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Surname

*StemUp Model Solution*

Other names

**Pearson Edexcel**  
**Level 3 GCE**

Centre Number

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**Biology B**

**Advanced Subsidiary**

**Paper 2: Core Physiology and Ecology**

Monday 4 June 2018 – Afternoon

**Time: 1 hour 30 minutes**

Paper Reference

**8BI0/02**

**You must have:**

Calculator, HB pencil, ruler

Total Marks

### Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*
- You may use a scientific calculator.
- In question(s) marked with an **asterisk** (\*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

### Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*

### Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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**Pearson**

Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

- 1 The photograph shows an insect.



Explain how the gas exchange system of an insect is adapted for the efficient uptake of oxygen.

(4)

*Air (oxygen) enters through the spiracles and passes along the tracheae to the tracheoles.*

*Oxygen moves by diffusion down a concentration gradient, directly to the cells (tissues).*

*There are many tracheoles, giving a large surface area, and their walls are thin, giving a short diffusion pathway.*

*The ends of the tracheoles contain fluid so oxygen can dissolve, and they supply oxygen directly to the respiring cells.*

*Air sacs provide a store of air (oxygen).*

*Abdominal (pumping) movements ventilate the system, moving air in and out, which maintains a high concentration gradient.*

(Total for Question 1 = 4 marks)



2 Water potential in plant cells can be represented by the equation

$$\text{Water potential} = \text{turgor pressure} + \text{osmotic potential}$$

$$\psi = P + \pi$$

(a) Plant tissue is placed in distilled water.

(i) Which of the following will occur?

(1)

- ☐ A more water will leave the tissue than enter
- ☒ B the cells will become turgid
- ☐ C the tissue will become flaccid
- ☐ D the cells will burst

(ii) When the plant tissue is placed in distilled water the value of

(1)

- ☐ A P will decrease
- ☐ B  $\pi$  will decrease
- ☒ C P will increase
- ☐ D  $\psi$  will not change

(iii) Which row of the table correctly identifies the values of P and  $\pi$  if the value of  $\psi$  is 0 kPa?

(1)

|                                       | P / kPa | $\pi$ / kPa |
|---------------------------------------|---------|-------------|
| <input type="checkbox"/> A            | 0       | 0           |
| <input type="checkbox"/> B            | -4.6    | 4.6         |
| <input checked="" type="checkbox"/> C | 4.6     | -4.6        |
| <input type="checkbox"/> D            | 4.6     | 0           |

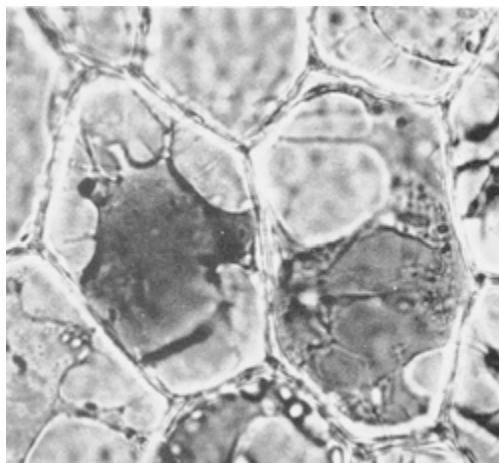
(iv) Which liquid has the lowest water potential ( $\psi$ )?

(1)

- ☐ A distilled water
- ☒ B 1.0 mol dm<sup>-3</sup> sodium chloride solution
- ☐ C 0.1 mol dm<sup>-3</sup> sodium chloride solution
- ☐ D 0.1 mol dm<sup>-3</sup> potassium chloride solution



- (b) If plant cells are placed in a solution with a lower water potential, the cell membranes will shrink away from the cell wall. The cells are described as plasmolysed.



The point at which 50% of the cells are plasmolysed can be used to estimate the osmotic potential of the cells.

