The shape and size of the object used to demonstrate will also impact what happens, so consider using different sized/shaped objects during the demonstration.

Students complete the explaining and evaluating results section of their **Shadow height investigation planner Resource sheet.**

#### Reflect on the lesson

You might:

* add new words and images to the [word wall](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-word-wall?utm_source=docx&utm_medium=lesson5&utm_campaign=LIA) or [glossary](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-glossary?utm_source=docx&utm_medium=lesson5&utm_campaign=LIA).
* add to the W and H sections of the [TWLH chart](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-twlh-chart?utm_source=docx&utm_medium=lesson5&utm_campaign=LIA).
* ask students to articulate exactly how they can make a shadow taller or shorter. Discuss how this might apply to making a shadow thinner, wider or a different shape.
* discuss how the learning from this lesson will be relevant to building their light sculptures at the end of the sequence: manipulating shadows to create desired shapes and sizes.

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**Year 5**

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| To read the most recent version of this task, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://primaryconnections.org.au/teaching-sequences/year-5/light-imitates-art/lesson-6-does-light-travel-through-water](https://primaryconnections.org.au/teaching-sequences/year-5/light-imitates-art/lesson-6-does-light-travel-through-water?utm_source=docx&utm_medium=lesson6&utm_campaign=LIA) |

Light imitates art • Lesson 6 • Does light travel through water?

**Lesson 6**

# Lesson overview

Students investigate to find out what happens when light travels through a substance other than air, in this case, water.

## Key learning goals

Students will:

* explain what an object look likes when it is observed through water.
* gather evidence to explain the scientific phenomenon of refraction.
* determine which explanation of the scientific phenomenon of refraction best suits the evidence they have collected.

Students will represent their understanding as they:

* draw diagrams of objects viewed through water.
* contribute to class discussions about refraction.
* write and draw labelled diagrams to explain their investigation results.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* students’ observations regarding what happens as the beam of light meets the plastic cup and water. Are they able to identify that the path of light changes as it is transferred through different transparent material other than air, such as water?
* students’ analysis of evidence. Are they able to determine which scientific explanation their evidence supports?

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Materials to create a word wall
* Optional: Demonstration copy of **Line of light investigation planner Resource sheet**
* Demonstration copy of **Exposing the illusion Resource sheet**

**Each student**

* Clear plastic cup, preferably with no ripples or patterns on it
* Pencil
* Access to water
* Piece of card, approximately 20cm x 20cm
* Ruler
* Scissors
* Torch

**Each student**

* Individual science journal (digital or hard-copy)
* **Line of light investigation planner Resource sheet**

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Reorient | 5 minutes | Whole class |
| Question | 10 minutes | Whole class |
| Investigate | 10 minutes | Collaborative team |
| Integrate | 10 minutes | Whole class |
| Question | 5 minutes | Whole class |
| Investigate | 15 minutes | Collaborative team |
| Integrate | 20 minutes | Whole class, Individual |

# Inquire

## Re-orient

## Revise what students learned in Lesson 4, focusing on transparent materials.

## Question • Seeing it through

Discuss what students think they know about two very common transparent substances: water and plastic.

**Potential discussion prompts**

* *How would you describe something that is transparent?*
* *Can you always see through plastic clearly? Why? Why not?*
* *What types of plastic can you see through?*
* *What types of plastic can you not see through?*
* *Can you always see through water clearly? Why? Why not?*
* *What happens when you try to look at something through plastic or water? What do you see?*

Refer to any questions students might have asked during the course of the sequence about plastic or water.

**Pose the question:**What do we see when we look through ‘clear’ plastic? Or ‘clear’ water?

## Investigate • A view through water

Students work in collaborative learning teams to investigate what happens to a pencil when it is viewed:

* through an empty clear plastic cup.
* through a plastic cup that is ¾ full with water.

One student holds the pencil behind the cup and moves it so that students can view the pencil:

* in the middle of the cup.
* at each side of the cup, noting what happens while the pencil moves from side to side.
* as it is brought closer and moved further away from the cup.

