

# Phizzi enquiry



## Shadows

**Target audience:** Year 3 (lower KS2) **Enquiry type:** fair test

**Science curriculum links:** light and working scientifically



### Big idea for pupils

Light travels in straight lines from a light source. Some materials let all the light through, we call them transparent. Some materials block all the light, we call them opaque. When an object blocks the light from a light source, a shadow is formed. The shadow is the area which light from the light source cannot reach.

### Prior learning

### New learning

### Future learning

#### Physics knowledge development

- To observe that some materials let light through and some do not.

- To recognise that shadows are formed when the light from a light source is blocked by a solid object.
- To find patterns in the way that the size of shadows change.

- To recognise that light appears to travel in straight lines.
- To use the idea that light travels in straight lines to explain why shadows have the same shape as the objects that cast them.

#### Working scientifically skills development

- To observe closely.
- To use observations and ideas to suggest answers to questions.

- To set up simple fair tests.
- To record findings using simple scientific language, labelled diagrams and tables.
- To use results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions.

- To take measurements, with increasing accuracy and precision, taking repeat readings when appropriate.
- To record data and results of increasing complexity using scientific diagrams and labels and line graphs.

#### Mastery of subject specific vocabulary

dark, light, material, block, bright, dim, shiny, source

shadow, opaque, transparent, translucent, object, length, height, straight lines, source

waves, transverse, luminous, illuminates, emit, emitting, radiation, transmission, scattering, absorption, medium

### English

- Write an email to the shadow theatre company telling them about your experiment and explaining how to make the giant's shadow as large as possible.
- Write a script for a shadow puppet show to re-tell a familiar tale or nursery rhyme.

### Maths

- Measure the size of shadows and distances between the object and the shadow.
- Record data in tables and plot line graphs.

## Big question

What can you do to make the shadow created by a shadow puppet as large as possible?

## Context

A shadow theatre company is creating a production of Jack and the Beanstalk. There is a giant in the story, and they need to know how to make the biggest shadow possible from the small puppet of a giant that they already have.

## Background science for teachers

Light travels in straight lines. When light hits an opaque object it is blocked and the area behind the object becomes dark. This is called a shadow. Totally transparent objects (like clean windows) do not create shadows because light passes straight through them. Opaque objects make shadows. The size of the shadow depends on the distance between the object and the surface on which it appears. If the screen is moved further from the object, the shadow gets bigger. We can draw a diagram showing light rays as lines that come from a light source, with arrows showing the direction in which the light is travelling. This can help us explain and predict the position of shadows.

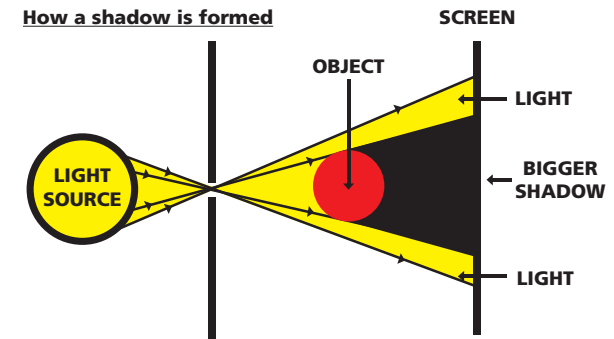
## Method

1. Children draw the design for their shadow puppet on black card and then carefully cut it out. The cut-out shape is then stuck to a lolly stick with tape to make the shadow puppet.
2. Groups are given equipment including a torch, a mini whiteboard, a tape measure and a ruler. Children are challenged to create a test to find out what factors affect the size of a shadow. They decide which one variable they will change (eg the distance between the torch and the puppet or the distance between the puppet and the screen), they decide which variable they will measure (the width or the height of the shadow) and which variables to control (size of the puppet and distance between torch and puppet or distance between puppet and screen).
3. In a darkened room, groups collaborate to systematically change their chosen variable and make measurements, collecting at least five sets of data. Children record their measurements in a table as they carry out their test.
4. Children analyse their data to find out what factors affect the size of the puppet shadow.