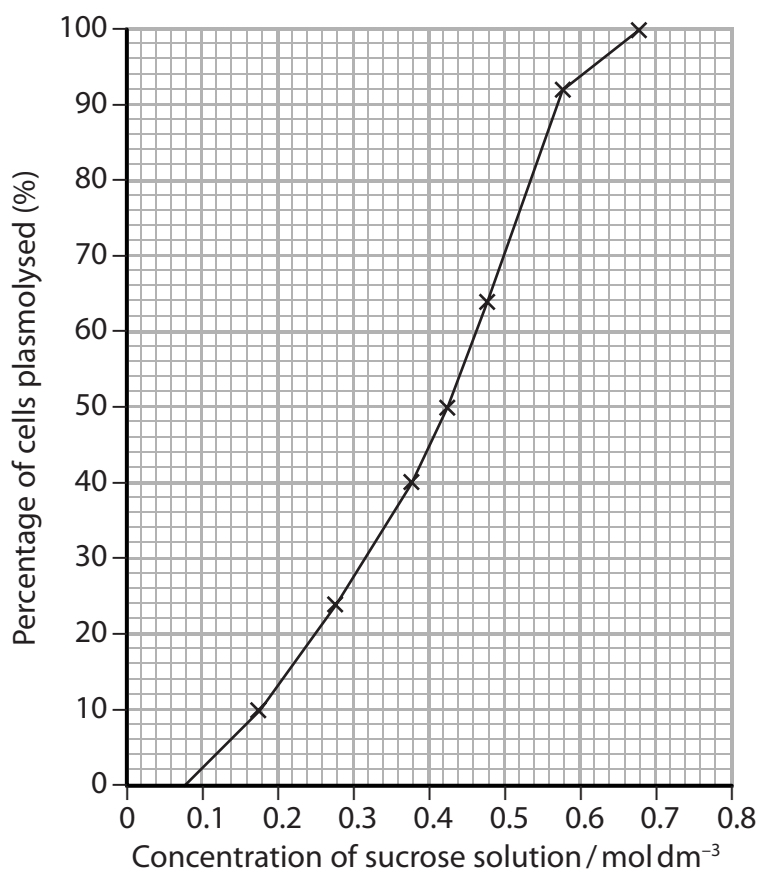
An experiment was carried out to determine the osmotic potential of onion cells.

Onion cells were placed in a range of sucrose concentrations and left for 10 minutes at 25 °C.

A sample of 50 cells was observed for each solution.

The percentage of plasmolysed cells was recorded.

The results are shown in the graph.



The table shows the osmotic potential of a range of sucrose solutions.

| Concentration of sucrose solution / mol dm <sup>-3</sup> | Osmotic potential / kPa |
|----------------------------------------------------------|-------------------------|
| 0.30                                                     | -860                    |
| 0.35                                                     | -970                    |
| 0.40                                                     | -1120                   |
| 0.45                                                     | -1280                   |
| 0.50                                                     | -1450                   |
| 0.60                                                     | -1800                   |

- (i) Analyse the data in the graph and in the table to explain how the osmotic potential of these onion cells could be determined.

(3)

*Use the 50% value on the graph, which is the point of incipient plasmolysis.*

*50% of the cells are plasmolysed at a sucrose concentration of 0.43 mol dm<sup>-3</sup>.*

*From the table, 0.43 mol dm<sup>-3</sup> has an osmotic potential of about -1200 kPa, so the osmotic potential of the onion cells is -1200 kPa.*

- (ii) Explain why the plant tissue was left in sucrose solution for 10 minutes before the cells were observed.

(2)

*To give time for water to move out of the cells by osmosis, so that osmosis is complete and equilibrium is reached (time for plasmolysis to occur).*

*Therefore an accurate value of the osmotic potential is obtained.*

(Total for Question 2 = 9 marks)



P 5 1 4 6 2 A 0 5 2 4

- 3 Stroke volume is the volume of blood that leaves the left ventricle of the heart in each beat.

Cardiac output is the volume of blood that leaves the left ventricle each minute.