Teams record their observations as labelled diagrams in their science journals.

## Integrate • What did you observe?

Share student observations.

**Potential discussion prompts**

* *What did you observe before water was added?*
* *What did you observe after water was added?*
* *What happened when you viewed the pencil directly behind the container?*
  + *It was magnified.*
* *Can you think of some other objects that magnify?*
  + *Eye glasses, magnifying glass, telescope.*
* *What happened when you viewed the pencil through the curved edge of the container?*
  + *It disappeared.*
* *Why do you think that happened?*

Record students’ observations and ideas in the class science journal.

## Question • How does light travel through water?

Review what students have learned about light, how it travels and how it helps us to see.

Discuss with students: *If light helps us to see objects, then what is happening to the light rays in the water before they reach our eyes to make the bottom of the pencil disappear?*

**Pose the question:***What happens to light when it travels through water?*

## Investigate • Light through water investigation

Demonstrate how to cut a small slit, approximately 2-3mm wide, in a piece of card. Then demonstrate how this slit in the card can be used to focus the beam/ray of light, making it easier to follow.

Discuss what is meant by the term ‘bird’s eye view’: to view something from above.

Using the **Line of light investigation planner Resource sheet,**students work in collaborative teams to investigate what happens when a beam of light travels through water. In this investigation students will focus the light ray using the slit in the card, then:

* shine the light ray through an empty glass.
* shine the light ray through a glass that is 3/4 full with water.
* draw a labelled ray diagram, from a bird's eye view, to illustrate their observations.

Students should not complete the *Explaining results* section of the sheet at this stage—this will be done at the end of the Integrate step of this lesson.

## Integrate • What happened?

Using the [QCER framework](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/facilitating-evidence-based-discussions?utm_source=docx&utm_medium=lesson6&utm_campaign=LIA) as a guide, invite each team to share their results. Reiterate the question that each team has answered: What happens to light when travels through water? Teams share their observations and possible explanations for what happened.

Using a demonstration copy of the **Exposing the illusion Resource sheet**, introduce the three claims and the accompanying ray diagrams that potentially explain what happened to the beam of light as it travelled through the water:

1. The light is reflected by the glass and does not reach my eyes.
2. The light reflected by the pencil bends when it goes from air to water and does not reach my eyes.
   * This is the most accurate explanation. Read the accompanying professional learning Refraction of light through water for further explanation.
3. The light reflected by the pencil gets trapped inside the glass and does not reach my eyes.

Discuss each claim with students and determine which claim they think is best supported by the evidence they collected. Record this claim in the class science journal.

Introduce the term ‘refraction’ as the scientific term to explain what is happening when light travels through water. Explain that light travels at different speeds as it is transferred through different transparent materials such as air, water and plastic. As the light changes its speed where the two materials meet, it changes the angle which the light travels.

Students revisit their **Line of light investigation planner Resource sheet** and complete the explaining results section.

#### Reflect on the lesson

You might:

* add new words and images to the [word wall](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-word-wall?utm_source=docx&utm_medium=lesson6&utm_campaign=LIA) or [glossary](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-glossary?utm_source=docx&utm_medium=lesson6&utm_campaign=LIA).
* add to the W and H sections of the [TWLH chart](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-twlh-chart?utm_source=docx&utm_medium=lesson6&utm_campaign=LIA).
* discuss how the learning from this lesson will be relevant to building their light sculptures at the end of the sequence. If parts of their sculpture will be viewed through transparent materials other than air, what impact might this have?
* **Optional low tech:** Use a ‘fishing rod’ made of string with a magnet attached to catch metal weights in the bottom of a bucket of water. The refraction (bending) of light can mean the fish appear closer to the person than they really are. If the person is directly above the bucket, then the difference is less noticeable.

