HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.3.1 Surface area to volume ratio

Topic question bank

Version 1 · 2 October 2026

Name

Date

QUESTIONS	TOTAL MARKS	TIME	YOUR SCORE
4	38	No time limit	/ 38

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Total		**38**

Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

Original questions by Helicate for AQA AS and A-level Biology (7401/7402), specification section 3.3.1. Not affiliated with or endorsed by AQA.

Do not write outside the box

Size, shape and surface area to volume ratio 3.3.1

0 1 . 1 An organism grows larger but keeps the same shape.
Which statement describes what happens to its surface area and volume?
Tick (✓) one box.

[1 mark]

- Surface area increases more than volume, so the surface area to volume ratio increases. ☐
- Surface area and volume increase by the same factor, so the surface area to volume ratio does not change. ☐
- Volume increases more than surface area, so the surface area to volume ratio decreases. ☐
- Surface area decreases as volume increases, so the surface area to volume ratio decreases. ☐

Question 1 continues on the next page

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Organisms **P** and **Q** are two species of single-celled organism that live in pond water. Table 1 shows their shapes and dimensions.

Table 1

Organism	Shape	Dimensions
P	Sphere	Diameter = 60 μm
Q	Cylinder with flat, circular ends	Diameter = 20 μm Length = 360 μm

Use these formulae, where r is the radius and l is the length:

- sphere: surface area = $4\pi r^2$ and volume = $\frac{4}{3}\pi r^3$
- cylinder with flat ends: surface area = $2\pi rl + 2\pi r^2$ and volume = $\pi r^2 l$

Organisms **P** and **Q** have the same volume.

0 1 . 2 Calculate the surface area to volume ratio of organism **Q**.
Give your answer in the form x : 1, to **two** significant figures.

[3 marks]

Answer _____ **: 1**

0 1 . 3 The surface area to volume ratio of organism **P** is 0.10 : 1.
Use this information and your answer to 01.2 to suggest how the shape of organism **Q** is an advantage for gas exchange, compared with the shape of organism **P**.

[2 marks]

6

Turn over for the next question

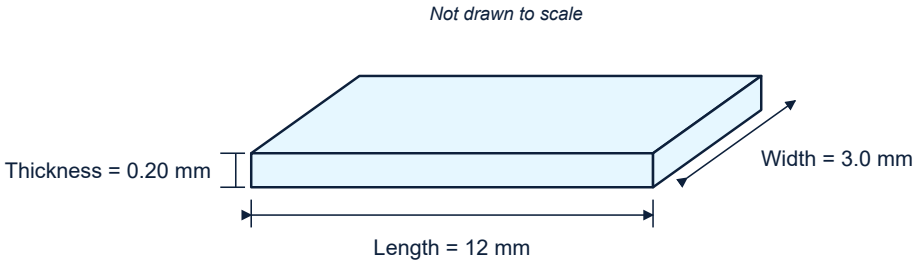
Do not write outside the box

Body shape and exchange systems in larger organisms 3.3.1

Flatworms are small animals that have no specialised gas exchange system and no circulatory system. Oxygen diffuses into a flatworm across its whole body surface.

Scientists modelled one flatworm as a rectangular block. Figure 1 shows the dimensions of their model.

Figure 1



0 2 . 1 Calculate the surface area to volume ratio of the model in Figure 1.
Give your answer in the form *x* : 1, to **two** significant figures.

[2 marks]

Answer ..... **: 1**

Question 2 continues on the next page

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0 2 . 2 The scientists changed **one** dimension of the model, keeping the other two dimensions the same.
Which change would **increase** the surface area to volume ratio of the model?
Tick (✓) one box.

[1 mark]

Doubling the length ☐

Doubling the width ☐

Doubling the thickness ☐

Halving the thickness ☐

Earthworms also absorb oxygen across their body surface. An earthworm is roughly cylindrical, with a diameter of about 5 mm.

Unlike flatworms, earthworms have a circulatory system. Blood is pumped through blood vessels, including capillaries just below the body surface.

0 2 . 3 Explain why the earthworm needs a circulatory system to supply its cells with oxygen but the flatworm does not.

[5 marks]