The table shows the relationship between heart rate, stroke volume and cardiac output in a person.

| Heart rate / beats $\text{min}^{-1}$ | Stroke volume / $\text{cm}^3$ | Cardiac output / $\text{dm}^3 \text{min}^{-1}$ |
|--------------------------------------|-------------------------------|------------------------------------------------|
| 60                                   | 110                           | 6.6                                            |
| 100                                  | 120                           | 12.0                                           |
| 120                                  | 120                           | 14.4                                           |
| 160                                  | 120                           |                                                |
| 175                                  | 120                           | 21.0                                           |

- (a) Calculate the cardiac output for the heart with a stroke volume of  $120 \text{ cm}^3$  and a heart rate of  $160 \text{ beats min}^{-1}$ .

(1)

$$\text{cardiac output} = 160 \times 120 = 19\,200 \text{ cm}^3 \text{ min}^{-1}$$

$$= 19\,200 \div 1000 = 19.2 \text{ dm}^3 \text{ min}^{-1}$$

Answer 19.2  $\text{dm}^3 \text{ min}^{-1}$

- (b) Analyse the data to explain the relationship between heart rate and cardiac output.

(2)

*As heart rate increases, cardiac output increases, e.g. from  $6.6 \text{ dm}^3 \text{ min}^{-1}$  at 60 beats  $\text{min}^{-1}$  to  $21.0 \text{ dm}^3 \text{ min}^{-1}$  at 175 beats  $\text{min}^{-1}$ .*

*This is because stroke volume reaches a maximum and stays the same at  $120 \text{ cm}^3$  above 100 beats  $\text{min}^{-1}$ , so the increase in cardiac output is due to heart rate.*



- (c) (i) Explain how electrical events during the cardiac cycle can lead to an increase in stroke volume.

(3)

*More (frequent) impulses (waves of excitation) are generated by the SAN.*

*The impulses pass from the SAN to the AVN, then down the bundle of His to the Purkyne fibres.*

*Therefore more of the ventricle muscle contracts, so there is a stronger (greater) contraction of the ventricles, which increases the stroke volume.*

- (ii) Explain why Olympic athletes who train for long distance events often have low resting heart rates.

(4)

*Endurance training causes more heart muscle to develop, giving thicker ventricle walls.*

*Therefore the stroke volume increases, so more blood is pumped out per contraction.*

*Therefore the same cardiac output is achieved with fewer beats per minute, so the resting heart rate is lower.*

