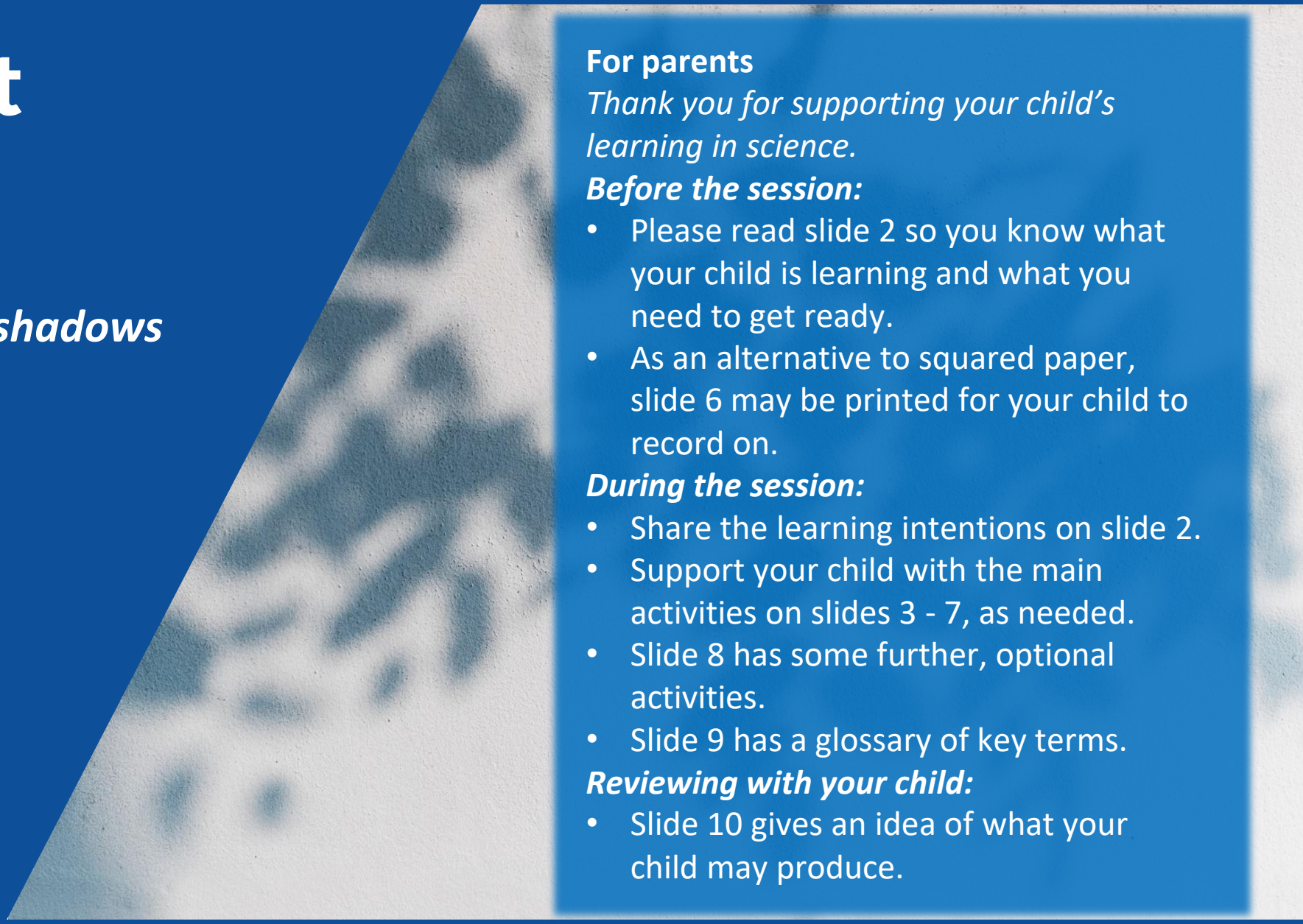
Year 6: Light

Making and measuring shadows

Year 6
Age 10-11



For parents

Thank you for supporting your child's learning in science.

Before the session:

- Please read slide 2 so you know what your child is learning and what you need to get ready.
- As an alternative to squared paper, slide 6 may be printed for your child to record on.

