

Questions**Q1.**

A model can be used to show the effect of surface area on the efficiency of diffusion in the lungs.

The lungs are modelled as two spheres, each with a diameter of 180 mm.

(i) Calculate the surface area in m^2 of a sphere with a diameter of 180 mm, using the formula

$$\text{Surface area} = 4\pi r^2 \quad (2)$$

Answer m^2

(ii) The volume of this sphere is 3.054 dm^3 .

Calculate the surface area to volume ratio for this sphere.

(1)

Answer

(Total for question = 3 marks)

Q2.

A scientist investigated the oxygen consumption of four different mammals. The table shows the results of this investigation.

| Mammal | Body mass / kg | Oxygen consumption / dm ³ h ⁻¹ | Oxygen consumption / dm ³ kg ⁻¹ h ⁻¹ |
|----------|----------------|--|---|
| Shrew | 0.002 | 0.0216 | 1.08 × 10 ¹ |
| Cat | 3 | 1.5 | 5.00 × 10 ⁻¹ |
| Human | 80 | 24 | 3.00 × 10 ⁻¹ |
| Elephant | 4000 | 50 | |

- (i) Calculate the oxygen consumption of the elephant.
Convert your answer into standard form.

(2)

Answer dm³ kg⁻¹ h⁻¹

- (ii) Explain the relationship between body mass and oxygen consumption in these mammals.

(4)

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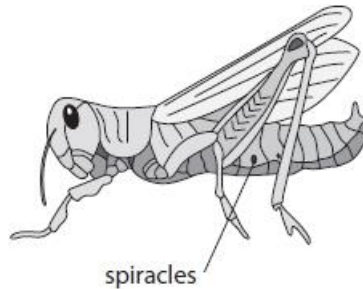
(Total for question = 6 marks)

Q3.

Insects such as locusts do not breathe through the mouth.

The gas exchange system of a locust includes air sacs, tracheae and tracheoles.

The diagram shows a locust before dissection.



Locusts have a complex gas exchange system because they are multicellular organisms.

Explain why single-celled organisms do not have a gas exchange system.

(2)

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(Total for question = 2 marks)

Q4.

The size of an animal can affect gas exchange.

As animals increase in size, their

(1)

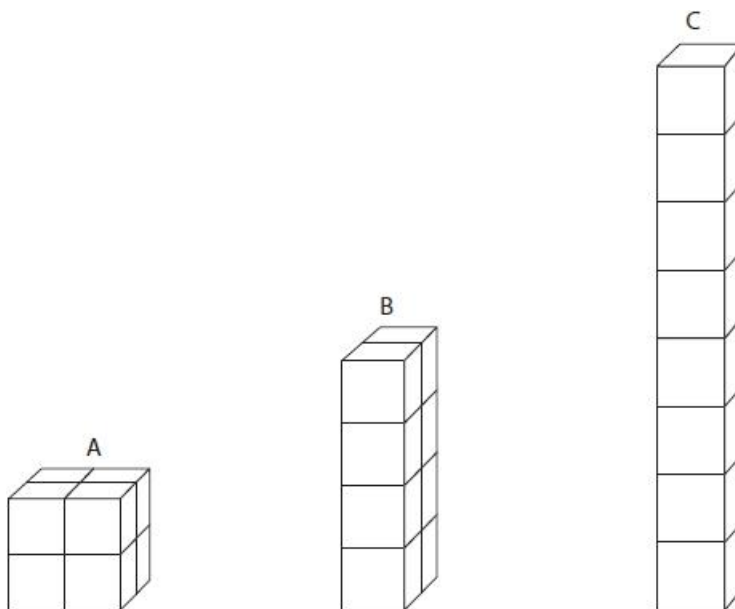
- A** surface area decreases and volume increases
- B** surface area to volume ratio decreases
- C** surface area to volume ratio increases
- D** surface area to volume ratio remains constant

(Total for question = 1 mark)

Q5.

A student investigated the effect of the shape of a potato chip on the rate of absorption of water.

Different shaped chips, A, B and C, were used.



Calculate the surface area to volume ratio of potato chip B.

(3)

Answer

(Total for question = 3 marks)

Mark Scheme

Q1.

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|--|---|------|
| (i) | <ul style="list-style-type: none"> radius calculated surface area calculated <p>0.102 / 0.1018 / 0.1017 / 0.10178 / 0.1017876 (2)</p> | <p><u>Example of calculation</u></p> $180 \div 2 = 90\text{mm} = 0.09\text{m}$ | (2) |
| | | $4 \times 3.142 \times (0.09)^2$ $4 \times 3.142 \times 8100 = 101800.8 \div 1000000 = 0.1018008$ $4 \times 3.14 \times 8100 = 101736 \div 1000000 = 0.101736$ <p>Correct answer with no working gains full marks</p> <p>ACCEPT one mark for 0.102 expressed in different version eg. 1.02 OR 0.1018008 / 0.101736 expressed in different version eg. 101800.8 OR 1017876 expressed in different version</p> | |
| Question Number | Answer | Additional Guidance | Mark |
| (ii) | <ul style="list-style-type: none"> convert dm^3 to m^3 so units are in m surface area to volume ratio calculated <p>33.39 : 1 / 33.4 : 1 / 33 : 1 /</p> <p>0.102 : 0.003054 /</p> <p>1 : 0.03 / 1 : 0.030 / 1 : 0.0299 (1)</p> | <p><u>Example of calculation</u></p> $0.003054 \text{ m}^3 = \text{volume}$ $0.102 \div 0.003054 = 33.4 : 1$ | (1) |

Q2.

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|---|--|------|
| (i) | <ul style="list-style-type: none"> divide oxygen consumption by body mass (1) express answer in standard form (1) | <p><u>Example of calculation</u></p> $50 \div 4\,000 = 0.0125$ 1.25×10^{-2} <p>Correct answer gains full marks, with no working shown</p> <p>ACCEPT one mark in working for 0.0125</p> | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|--|--|------|
| (ii) | <p>An explanation that makes reference to four of the following:</p> <ul style="list-style-type: none"> {small(er) mammals / small(er) body mass} consume more oxygen (per kg) (1) mammals are endotherms / maintain body temperature / regulate body temperature (1) small mammals have larger surface area to volume ratio (1) therefore lose more heat (1) heat by respiration (1) | <p>ACCEPT large(r) mammals consume more oxygen in $\text{dm}^3 \text{h}^{-1}$</p> <p>ACCEPT converse for Mps 1, 3 and 4 and 5</p> | (4) |

Q3.

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|--|---|------|
| | <p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> they have a large surface area to volume ratio (1) therefore diffusion is sufficient (1) | <p>Accept short diffusion distance</p> | (2) |

Q4.

| Question Number | Answer | Mark |
|-----------------|--|------|
| | <p>The only correct answer is B surface area to volume ratio decreases</p> <p><i>A is not correct because surface area increases</i></p> <p><i>C is not correct because surface area to volume ratio does not increase</i></p> <p><i>D is not correct because surface area to volume ratio does not stay constant</i></p> | (1) |

Q5.

| Question Number | Answer | Additional Guidance | Mark |
|-----------------|---|--|------|
| | <ul style="list-style-type: none"> • surface area calculated (1) • volume calculated (1) • surface area to volume ratio calculated (1) | <p>28</p> <p>8</p> <p>3.5 : 1</p> <p>unsimplified but correct ratio with no working = 2 max</p> <p>allow 2 for 3.5 alone</p> | (3) |