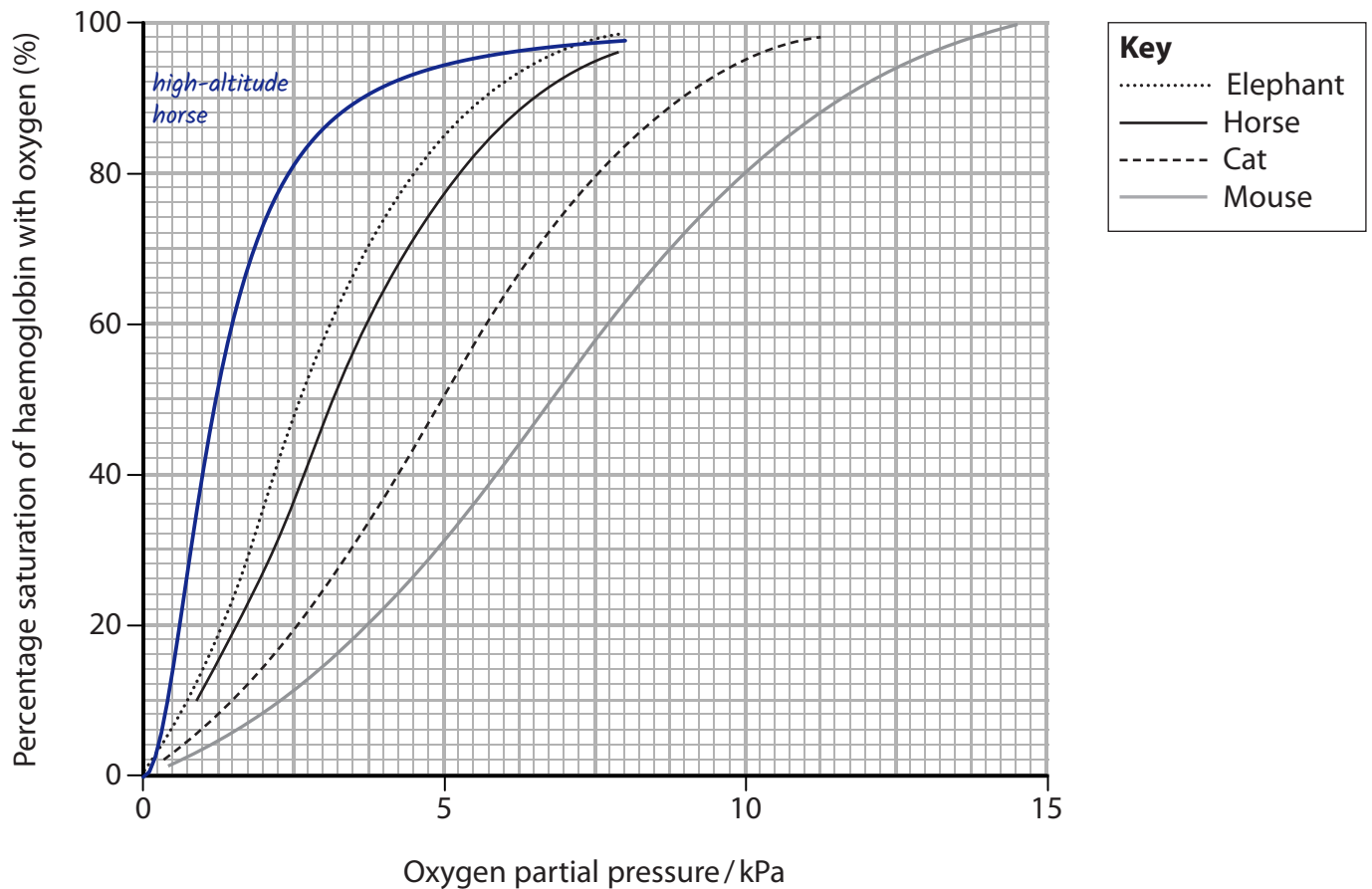
*This still gives a sufficient supply of oxygen and glucose to the cells (tissues).*

*This allows aerobic respiration in the cells to continue.*

(Total for Question 3 = 10 marks)



- 4 The graph shows the oxygen dissociation curves of haemoglobin from four species of mammal.



- (a) Explain the shape of the haemoglobin dissociation curve.

(3)

Haemoglobin has a high affinity for oxygen and is (nearly) saturated at high  $ppO_2$ , but has a low affinity and dissociates (is less saturated) at low  $ppO_2$ .

At low  $ppO_2$  the curve is shallow because binding of the first oxygen molecule is difficult.

Once it binds, it changes the shape of the haemoglobin molecule.

Therefore this facilitates the binding of the other oxygen molecules, so the curve becomes steep (S-shaped).

- (b) Calculate how much more oxygen is released as the partial pressure falls from 10 kPa to 5 kPa in the mouse than in the cat.

(3)

cat:  $95 - 50 = 45\%$

mouse:  $80 - 31 = 49\%$

difference =  $49 - 45 = 4\%$

Answer 4%

- (c) Explain why the dissociation curve for mouse haemoglobin is to the right-hand side of the dissociation curve for elephant haemoglobin.

(3)

*Mouse haemoglobin has a lower affinity for oxygen, so it releases more oxygen (is less saturated) at the same  $ppO_2$ .*

*This is because mice have a higher metabolic rate (respiration rate), so their cells need more oxygen.*

*This is because mice have a larger surface area to volume ratio than elephants.*

*Therefore mice lose more heat, so they need more respiration to keep warm.*

- (d) Some species of horse live at high altitudes where the partial pressure of oxygen is very low.

Draw a curve on the graph to show the oxygen dissociation curve of these horses.

(1)

**(Total for Question 4 = 10 marks)**



5 Gel electrophoresis is used to separate biological molecules such as proteins.

(a) Explain how gel electrophoresis separates molecules.