During the session:

- Share the learning intentions on slide 2.
- Support your child with the main activities on slides 3 - 7, as needed.
- Slide 8 has some further, optional activities.
- Slide 9 has a glossary of key terms.

Reviewing with your child:

- Slide 10 gives an idea of what your child may produce.

The Association for Science Education

Light

Making and measuring shadows

Key Learning

- The idea that light travels in straight lines explains why **shadows** have the same shape as the **objects** that cast them.
- That the size of a shadow depends on the relative position of the light source and the object.

I can…

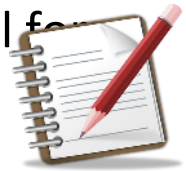
- record my measurements in a table.
- plot a line graph showing how the size of an objects shadow depends on the distance between the light source and the object.

Activities (pages 3-7): 40 - 60 mins

Household items to support learning:

- a torch/desk lamp
- a tape measure/ruler
- a dinner fork
- masking tape/blu tack
- an empty plastic bottle

Use squared paper, a ruler and a pencil for recording. *Alternatively you may wish to print page 6 as a worksheet.*



Find out more… (page 8)

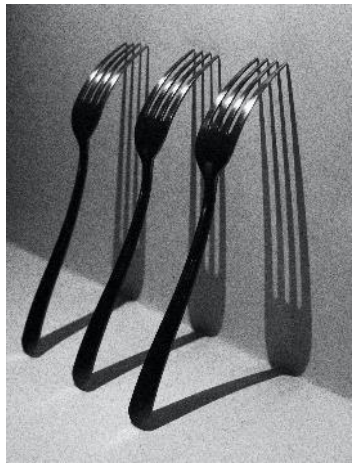
- You may like to watch some great clips, find out more about shadows and how to make a shadow theatre yourself.

Explore, review, think, talk...

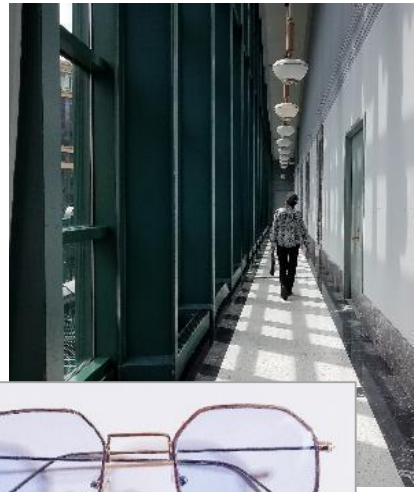
What do you already know about shadows?

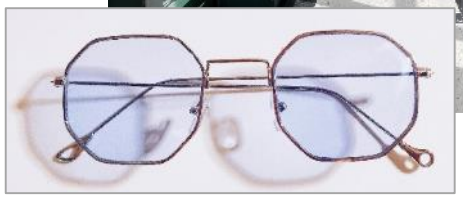
(5-10 minutes)

Think and talk about these shadows…



- What's needed to make a **shadow**?
- Where are the shadows seen?
- Are they the same shape and colour as the object that produced them?
- How do shadows from **opaque**, **transparent** and **translucent** objects compare?
- What changes the size of shadows?





Explore, review, think, talk...

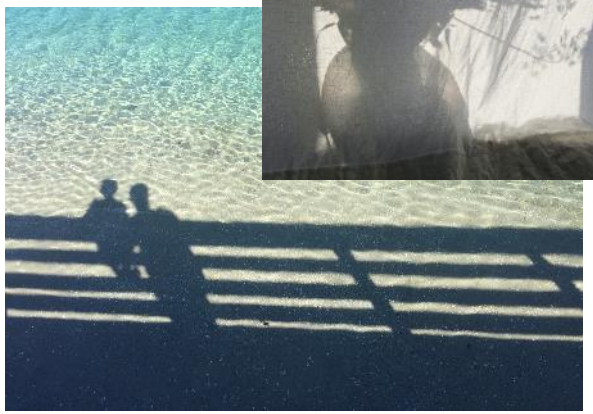
Where and how are shadows made?