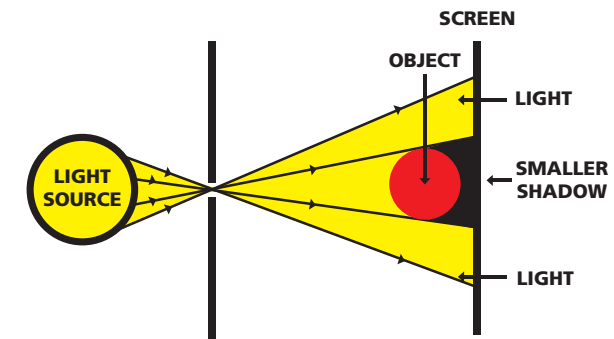
## Equipment

- Lolly sticks
- Black card
- Torch (LED light source)
- Scissors (not provided)
- Rulers/tape measures (not provided)
- Mini whiteboard (not provided)

How a shadow is formed



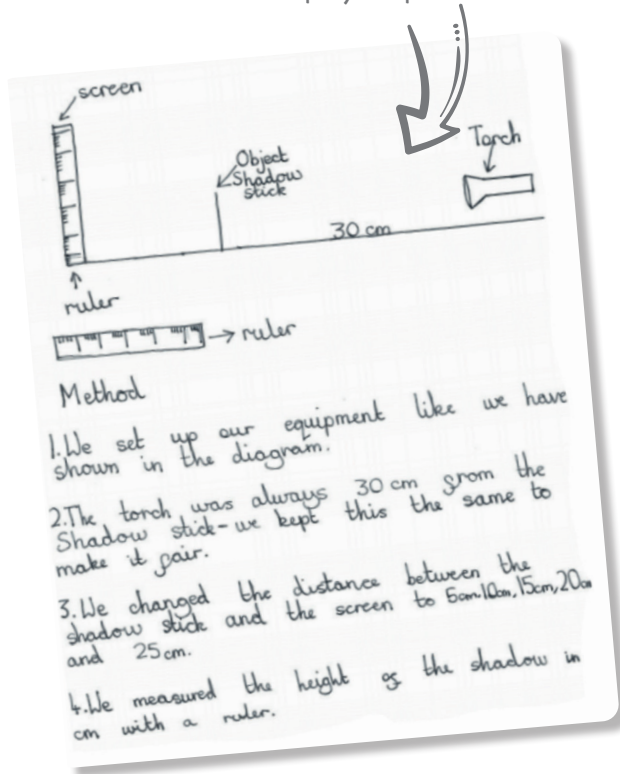
Object closer to the screen



## Safety tips

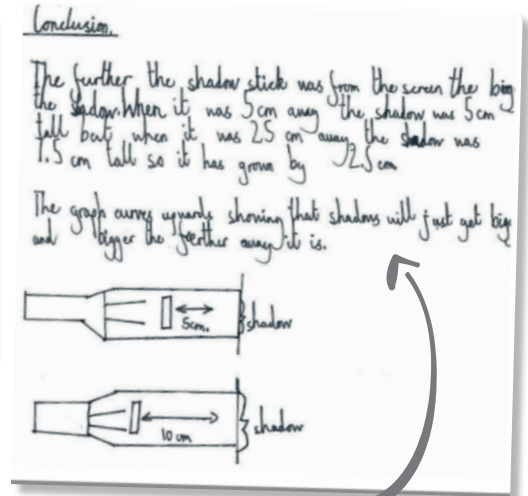
Guidelines on the safe use of scissors in the classroom can be found on the CLEAPSS website. This enquiry takes place in a darkened room, extra care will be needed to avoid tripping accidents.

This is an ideal enquiry for children to plan their own method to explore the factors that affect the size of shadows. They can share their ideas by drawing a diagram of their simple test and writing a simple method to describe how to carry out their test, step by step.