(2)

*An electric current is passed through the gel using electrodes (a potential difference).*

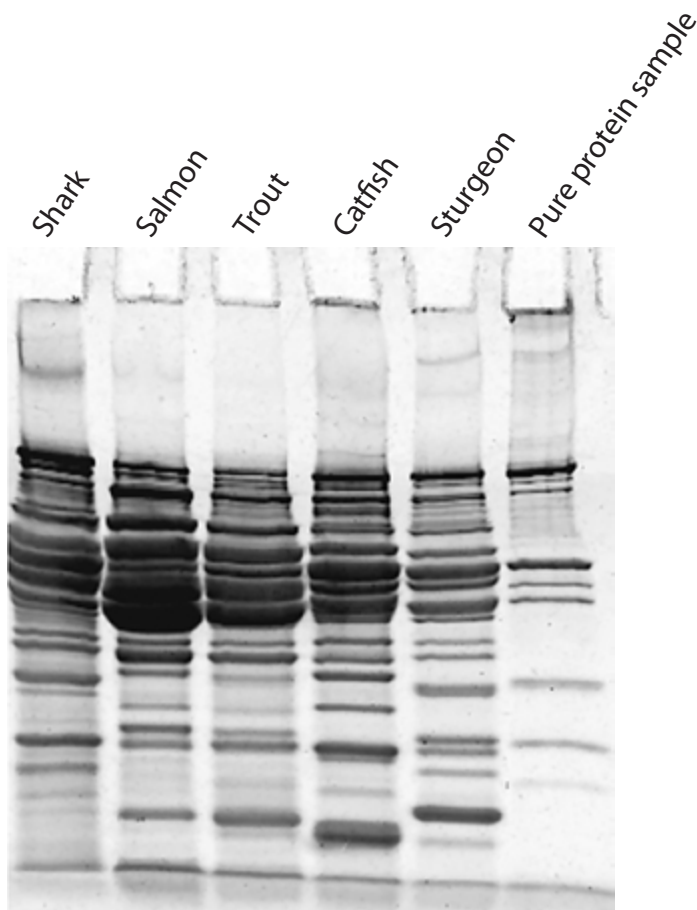
*The molecules are charged, so they move through the gel towards the oppositely charged electrode.*

*Larger (heavier) molecules move more slowly so travel a shorter distance, and smaller molecules move further, so the molecules separate.*

(b) Proteomics is the study of proteins that are produced in different species.

Scientists used gel electrophoresis to separate muscle proteins from five species of fish and from a pure protein sample.

The photograph shows the results of a gel separation of proteins from these fish and from the pure protein sample.



- (i) Protein molecules in solution do not separate as easily as DNA fragments.

Explain how protein molecules in solution must be treated so that they can be separated by gel electrophoresis.

(2)

The proteins are hydrolysed (digested) using a protease enzyme, which produces smaller fragments (polypeptides).

Also, the pH is changed using a buffer, or a detergent is used, so the molecules are charged and denatured (unfolded).

- (ii) Analyse the information shown in the photograph to explain how this banding pattern can be used to confirm that these are separate species of fish.

(4)

The banding patterns of the five fish are all different.

The different species have bands in different positions and bands of different thickness.

This is because the different species of fish have different proteins.

Therefore the different species have different genetic material (DNA).

This is because DNA (genes) codes for the proteins.



(iii) Give a reason why pure protein samples were included in the gel.

(1)

*To identify the proteins in the fish, by comparing the pure protein sample with the fish proteins.*

(iv) The bands in the photograph vary in thickness.

State what the thickness of the bands indicates.

(1)