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**Year 5**

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| To read the most recent version of this task, download associated resources, and view embedded professional learning including classroom videos and work samples, visit: [https://primaryconnections.org.au/teaching-sequences/year-5/light-imitates-art/lesson-7-what-colour-light](https://primaryconnections.org.au/teaching-sequences/year-5/light-imitates-art/lesson-7-what-colour-light?utm_source=docx&utm_medium=lesson7&utm_campaign=LIA) |

Light imitates art • Lesson 7 • What colour is light?

**Lesson 7**

# Lesson overview

Students investigate the primary colours of light and what happens when these colours are combined.

## Key learning goals

Students will:

* explore what happens when they combine different colours of light.
* identify the colours that are made when different colours are combined.
* explain that light is made up of different colours that, when combined, make ‘white’ light as it appears to humans.

Students will represent their understanding as they:

* create ray diagrams showing shadows created by different colours of light.
* contribute to consensus building discussions about the colours of light.
* explain the formation of shadows by different colours of light.

## Assessment advice

In this lesson, assessment is formative.

Feedback might focus on:

* how students describe the formation of the shadows cast by their light, and the colours created when mixing the light beams.
* how students apply their understanding of the umbra and penumbra to describe what is happening when the coloured shadows are created.

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Materials to create a word wall
* Optional: Demonstration copy of **Mixing colours Resource sheet**
* Optional: A glass prism
* Optional: A torch

**Each group**

* A small amount of red, blue and green paints
* 3 x torches, each with the lens coloured (1 x blue, 1 x red, 1 x green). (See notes [in list of materials](https://primaryconnections.org.au/teaching-sequences/year-5/light-imitates-art?utm_source=docx&utm_medium=lesson7&utm_campaign=LIA) for advice)

If you do not have enough torches available for three per group, the investigation can be done on a rotational basis alongside a supplementary investigation. There are three options for this supplementary investigation, for which you will need the following resources. See lesson for description of each investigation.

**Optional for supplementary investigation—option 1**

* Sticky tape
* 3 x mirrors

**Optional for supplementary investigation—option 2**

* 3 x pieces of cardboard
* 3 x pieces of foil large enough to cover the pieces of cardboard
* Glue

**Optional for supplementary investigation—option 3**

* Access to view the [Simple Science: DIY Kaleidoscope](https://www.youtube.com/watch?v=KK4lNtewhFU&t=139s) YouTube video
* Cardboard tube
* Mirror paper or aluminium foil
* Ruler
* Scissors
* Cardboard circle, about 10cm in diameter, or a compass or items to trace to make a circle
* Coloured textas

**Each student**

* Individual science journal (digital or hard-copy)
* **Mixing colours Resource sheet** (or create their own)

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Reorient | 5 minutes | Whole class |
| Question | 10 minutes | Whole class |
| Investigate | 20 minutes | Collaborative teams |
| Investigate (supplementary) | 20 minutes | Collaborative teams |
| Integrate | 25 minutes | Whole class |

# Inquire

## Re-orient

Review the definition of refraction, and the agreed-upon claim about what happens as light travels through water from the previous lesson.

## Question • Mixing colours

Ask students how they might describe the colour of light. Prompt them to consider how light ‘lights up’ the classroom, and what it looks like when we look at a ‘concentrated beam’ of light, like when we shine a torch onto our hand, or when they focused the beam/ray of light through the slit in the cardboard in the previous lesson.

Ask students to describe any experiences or observations of light being a different/specific colour, and how they think that happened (e.g. coloured light bulbs, rainbows after a storm, rainbows when light reflects off water or glass).

Next discuss what students know about mixing colours, for example when painting. Ask students how different colours are made.