8

Turn over for the next question

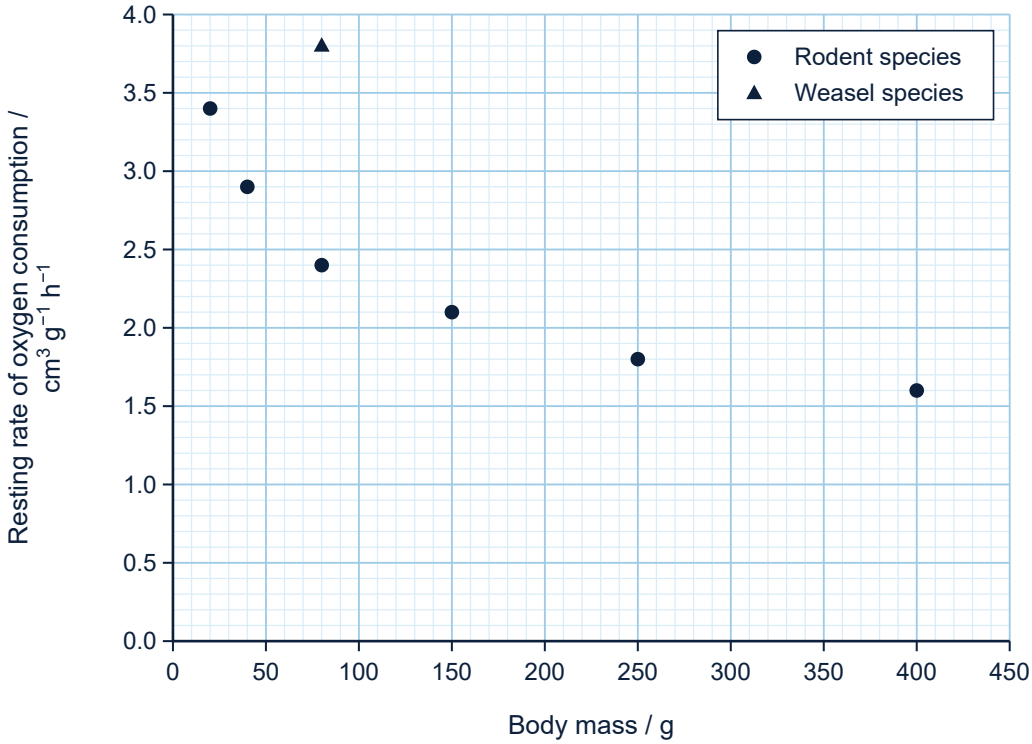
Do not write outside the box

Surface area to volume ratio and metabolic rate 3.3.1

Weasels are small mammals with long, thin bodies. Scientists measured the resting rate of oxygen consumption of one species of weasel and of six species of rodent. The rodents all have compact, rounded bodies. Every measurement was made at an air temperature of 10 °C.

Figure 2 shows the results. Each point is the mean for one species.

Figure 2



Question 3 continues on the next page

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0 3 . 1 For the rodents, the resting rate of oxygen consumption per gram of body mass decreases as body mass increases.
Explain why.

[3 marks]

The scientists estimated the surface area of the weasel and of the rodent species with the same body mass, 80 g.

- Weasel: surface area = 250 cm^2
- Rodent: surface area = 170 cm^2

Assume that 1 g of body tissue has a volume of 1 cm^3.

0 3 . 2 Calculate the surface area to volume ratio of the weasel and of the rodent.
Give each answer in the form *x* : 1, to **two** significant figures.

[2 marks]

Weasel ..... : 1

Rodent ..... : 1

Question 3 continues on the next page

Do not write outside the box

0 3 . 3 A student concluded that the weasel's higher resting rate of oxygen consumption is caused by its long, thin body shape.
Use Figure 2 and your answers to 03.2 to evaluate this conclusion.

[4 marks]

0 3 . 4 When resting in cold conditions, a weasel often curls its body into a tight ball.
Suggest how this behaviour reduces the amount of food the weasel needs.

[2 marks]

11

Turn over for the next question

Do not write outside the box

Investigating diffusion into agar cubes 3.3.1

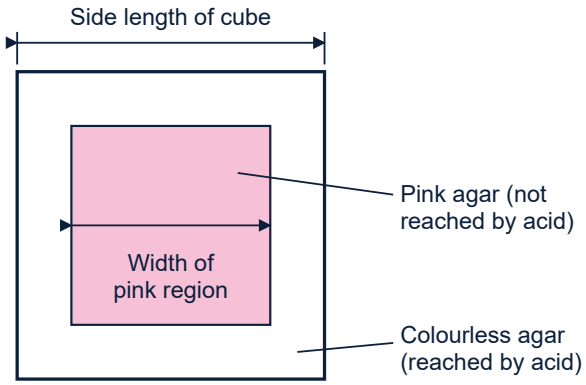
A student investigated how the surface area to volume ratio of agar cubes affects how much of each cube an acid reaches by diffusion.

She made agar containing sodium hydroxide, an alkali, and a pH indicator. The indicator is pink in alkaline conditions and becomes colourless when acid neutralises the alkali.

The student:

- cut agar cubes with side lengths of 5, 10, 20 and 30 mm
- placed each cube in its own beaker containing 200 cm^3 of 0.10 mol dm^{-3} hydrochloric acid at 20 °C
- after 10 minutes, removed each cube, blotted it dry and cut it in half through its centre
- used a ruler marked in millimetres to measure the width of the pink region on the cut face, as shown in Figure 3.

Figure 3



Question 4 continues on the next page

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She assumed that the pink region was a cube at the centre of the agar cube.
Table 2 shows her results.

Table 2

Side length of cube / mm	Surface area to volume ratio	Width of pink region / mm	Percentage of cube volume reached by acid
5	1.2 : 1	1	99.2
10	0.60 : 1	6	78.4
20	0.30 : 1	16	
30	0.20 : 1	26	34.9

0 4 . 1 Calculate the percentage of the volume of the 20 mm cube that was reached by the acid.
Give your answer to **three** significant figures.

[2 marks]

Answer ..... **%**

0 4 . 2 Use Table 2 to describe how the percentage of the cube volume reached by the acid changed as the surface area to volume ratio decreased. Explain this change.

[2 marks]

Question 4 continues on the next page

Do not write outside the box

0 4 . 3 Suggest why the student's measurement for the 5 mm cube is likely to have the largest percentage error.

[1 mark]

0 4 . 4 The student said that her agar cubes are a model of how oxygen reaches the cells inside an animal.
Suggest **two** ways in which the agar cubes are not a good model of this.

[2 marks]

1

2

Question 4 continues on the next page

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0 4 . 5 The student then planned to investigate the effect of the concentration gradient on the rate of diffusion of the acid into agar.
Describe how she could adapt her method to do this. Include how she would control variables and process her results.

[6 marks]

13

END OF QUESTIONS

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