(5-10 minutes)

- A **shadow** is the dark area made when an **object** blocks the straight-line path between a **light source** and something acting as a **screen**.
- Because light travels in straight lines, the shape of the shadow is the same as the object's outline as seen from the location of the light source. This sometimes seems stretched or squashed compared to what we see, as our viewpoint is different!
- Shadows made by **opaque** objects are darkest. **Translucent** objects cast paler shadows and they can show the object's colours (or changes in its thickness). *Completely* **transparent** objects make *no* shadows.

For these pictures, think and discuss:

- What are the **objects**?
- What are the **light sources**?
- What is the **screen** made of in each case?



- Watch this BBC clip about shadows

www.youtube.com/watch?v=3Mv4qa5c0q8

Investigating the size of shadows

Measuring the size of a shadow as you change the distance of the object from the light source

(20-30 minutes)

1. Fix a blank sheet of paper to a wall using masking tape or blu tack.
2. Place your fork (the **object**) in the top of the water bottle and position this about 20cm in front of the wall.

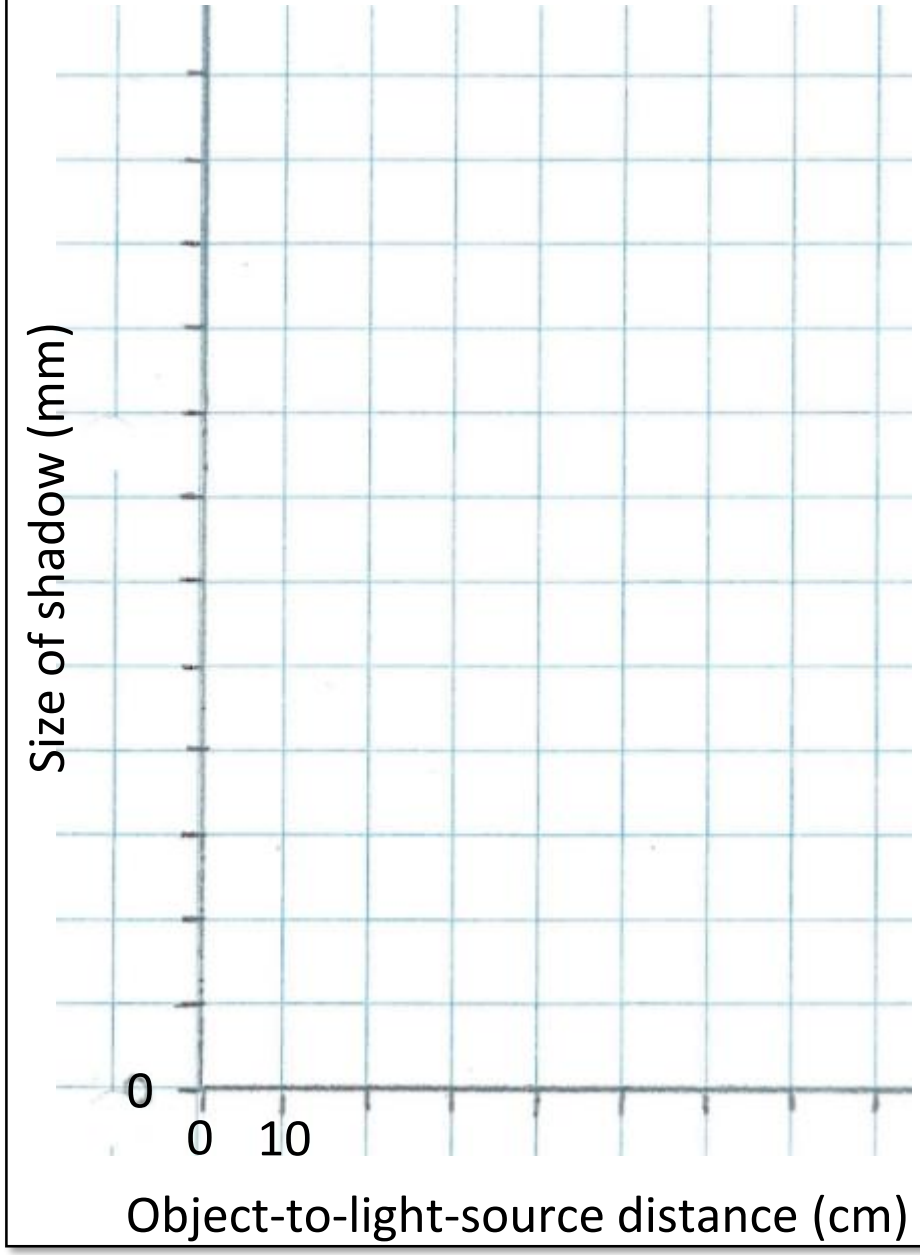
3. Support your torch at the height of the fork, to cast a shadow directly behind it onto the paper.
4. Darken your room, if possible.
5. Position your torch 80cm away from your object.
6. Draw the length/width of the fork (or one of its prongs), on the paper and note, above this, the distance between the object and light source.