*The amount (concentration) of that protein.*

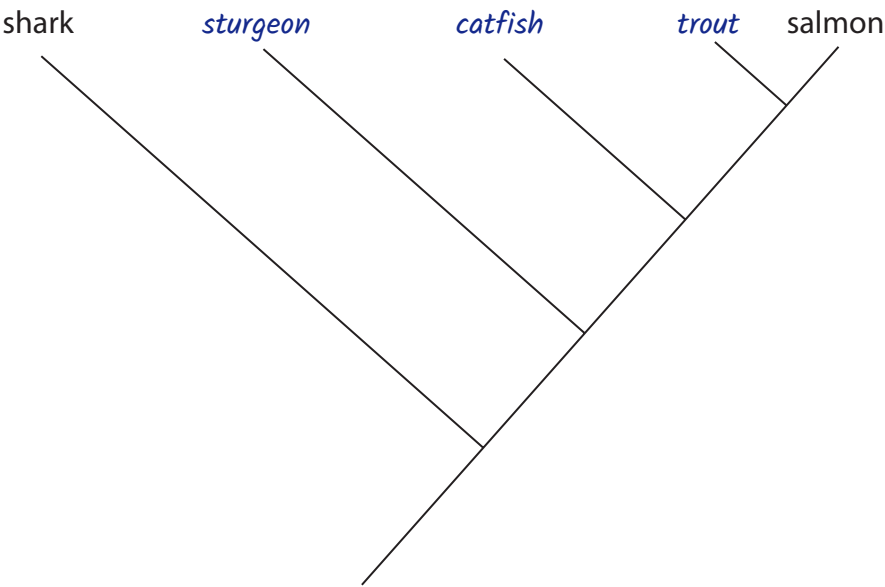


(c) The table shows the number of bands each fish has in common with the other species.

| Species  | Shark | Salmon | Trout | Catfish | Sturgeon |
|----------|-------|--------|-------|---------|----------|
| Shark    | 8     | 2      | 2     | 2       | 2        |
| Salmon   |       | 10     | 10    | 5       | 3        |
| Trout    |       |        | 13    | 5       | 4        |
| Catfish  |       |        |       | 10      | 2        |
| Sturgeon |       |        |       |         | 12       |

Analyse the data to complete the diagram showing the evolutionary relationships between these species of fish.

(2)



(Total for Question 5 = 12 marks)



6 Natural selection can lead to adaptations in organisms.

(a) Explain how evolution can occur through natural selection.

(3)

*There is genetic variation in a population, caused by mutation.*

*Some organisms are better adapted to the environment, so they survive.*

*These organisms reproduce and have offspring.*

*Therefore their (advantageous) alleles are passed on, so the allele frequency changes over generations.*

(b) (i) Which of the following is an example of a behavioural adaptation?

(1)

- ☒ A courtship display in sticklebacks
- ☐ B litter size in pigs
- ☐ C number of *Drosophila* eggs that hatch
- ☐ D pollen production in sycamore trees

(ii) Which of the following is an example of anatomical adaptation?

(1)

- ☐ A an alarm call by a song thrush
- ☐ B dominance behaviour in dairy cattle
- ☒ C limb structure in primates
- ☐ D water potential in root hair cells



(iii) Which of the following is an example of physiological adaptation?

(1)

- ☐ A increased number of stomata on leaf upper surface in a water lily
- ☒ B production of venom by a snake
- ☐ C reduction of leaves to spines in a cactus
- ☐ D salmon swimming upstream to mate

(c) Natural selection can lead to speciation.

(i) Which information about a new organism would lead to it being classified as a new species?

(1)

- ☐ A anatomical differences
- ☐ B behavioural differences
- ☐ C genetic differences
- ☒ D inability to produce fertile offspring with similar species

(ii) Give one method that a scientist might use to inform the scientific community about the discovery of a new species.

(1)

*Publish a (scientific) paper in a scientific journal, after peer review.*

.....

.....



(d) Compare and contrast allopatric and sympatric speciation.

(4)

*Similarities: both start from one original population (a common ancestor) and both involve reproductive isolation, so the groups no longer mate.*

*In both there is no gene flow, so genetic differences accumulate.*

*Differences: allopatric requires geographic isolation (e.g. a river), whereas sympatric happens in the same geographic area.*

*Sympatric is caused by e.g. behavioural, seasonal (temporal) or food isolation, or by polyploidy.*

**(Total for Question 6 = 12 marks)**



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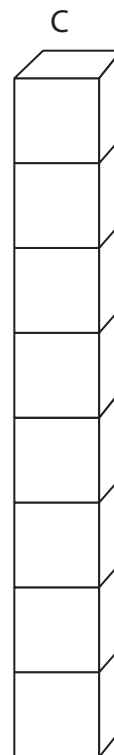
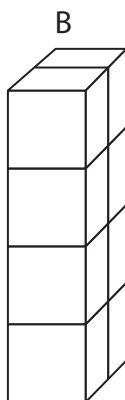
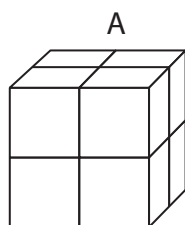
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- 7 A student investigated the effect of the shape of a potato chip on the rate of absorption of water.

