

Week 2 Lesson 3

What's special about a lotus leaf?

Aim: To look at the development of a product on the market, inspired by nature.

Keywords: hydrophobic, nanotechnology, porous, waterproof

Starter activities

1. What's special about a lotus leaf?

Use the PowerPoint to introduce the hydrophobic properties of lotus leaves. There is a short clip to watch with some accompanying questions.

2. Hydrophobic coatings

Show students the following clip that shows an example of a hydrophobic coating in action.

www.hydrobead.com/#!/mud/c130h

Ask students to discuss why two of the wheels remain clean and to suggest uses for the coating.

Main activities

1. Practical investigation - leaf surfaces

The hydrophobic property of the surface of a lotus leaf is not unique to that plant.

Students can investigate the beading of water on the leaves of a range of garden plants. The plants need to be freshly picked.

Suggested plants:

Nasturtium, lady's mantle, brassica, water lily, hosta

Using hand lenses, students can observe the water droplets on the leaf surface. They could take photographs and measure the angle of the droplet.

Using microscopes, students can study the surface of the leaf. Are there hairs present which will trap a layer of air?

2.3: What's special about a lotus leaf?

2. Practical investigation - hydrophobic coatings

Hydrophobic coating products are available at a reasonable cost from DIY stores. Compare the hydrophobic coating with other more traditional water repellent coatings e.g. car wax, oil or grease. Prepare microscope slides with the coatings prior to the lesson. Students could examine drops of water on the slides using hand lenses.

3. Magnification activity

Students calculate the actual size of various animals from photographs. Students will need calculators and rulers for this activity.

Differentiation

Some students may need more support with working out the actual sizes of the objects and it may be useful to talk through some examples step by step.

Extension

Ask students to write down the equations they would use to work out:

- the magnification of an object
- the size of an image.

Assessment opportunity

This activity tests a variety of mathematical skills such as measuring and calculations using equations.

Plenary activities

1. Twitter

Ask students to sum up what they have learnt today in 140 characters.

2.3: What's special about a lotus leaf?

2. A quick fire magnification quiz

Suggested questions, with answers in brackets.

Work out the length of the actual object in the following:

- a. Image = 20 mm, magnification x5 (object = 4 mm)
- b. Image = 4.8 mm, magnification x2 (object = 2.4 mm)
- c. Image = 5.5 mm, magnification x11 (object = 0.5 mm)
- d. Image = 15 mm, magnification x0.5 (object = 30 mm)

Work out the magnification of the object in the following:

- a. Object = 17 mm, image = 34 mm (magnification x2)
- b. Object = 8 mm, image = 8 cm (magnification x10)
- c. Object = 50 mm, image = 25 mm (magnification x0.5)
- d. Object = 150 cm, image = 500 mm (magnification x1/3)

Assessment opportunity

Check students' ability to change the subject of an equation by giving them examples in which they work out the magnification of an object.


Starter 1

What's special about a lotus leaf? – PowerPoint

2.3: What's special about a lotus leaf?

What's special about a lotus leaf?

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2.3: What's special about a lotus leaf?

What do these images have in common?






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2.3: What's special about a lotus leaf?

The lotus (a water lily) has long been regarded as sacred by several of the world's religions. Rooted in mud, the lotus blossom rises, clean and bright, high above the water, symbolising purity and resurrection.

In India, Hindus regard the lotus seed to be especially sacred because the seed contains perfectly formed leaves, like an adult plant in miniature.

In Buddhism, the blue lotus is the symbol of the victory of the spirit over the senses and of intelligence, wisdom and knowledge.

This clip shows the product which has been inspired by the ability of lotus leaves to remain clean; the science behind the idea and some of the possible applications.

www.ted.com/talks/mark_shaw_one_very_dry_demo?language=en

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2.3: What's special about a lotus leaf?

After watching the video answer these questions:

1. What materials can the product be applied to? almost any
2. Materials which repel water are described as hydrophobic. How do they measure this? by measuring the angle of the droplet on the material
3. How many nanometres wide is a human hair? 50 000 nm
4. What texture is the surface of the super-hydrophobic material? rough
5. List some of the uses of this coating.
 - anti-icing
 - anticorrosion
 - antibacterial
 - for self-cleaning surfaces

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Main 3

Magnification activity – Examples

White crab spider, magnification x3



width of spider in image = 42 mm

magnification x3

actual width = image length \div magnification

$$= 42 \text{ mm} \div 3$$

$$= 14 \text{ mm}$$

The spider is three times smaller than the image.

African white-backed duck (magnification x $\frac{1}{4}$)



width of duck in image = 64 mm

magnification x $\frac{1}{4}$

actual width = image length \div magnification

$$= 64 \text{ mm} \div \frac{1}{4}$$

$$= 64 \text{ mm} \times 4$$

$$= 256 \text{ mm}$$

The duck is two times bigger than the image.

Magnification activity - Task

Use the information to work out the actual size of the following animals. Write your answers to the nearest whole number.

1. Fritillary butterfly, magnification x2



Width of butterfly in image = mm, magnification

Actual width of butterfly = image width \div magnification

= mm \div

= mm

2. Rhopalid bug, magnification x3



Length of bug in image =mm, magnification

Actual width of bug = image width \div magnification

= mm \div

= mm

2.3: What's special about a lotus leaf?

3. Hereford cow, magnification $\times \frac{1}{20}$



How tall is the Hereford cow (measure foot to shoulder)?

4. Grapes on a vine, magnification $\times \frac{1}{2}$



How long is the bunch of grapes?

5. Slow worm, magnification $\times \frac{1}{3}$



How long is the slow worm?

Magnification activity – Answers

Students' answers will depend on exactly where they have taken their measurements. Encourage students to mark on the pictures where they have measured. This provides an opportunity to discuss the difficulties of measuring objects accurately.

1. 45 mm
2. 13 mm
3. 118 cm
4. 16.8 cm
5. 22.2 cm