7. Move your light source closer to the object in 10cm steps, marking the shadow size each time on your paper.
8. After your 10cm take an additional reading at 5cm, then remove your paper and measure the size of each drawn shadow in mm.
9. Record the light-source-to-object distances and their shadow sizes in a table of results and plot a line graph (see page 7).

I can record my measurements in a table

Distance between object & lamp (cm)	Size of shadow (mm)

I can plot a line graph showing how the size of an object's shadow depends on the distance between the light source and the object



My answers to the page 7 questions:

As the distance between the **object** and the **light source** decreases, ...

_____

_____

I also noticed that …

_____

_____

I kept the distance between **object** and **screen** the same because …

_____

_____

I _____ get exactly the same results because…

_____

_____

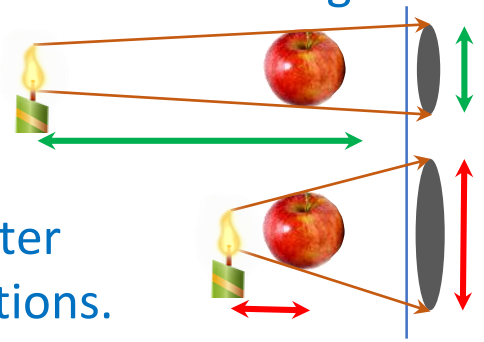
Think and talk about your findings...

What exactly did you observe and why?

(10 minutes)

- Draw a **line of best fit** for your data and describe the pattern you see in your results.
- Did you observe any other differences in the shadow?
- Why do you need to keep the distance between the **object** and the **screen** the same?
- Repeat some of your measurements (20, 40, 60, 80 cm) and see if you get the same results. If not, why not?
- If you want to, you could carry out a second related experiment, where you keep the distance between the light source and the object the same and move them closer to the screen. (You might find a tray helps with this.)

- The size of the object's **shadow** increases as the distance between the **light source** and the **object** decreases. This is because light travels in **straight lines**, so objects closer to the light source block light travelling in a greater range of different directions.



- As a wide light source moves towards an object, the shadow's edges become less sharp (as it actually consists of overlapping shadows due to different parts of the light source).
- We only change one **variable** in a **fair test**.
- It is tricky to measure with 100% accuracy.

Find out more...

Explore more about shadows and how they are used

(Optional)

- Watch this clip of the 2013 Britain's Got Talent winner 'Attraction'. Think or talk about how you would explain to one of the judges how, in the last scene, two dancers of about the same height can appear as a small girl and her much larger mother.
  www.youtube.com/watch?v=a4Fv98jttYA&t=1s

Image courtesy of: Britain's Got Talent
www.youtube.com/watch?v=a4Fv98jttYA&t=1s

- Watch this clip about making hand shadows and how shadows are used.
  www.youtube.com/watch?v=ss9FAdhX4mI
- Watch this BBC clip about shadow puppets.
  www.bbc.co.uk/bitesize/clips/z87jmp3

- You may like to try making a shadow puppet theatre using a cardboard box, greaseproof paper, a lamp and some simple characters cut out of card.
  Ask a responsible adult to help cut out the hole for the translucent screen for shadows to be cast onto.
  www.carlemuseum.org/blogs/making-art/copy-paper-box-shadow-puppet-theater

Glossary of terms

fair test: A **fair test** is an enquiry (to answer a scientific question) in which all except one variable is kept the same (controlled).

