

Please check the examination details below before entering your candidate information

Candidate surname <i>StemUp Model Solution</i>		Other names
Centre Number	Candidate Number	

Pearson Edexcel GCE

Thursday 22 May 2025

Morning (Time: 1 hour 30 minutes)

Paper reference **8BI0/02**

Biology B

Advanced Subsidiary

PAPER 2: Core Physiology and Ecology

You must have:
Scientific 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.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

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.*
- 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 from each other where appropriate.

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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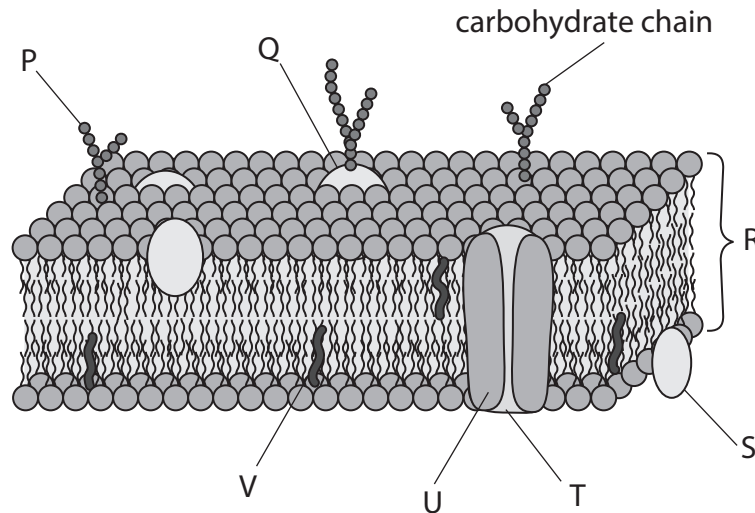

Pearson

Answer ALL questions.

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 cell surface membrane controls transport into and out of the cell.

(a) The diagram shows a cell surface membrane with some structures labelled.



(i) Which of the following labelled structures is cholesterol?

(1)

- ☐ A P
- ☐ B Q
- ☐ C S
- ☒ D V

(ii) Which of the following labelled structures is an integral protein?

(1)

- ☐ A Q
- ☐ B R
- ☐ C S
- ☒ D U



(iii) Which structure allows water molecules into the cell?

(1)

- ☐ A P
- ☐ B Q
- ☒ C T
- ☐ D V

(b) Explain how the properties of oxygen and of sodium ions determine how they enter a cell.

(4)

Oxygen

Oxygen is a small, uncharged (non-polar) molecule, so it can pass directly through the phospholipid bilayer.

So oxygen enters the cell by simple diffusion, down a concentration gradient (from a high concentration to a lower concentration).

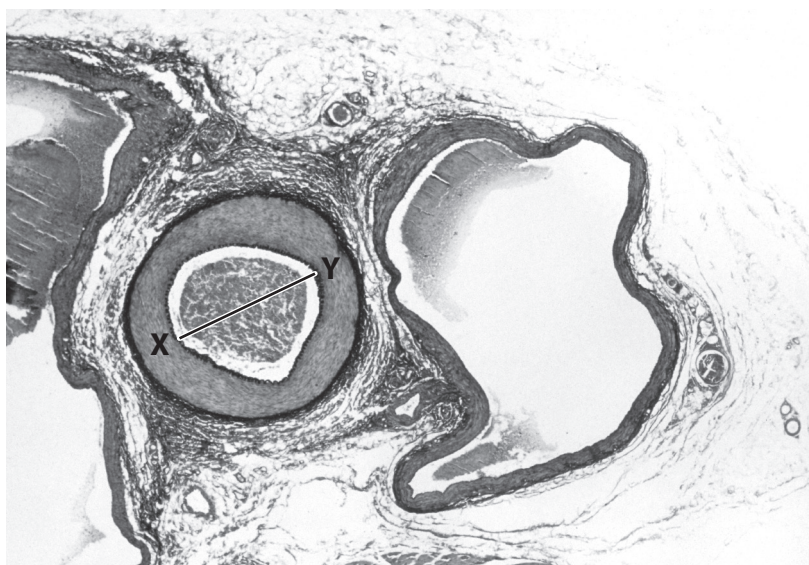
Sodium ions

Sodium ions are charged, so they cannot pass through the hydrophobic core of the phospholipid bilayer.

Therefore sodium ions enter through a channel protein by facilitated diffusion, or by active transport using a carrier protein and ATP.

(Total for Question 1 = 7 marks)

- 2 (a) The photograph shows a section through an artery and a vein, as seen using a light microscope.



(Source: © BIOPHOTO ASSOCIATES/SCIENCE PHOTO LIBRARY)

- (i) The actual diameter of the artery measured from X to Y is 1.2mm.

Calculate the magnification of this photograph.

(1)

$$\text{magnification} = \text{image size} \div \text{actual size}$$

$$= 20 \text{ mm} \div 1.2 \text{ mm} = 16.7$$

Answer $\times 16.7$

- (ii) Explain how **two** features of that artery distinguish it from the vein shown in the photograph.