**Optional:** Discuss primary and secondary colours and the colour wheel.

**Pose the question:** Does mixing different coloured lights make the same colours as mixing different coloured paints?

## Investigate • Colours of light

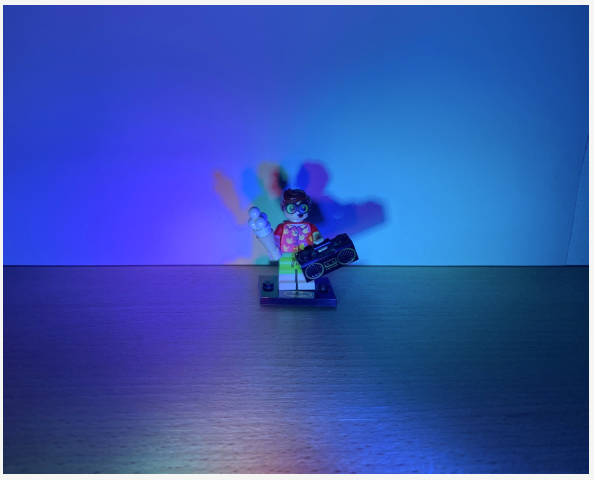
If you do not have enough torches available for three per group, student groups can rotate between this investigation and the supplementary investigation below.

Using a demonstration copy of the **Mixing colours Resource sheet** explain and discuss the steps of the following investigation as required.

Students work in collaborative teams to investigate what colours are made when they mix different combinations of red, blue and green paint, including when they mix all three colours together.

Students then combine different combinations of red, blue and green light. Using the 3 torches with coloured lenses, they shine each colour onto a white wall (or a white piece of paper affixed to the wall), merging the colours of light in each combination and recording the colour that is made, including when all three colours are merged.

Finally, students place a small object in the merged beam from all three torches and record what the shadow looks like using drawings, descriptions and/or photographs. Using an object with lots of edges, protuberances or moving parts will create the best results.

The main part of the shadow, the umbra, will be dark with no colour. However the lighter part of the shadow, the penumbra, will show different colours, including colours that are not being emitted by the torches such as yellow. The objects edges and protuberances will ensure that a penumbra (or multiple penumbra) will be seen, providing students with a more detailed experience of the phenomenon. Read the embedded professional learning The colours of light for more information.

An example of how the shadows created might look.

## Investigate • Kaleidoscope

This supplementary investigation can be omitted, along with any related questions in the following Integrate routine. However, it is a worthwhile inclusion as students may wish to explore kaleidoscopes as part of their final sculpture/artwork.

In this investigation students further explore reflections by making a simple kaleidoscope. They can do this individually or in teams, depending on available resources.

Three methods students can use to build kaleidoscopes:

* Connect three mirrors of the same size using sticky tape to tape the edges together to create a triangular prism shape, with the reflective surfaces facing inwards.
* Use three pieces of card covered with aluminium foil to replicate the reflective surfaces of the mirrors.
* Create the more advanced, yet still easily constructed kaleidoscope demonstrated in the [Simple Science: DIY Kaleidoscope](https://www.youtube.com/watch?v=KK4lNtewhFU) YouTube video.

## Integrate • Discussing results

Share and discuss students’ results of the investigation on the mixing of different coloured lights.

**Potential discussion prompts**

* *What colours did you make when you mixed the different paint combinations?*
* *What colours did you make when you mixed the different light combinations?*
* *Where the colours the same?*
* *What did the shadow look like when you mixed the light beams?*
* *How where the different from the other shadows we have investigated?*
  + *A part of the shadow (or the umbra) was black, but some parts (the penumbra) were different colours.*
* *Why do you think this happened?*
  + *Where the three colours of the light were mixed together the light looked white, and the shadow was black. In the parts where only two of the colours were mixed together, or the coloured beam of light was not mixed with another, the shadows were different colours.*
* *Could you make yellow when you mixed the paints?*
  + *No, yellow is a primary colour in terms of pigment, and cannot be made by mixing different coloured paints/crayons etc.*
* *Could you see yellow when you mixed the different light combinations?*
  + *Yes, yellow can clearly be seen between the green and the red, particularly when the shadow is created by placing an object in the mixed beams of light.*
* *What does this tell you about the primary colours of pigment (paint, dye etc.) and the primary colours of light?*
  + *The primary colours of light are red, blue and green. They combine in different ways to make the colours we can see in a rainbow for example. The colours of pigment are different—they are blue, red and yellow. To make yellow light we combine red and green. But you can’t make yellow paint the same way.*
* *What are some objects that we use every day that rely on the combination of light?*
  + *Televisions, computers, mobile phones etc. The screens on these devices use combinations of pixels of light to create the colours that make images on the screen.*
* *What did you see when you looked through your kaleidoscope?*
* *How do you think a kaleidoscope works?*
* *Why might we decide to add more folds to the foil/mirror paper?*
* *What would happen if we added more folds to the foil/mirror paper?*