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



- (a) Calculate the surface area to volume ratio of potato chip B.

$$\text{surface area} = 2(1 \times 2) + 2(1 \times 4) + 2(2 \times 4) = 4 + 8 + 16 = 28$$

(3)

$$\text{volume} = 1 \times 2 \times 4 = 8$$

$$\text{ratio} = 28 : 8 = 3.5 : 1$$

Answer 3.5 : 1

- (b) These three chips will absorb water at different rates.

Predict the order in which the chips will absorb water, from the lowest rate to the highest rate.

(1)

A, then B, then C (lowest to highest rate)



\*(c) Devise an investigation to determine the effect of shape on the rate of absorption of water by potato chips.

(6)

Cut potato chips of different shapes (A, B and C) from the same potato, using a cork borer and scalpel, so each chip has the same volume (mass) but a different surface area.

Control the potato variety and age by using one potato.

Blot each chip with paper towel and measure its starting mass on a balance.

Place each chip in a beaker of distilled water so it is fully submerged, and leave for a stated time, e.g. 30 minutes (at least 10 minutes).

Control the temperature using a water bath at 25 °C, and use the same volume of water each time.

Remove each chip, blot it dry to remove surface water, and reweigh it.

Calculate the gain in mass, then the rate of absorption as  $\text{gain in mass} \div \text{time}$  ( $\text{g min}^{-1}$ ).

Use several (at least three) chips of each shape and calculate the mean rate for each shape.

Plot the mean rate against the surface area to volume ratio of each shape to see the effect of shape.

(Total for Question 7 = 10 marks)



- 8 Water enters a plant through root hair cells and then travels by the apoplastic and by the symplastic pathways.

(a) Describe the differences between the apoplastic and the symplastic pathways.

(3)

*The apoplastic pathway is through non-living parts, the cell walls and intercellular spaces, whereas the symplastic pathway is through living cytoplasm and plasmodesmata.*

*The apoplastic pathway is faster (less resistance) and passive, whereas the symplastic is slower and is affected by metabolism.*

*The apoplastic pathway is blocked by the Casparian strip, but the symplastic pathway is not.*

(b) Herbicides are chemicals used to control the growth of weeds.

Herbicides that are absorbed from the soil also travel through the apoplastic and symplastic pathways.

The rate of absorption of herbicides is affected by their chemical properties.

- (i) Explain how the properties of herbicide molecules affect their ability to pass through plant cell membranes.

(3)

*Small molecules (polar or non-polar) pass through the phospholipid bilayer by diffusion.*

*Large non-polar (lipid soluble) molecules can also pass through the phospholipid bilayer.*

*Large, polar, charged (ionic) or water soluble molecules pass through protein channels or carriers, by facilitated diffusion or active transport.*



(ii) Some herbicides are applied to the soil.

Explain how these herbicides will be transported to the leaves.

(2)

*The herbicides enter the roots by diffusion or active transport.*

*They are then transported up in the xylem in the transpiration stream (and may also move in the phloem by mass flow).*

(c) To grow plants successfully in a glasshouse, the humidity needs to be controlled because the humidity would be higher in the summer than in the spring.

Explain why the humidity in a glasshouse would be higher in the summer than in the spring.

(5)

*In summer it is warmer and lighter than in spring.*

*Therefore water molecules have more kinetic energy, so there is more evaporation and transpiration.*

*In the light, the stomata are open for longer and open wider, so more water vapour is lost.*

*Plants also have more leaves (a larger leaf area) in summer, so more water is transpired into the air.*

(Total for Question 8 = 13 marks)

TOTAL FOR PAPER = 80 MARKS



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