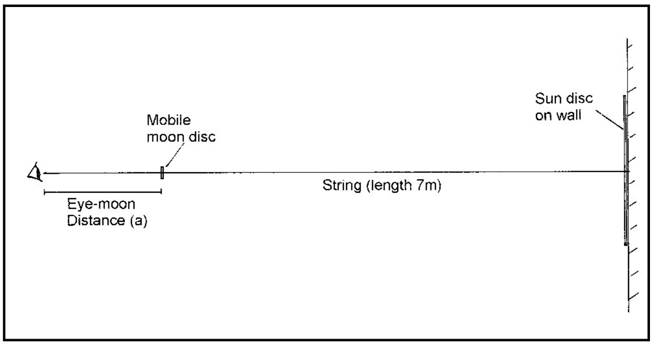
Why does the Sun disappear?
Demonstrate what happens when the Moon hides the Sun

Solar eclipse - image from NASA website
http://eclipse.gsfc.nasa.gov/eclipse.html

This activity demonstrates how a small object, which is near, can block out the view of a much larger one that is further away. Do you think the Sun and the Moon often appear to be the same size in the sky? In fact, they are not the same size at all and yet the Moon can block out the Sun completely, so that it goes quite dark. This is called a total eclipse of the Sun (or a solar eclipse).

We can use a straightforward calculation, based on what happens during a solar eclipse, to work out the size of the Sun (its diameter). In this activity, we are showing how it can be done, using cardboard models, so you will only find the diameter of the model sun. The same principle is used to find the diameter of the real Sun.

Ask the pupils to do the following:-
- Attach a 7m (700cm) string through the hole in the centre of the disc representing the Sun, as shown in the photo.
- Hold the disc representing the Sun against a wall.
- Thread the disc representing the Moon on to the string.
- Hold the end of the string to your eye and view the disc representing the Sun - as in the diagram below.
- Ask someone to move the Moon along the string until it completely covers (obscures) the Sun



- Measure the distance from your eye to the Moon in cm (d) and the Moon's diameter (M)
- Now calculate the Sun's diameter using this formula:

Moon's diameter = M (cm)
Moon to eye distance = d (cm)
Sun's diameter = S (cm)
Sun to eye distance = 700cm

$$\frac{M}{d} = \frac{S}{700}$$

$$S = \frac{M \times 700}{d}$$

- Check your answer by measuring the diameter of the disc representing the Sun with a tape measure or ruler.

Finally, demonstrate how a solar eclipse works, when the moon hides the Sun, by blocking out the view of somebody's head with your thumb. In this 'model', what represents the Sun?; what represents the moon?; what represents your eye?
Answers: somebody's head; your thumb; your eye.

Using the 'Moon' to block out the 'Sun'
Photo: Peter Kennett

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The back up:

Title: Why does the Sun disappear?

Subtitle: Demonstrate what happens when the Moon hides the Sun

Topic: This activity can be carried out when investigating our Solar system. It compares the relative sizes and positions of the Moon and the Sun in relation to the Earth.

Age range of pupils: 12 - 18 years

Time needed to complete activity: 20 minutes.

Pupil learning outcomes: Pupils can:
- appreciate that the Sun and the Moon are of vastly different sizes even though, when they appear in the sky together, they seem to be of comparable diameter;
- explain that a small object that is near the Earth can block out a much larger object that is much further away;
- do simple calculations to work out the model Sun's diameter.

Context:
When they have adjusted the position of the Moon until the Sun is eclipsed, the eye-Moon distance will be 100cm.

Without it being stated, pupils are using the fact that the angle subtended by the Moon is greater than or equal to the angle subtended by the Sun; otherwise the eclipse would not be complete and a ring of light would remain visible. For the purpose of this activity, the case where the subtended angles are equal is assumed.

Tangent of angle subtended by the Moon = radius/distance = 2/100 = 1/50

Tangent of angle subtended by the Sun = radius/distance = 14/700 = 1/50

From this, we can derive the equation:

$$\frac{\text{Moon's diameter (M)}}{\text{Moon to eye distance (d)}} = \frac{\text{Sun's diameter (S)}}{\text{Sun to eye distance}}$$

So $\frac{M}{d} = \frac{S}{700}$

Therefore the Sun's diameter (s) = $\frac{M \times 700}{d}$

Note that the dimensions chosen for the demonstration are NOT to scale (otherwise it cannot be made to work in a schoolroom). The demonstration shows the principle of eclipsing, rather than the correct ratios.

Following up the activity:
Use this method of calculation to find the height of a tall building.
Investigate a lunar eclipse.

Underlying principles:
- Because of their different distances from planet Earth, the Sun and Moon appear to be comparable in size when viewed from Earth.
- A small object that is near can block out the view of a much larger object that is much further away.

Thinking skill development:
- The step by step progression needed to complete this activity demonstrates construction.
- The fact that two objects can appear to be the same size but finding that one can block out the other causes cognitive conflict.
- The reasoning involved in this activity involves metacognition.
- This model for calculating the cardboard Sun's diameter demonstrates how the true diameter of the Sun can be calculated; this is bridging.

Resource list:
- string (length 700 cm)
- 28cm diameter circular disc cut from card to represent the Sun, with a hole in the centre for the string
- 4cm diameter circular disc cut from card to represent the Moon, with a hole in the centre for the string
- tape measure or ruler.

Useful links:
http://sunearth.gsfc.nasa.gov/eclipse/solar.html
http://csep10.phys.utk.edu/astr161/lect/time/eclipses.html
http://www.mreclipse.com/Special/SEprimer.html

Source: Earth Science Education Unit, Keele University - www.earthscienceeducation.com
2005, Sensing the Earth: teaching KS4 Physics.