Shine the beam of a torch through a glass triangular prism. Alternatively, if you don't have a glass triangular prism available, watch [a video of this being demonstrated](https://www.youtube.com/watch?v=9eEyTw4wylk).

Through questioning, draw out students’ observations, including the colour of the light before it hits the prism, what happens as the light travels through the prism, and the colours that can be seen.

Allow students time to complete the final section of their **Mixing colours Resource sheet**, explaining what is happening when the coloured shadows are created.

#### Reflect on the lesson

You might:

* add new words and images to the [word wall](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-word-wall?utm_source=docx&utm_medium=lesson7&utm_campaign=LIA) or [glossary](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-glossary?utm_source=docx&utm_medium=lesson7&utm_campaign=LIA).
* add to the W and H sections of the [TWLH chart](https://primaryconnections.org.au/pedagogical-tools/learning-through-inquiry-tools/using-twlh-chart?utm_source=docx&utm_medium=lesson7&utm_campaign=LIA).
* discuss how the learning from this lesson will be relevant to building their light sculptures at the end of the sequence:
  + How might they consider colour when designing their sculptures?
  + How could they change the colours people see? The colours of the shadows cast?

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**Year 5**

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Light imitates art • Lesson 8 • Designing a light artwork

**Lesson 8**

# Lesson overview

Students apply their understanding of light, reflection, the creation of shadows, refractions and the colour spectrum of light, to design (and potentially make) a sculpture or artwork utilising one or more of these aspects.

## Key learning goals

Students will:

* design, and potentially create, an artwork that features reflection or refraction of light, shadows, and different colours.
* explain the aspects of light they have utilised or manipulated to create their artwork.

Students will represent their understanding as they:

* draw diagrams of their designed artwork.
* label the source of light, the direction light travels, and the shadows formed in these diagrams.
* communicate their understanding of how light was used and manipulated in their design.

## Assessment advice

In the Act phase, assessment is summative.

Students working at the achievement standard should have:

* demonstrated an understanding that light needs a source. Evidence might include:
  + drawings of light travelling in a straight line (with arrows).
  + labelled diagrams identifying how shadows are formed.
  + labelled diagrams of light being reflected.
  + labelled diagrams of light being refracted.
  + labelled diagrams of coloured light being combined to form white light.
* described how individuals and communities use scientific knowledge.

Refer to the [Australian Curriculum content links on the Our design decisions tab](https://primaryconnections.org.au/teaching-sequences/year-5/light-imitates-art?tabIndex=2) for further information.

## List of materials

**Whole class**

* Class science journal (digital or hard-copy)
* Optional: Demonstration copy of the **Creatively light Resource sheet**

**Each student**

* Individual science journal (digital or hard-copy)
* Various sources of light suitable to use in a classroom
* Various transparent, translucent or opaque materials
* Other materials as required to design/build a light sculpture/artwork such as glue, sticky tape, blu-tac, scissors etc.

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| **Lesson Routine** | **Estimated time** | **Task type** |
| Anchor | 15 minutes | Whole class |
| Connect | 15 minutes | Whole class |
| Design | Variable | Whole class, Individual |
| Communicate | Variable | Whole class, Individual |

# Act

## Anchor • What have we learned?

Review the learning that has occurred over the course of the sequence using the class science journal,

including concepts relating to:

* sources of light
* how light helps us to see
* shadows
* how light interacts with translucent, transparent and opaque materials
* refraction
* light and colours

## Connect • Sculpture review

Review the light sculptures/artworks that students viewed in Lesson 1, either by viewing the **Creatively light Resource sheet**, or the collection of images selected for your specific context.