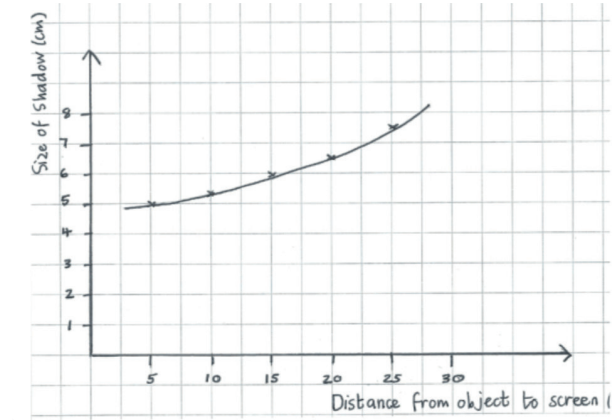
Distance from object to the screen (cm)	Size of Shadow (cm)			
	Test 1	Test 2	Test 3	Average
5 cm	5 cm	5 cm	5 cm	5 cm
10 cm	5.6 cm	5.3 cm	5.1 cm	5.3 cm
15 cm	6.5 cm	5.9 cm	5.6 cm	6 cm
20 cm	6.9 cm	6.5 cm	6.1 cm	6.5 cm
25 cm	7.4 cm	7.5 cm	7.7 cm	7.5 cm

Children can design their own results table to record their measurements, remembering to include column headings with units for the variable they are changing and the variable they are measuring.



Children answer the big question in the form of a conclusion, clearly explaining how their data helped them come up with this conclusion.

Children can plot their data on pre-prepared axes to help them identify trends in their measurements.



### Links to everyday life

There are many real-life examples of shadows and their changing sizes. Sticking with the creative theme, children could explore shadow hand puppets, trash sculptures by Tim Noble and Sue Webster and shadows in paintings such as de Chirico's work or 'Night Shadows' by Edward Hopper. Other familiar examples include a parasol, a sundial and, on a much larger scale, eclipses. This resource is supported by a collection of Royal Society Brian Cox videos.

### Notes for teachers

Sharing a video of shadow theatre company Attraction on Britain's Got Talent is a fantastic introduction to this enquiry. This enquiry is useful for developing children's skills in measuring carefully. Circulate while children are carrying out their enquiry, asking prompt questions to encourage them to think about how to measure carefully.



## Remembering

- Q. What happens to the size of the shadow when you move the puppet further from the screen?  
Q. Was the shadow equally dark all over? Q. What variables did you keep the same to make your investigation fair?



## Understanding

- Q. Why did the shadow form?  
Q. Why did the size of the shadow change?  
Q. How would you describe the material that you made the shadow stick with? Was it transparent, translucent or opaque?



## Applying

- Q. Can you use the results of your investigation to explain how to change the size of a character during a shadow theatre show?  
Q. How could you use your hands to make a huge shadow on the bedroom wall using a bedside light as the light source?

## Analysing

- Q. What pattern can you see linking the size of the shadow to the distance from the screen?  
Did you repeat your readings? What was the advantage of doing this?



- A. The further the puppet is from the screen, the longer the shadow. The closer the puppet to the light source, the longer the shadow. When we repeat measurements, we can spot odd results. This can help us to improve our method so that we don't get odd results in the future.

## Evaluating

- Q. Can you describe any problems that you encountered when doing the investigation?



A. Children's own answers may include:

- Keeping the torch, shadow puppet and/or screen in the same place.
- Deciding where to measure the shadow because the edges were blurred.
- The shadow being larger than the screen.

Use prompt questions to encourage pupils to discuss how they might solve these problems.



## Creating

- Design some puppets that could be used to tell your favourite story in a shadow theatre show.  
Design a puppet that has eyes that show up as bright areas on the screen.  
Practise and perform a hand shadow show using the classroom data projector as a light source.