(2)

The artery has a smaller lumen than the vein, and the artery has a thicker wall with a thicker layer of smooth muscle and elastic fibres than the vein.

This is because the artery needs to withstand a higher blood pressure than the vein, and needs elastic recoil, which the vein does not.



(b) The following are stages in blood clotting:

- M – platelets form a plug and release clotting factors
- N – fibrin network traps red blood cells and platelets
- P – prothrombin activator converts prothrombin into thrombin
- Q – thrombin converts fibrinogen into fibrin.

Which is the correct sequence of these stages in the formation of a blood clot?

(1)

- ☐ **A** M Q P N
- ☐ **B** M N Q P
- ☐ **C** N M Q P
- ☒ **D** M P Q N

(c) Blood clots can form in arteries and in veins.

- (i) Give **one** reason why the development of blood clots in an artery is more dangerous than the development of blood clots in a vein.

(1)

A clot in an artery can stop oxygenated blood reaching important organs such as the heart or brain, as arteries have a narrower lumen so are more likely to be blocked.

.....

.....

- (ii) Explain how **three** lifestyle factors can lead to an increase in the risk of developing atherosclerosis.

(3)

Smoking: chemicals in smoke damage the endothelium (lining) of the arteries and

increase blood pressure, which increases plaque build-up.

Lack of exercise increases blood pressure and body mass, which increases the build-up of plaques.

A diet high in saturated fat increases blood cholesterol (high LDL and low HDL), which increases plaque build-up in the artery walls. A diet high in salt raises blood pressure.

(Total for Question 2 = 8 marks)

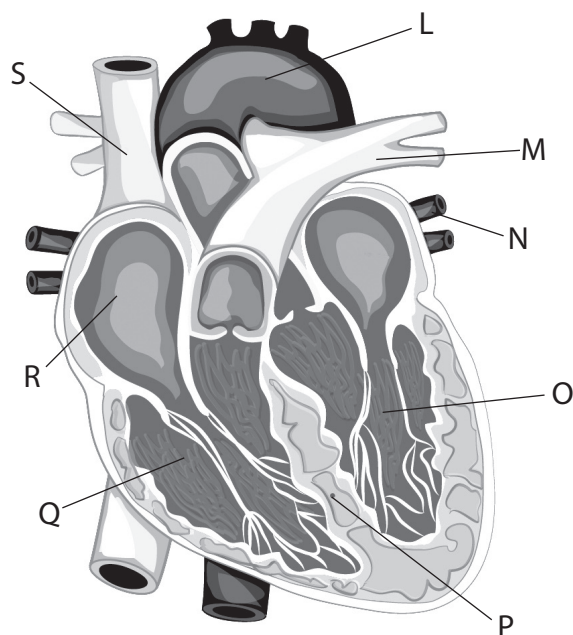
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3 Diagram 1 shows a human heart with some structures labelled.



(Source: © okili77/Shutterstock)

Diagram 1

(a) (i) Which blood vessel carries oxygenated blood to the heart from the lungs?

(1)

- ☐ A L
- ☐ B M
- ☒ C N
- ☐ D S

(ii) Which labelled structure has the highest pressure during the cardiac cycle?

(1)

- ☐ A M
- ☒ B O
- ☐ C Q
- ☐ D R

(iii) Which labelled structure is the septum?

(1)

- ☐ A O
- ☒ B P
- ☐ C Q
- ☐ D R

(b) Bony fish have a heart with one atrium and one ventricle.

Diagram 2 shows the structure of a heart from a bony fish with some structures labelled.

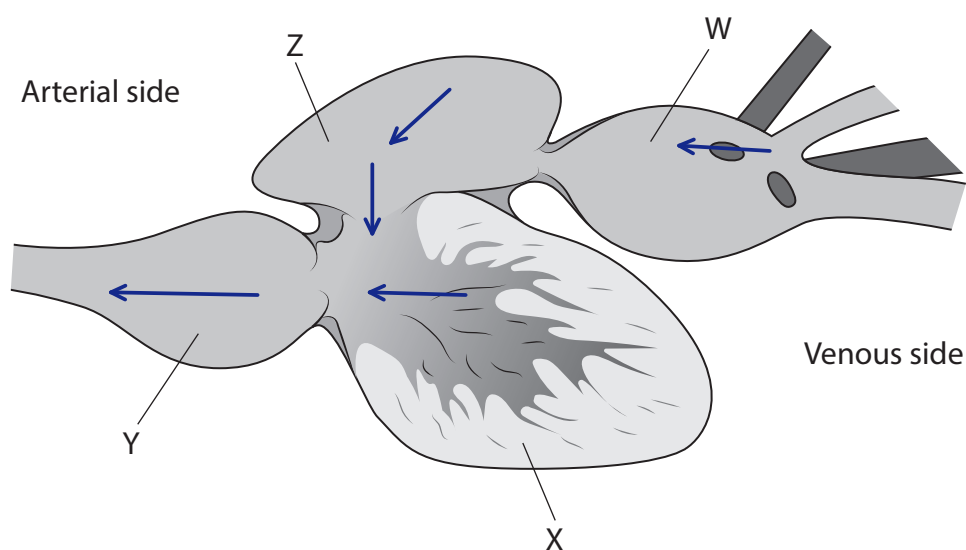


Diagram 2

(i) Which of the following structures is the atrium?