Discuss how these sculptures have been created, and how light has been utilized in each, particularly in light of what students have learned over the course of the sequence

## Design • Designing/making a sculpture/artwork

### Students will design, and potentially create an artwork that utilises light and the aspects students have learned during the course of the sequence.

### Define

Outline the task in a simple manner such as:

How can we design a piece of art that utilises/manipulates light coming from a source that an audience would enjoy looking at?

### Ideate

Brainstorm ideas related to the design of the artwork.

At this stage, to support creative thinking, every idea offered by students should be recorded in the class science journal. No idea is discounted, as the practicality/possibility of each idea will be considered later.

As students offer ideas, ask probing questions (What aspect of light that we have learned about are you utilising there? or How does that rely on light?) to draw out how students are applying their understanding of the aspects of light they have learned about.

Determine the criteria for how students’ light sculptures might demonstrate the scientific concepts explored during the sequence. For example:

* Shadows of different lengths, shapes and sizes are created by varying the distance from and angle of the light source.
* The direction that light is travelling in changed by the use of reflective surfaces.
* Light is diffused through translucent materials.
* Light travels through transparent material.
* Light travels through a coloured transparent material, blocking some coloured wavelengths, and allowing others.

### Prototype

Determine if students are going to build prototypes of their sculptures, or simply design them.

If students build a prototype this will influence what they are able to design, as they need to be able to replicate it in a classroom environment. However, it could be helpful if students still need to consolidate their understanding and test ideas as they are creating.

Designing the sculpture only imposes fewer limitations, but can be more challenging as students are required to express their understanding in an abstract manner. Teacher judgement should be used to determine which approach is best for your students.

You might also consider designing a combined sculpture, with an accompanying proposal to the school community, principal or parent organisation advocating for its construction.

Allow teams/students time to design/build their artworks.

All works should require at least an accompanying labelled diagram identifying the main source of light, its location/s, the direction/s the light is travelling in, as well as any changes in direction of light, shadows formed, any refraction of light, or use of colour.

Students might also include an explanation of how they manipulated shadows, colours, or utilised different transparent materials in their artworks.

**Optional:**Students/teams are provided opportunities to share their ideas and receive peer feedback ([download AITSL's guide for more on peer feedback](https://www.aitsl.edu.au/docs/default-source/feedback/aitsl-peer-feedback-stratedy.pdf)).

## Communicate • Sharing communications

### Test and share

Students share their artworks with a chosen audience. The audience may include other students in the school, an evening art/science fair, or a local artist.

You might consider using the [CROWN tool](https://primaryconnections.org.au/crown?utm_source=docx&utm_medium=lesson8&utm_campaign=LIA) to support students in this.

Students should be encouraged to prepare questions to ask this audience that tests the possibility of their design, for example if talking to a local artist they might ask questions about cost, space and safety.

They should also be prepared for any possible questions the audience may ask them about how they created the work, the science concepts on display, or how they felt about it.

#### Reflect on the sequence

You might:

* refer to the list of student questions asked in Lesson 1. Determine which questions have been answered over the course of the learning sequence, what the ‘answers’ to the questions are, and the evidence that supports these claims. Address questions that have not been answered during the learning sequence, discuss why they might not have been addresses and potential investigations that might support students to answer them.
* review students’ responses to the **My thoughts** and/or **In the dark** activities completed in Lesson 1, comparing students’ initial ideas to what they think now and considering how their thinking has changed.
* consider what students have learnt about light.
* ask students to represent this learning in words, symbols and pictures.
* discuss why it’s important to have a good understanding of light transfer: what kinds of jobs would require you to understand this? What about in your everyday life? What tasks that you do around the house involve light transfer? What activities might be affected?