line of best fit: A **line of best fit** is a curved or straight line that best describes the pattern that the graph data show. It is not a dot-to-dot, and in fact it does not need to go through any of the data points, provided it goes as close to as many as possible.

light source: A **light source** emits (gives out) light.

object: A shadow is seen when an **object** blocks light from a surface.

opaque: **Opaque** materials/objects block all light.

screen: A **screen** is a surface on which a shadow is seen.

shadow: A **shadow** is a dark area caused by blocking light from reaching a surface or screen.

transparent: **Transparent** materials look clear, as all light passes through them.

translucent: **Translucent** materials look cloudy, as they only let some light through.

variable: A **variable** is something (a factor) that we either change or decide not to change in an experiment. In a fair test we only change one variable.

Possible learning outcome for reviewing your work:

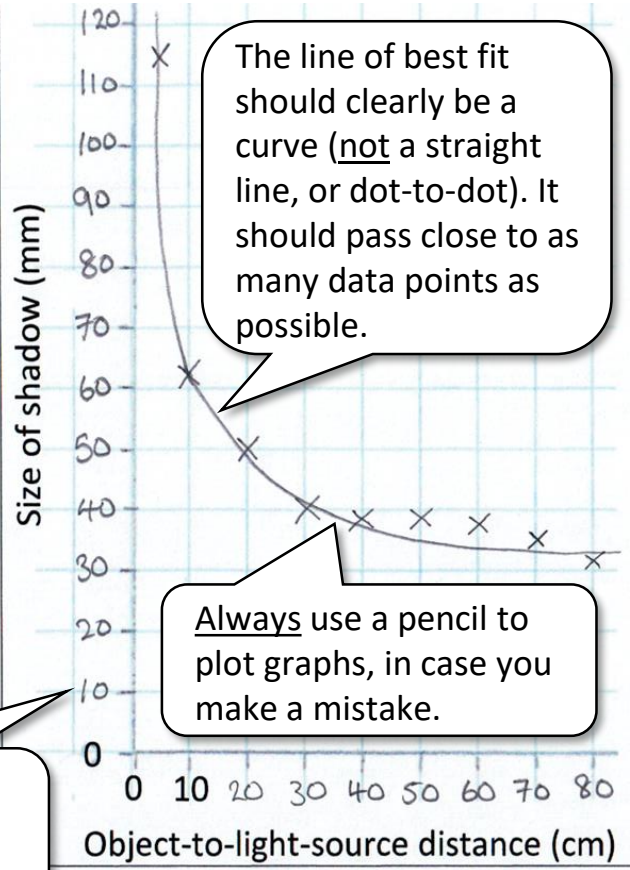
I can record my measurements in a table

I can plot a line graph showing how the size of an objects shadow depends on the distance between the light source and the object

Your rows of results should only have numbers (not units), since the units are shown in the header line so they apply to all rows of the table.

This extra measurement at 5cm distance was valuable, since the size of the shadow had changed a lot over the last two readings (even though the shadow was blurry, so it was tricky to take an accurate measurement).

Distance between object & lamp (cm)	Size of shadow (mm)
80	31
70	36
60	38
50	39
40	39
30	40
20	50
10	61
5	115



The line of best fit should clearly be a curve (<u>not</u> a straight line, or dot-to-dot). It should pass close to as many data points as possible.

<u>Always</u> use a pencil to plot graphs, in case you make a mistake.

Your graph scales should always go up by a fixed amount between each evenly-spaced mark.

My answers to the page 7 questions:

As the distance between the **object** and the **light source** decreases, ...

the size of the shadow increases.

I also noticed that ...

the shadow got blurry as the torch got closer.

I kept the distance between **object** and **screen** the same because ...

the experiment wouldn't be a fair test otherwise.

I do not get exactly the same results because...

it is hard to measure the blurry shadow.

The graph shows that as the x-variable on the graph increases, the y-variable gets decreases.

In a fair test, only one variable is changed and the effect of this is measured. If we changed lots of things, it would be tricky to see which caused an effect.

Experimental results are usually not exactly the same when repeat readings are taken, even if you work really carefully.