(1)

- ☐ **A** W
- ☐ **B** X
- ☐ **C** Y
- ☒ **D** Z

(ii) Draw arrows on diagram 2 to show the direction of blood flow through this heart.

(1)

(iii) Explain how the heart and circulatory system of a bony fish differ from those of a mammal.

(3)

A fish has a single circulatory system, whereas a mammal has a double circulatory system.

In a fish, blood passes through the heart once for each complete circuit of the body, but in a mammal blood passes through the heart twice.

A fish heart only has two chambers (one atrium and one ventricle), whereas a mammal heart has four chambers (two atria and two ventricles).

Therefore in the fish there is no separation of oxygenated and deoxygenated blood, but in the mammal they are kept separate by the septum.

(Total for Question 3 = 8 marks)



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- 4 Crickets are medium-sized insects, similar to grasshoppers. They are found in many parts of the world.

Scientists studied the factors that are associated with mating behaviour in two related species of cricket, *Gryllus rubens* and *Gryllus texensis*.

These species can exist as allopatric and sympatric populations.

The male crickets produce a courtship 'song' to attract females.

This song is different for each species.

The scientists compared mating behaviour of male crickets.

They did this for sympatric and allopatric populations.

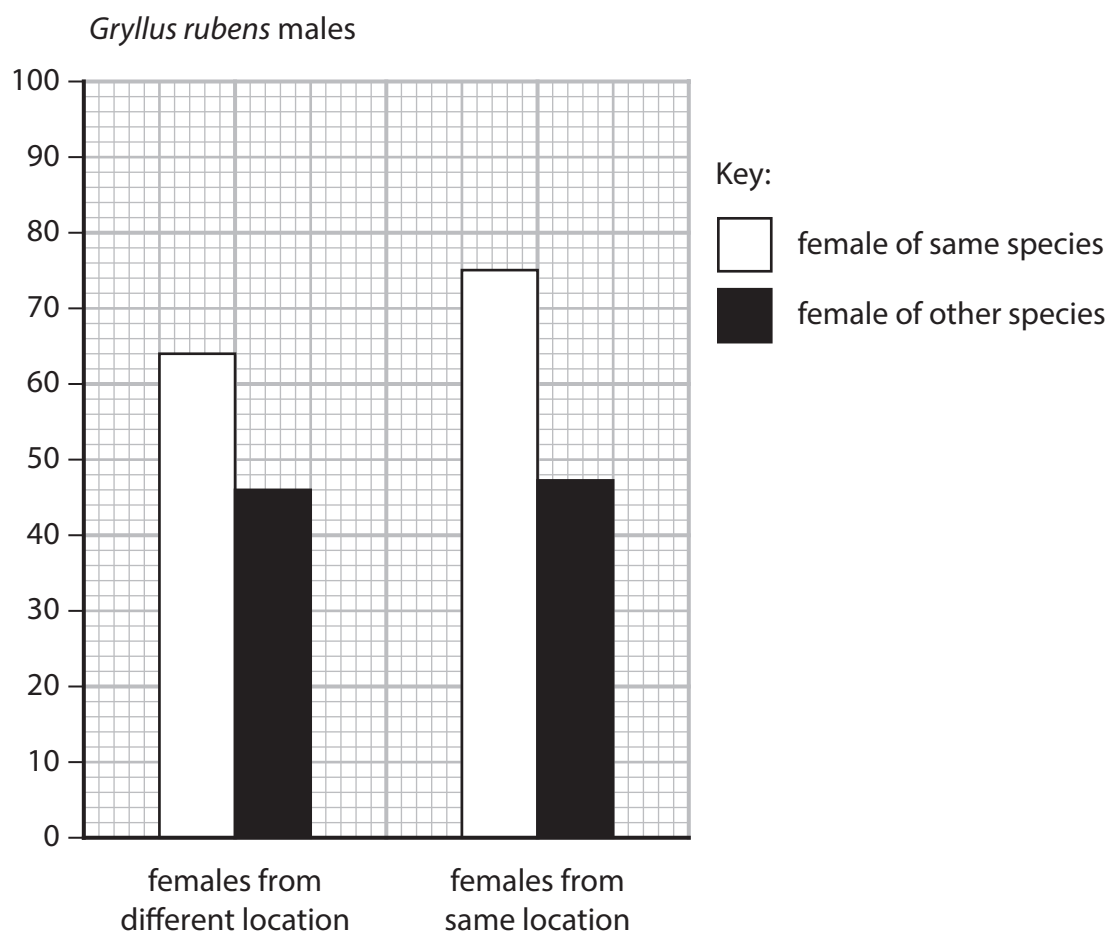
Male crickets of each species were placed with:

- Females of the same species that were from different locations
- Females of the same species that were from the same location
- Females of the other species that were from different locations
- Females of the other species that were from the same location.

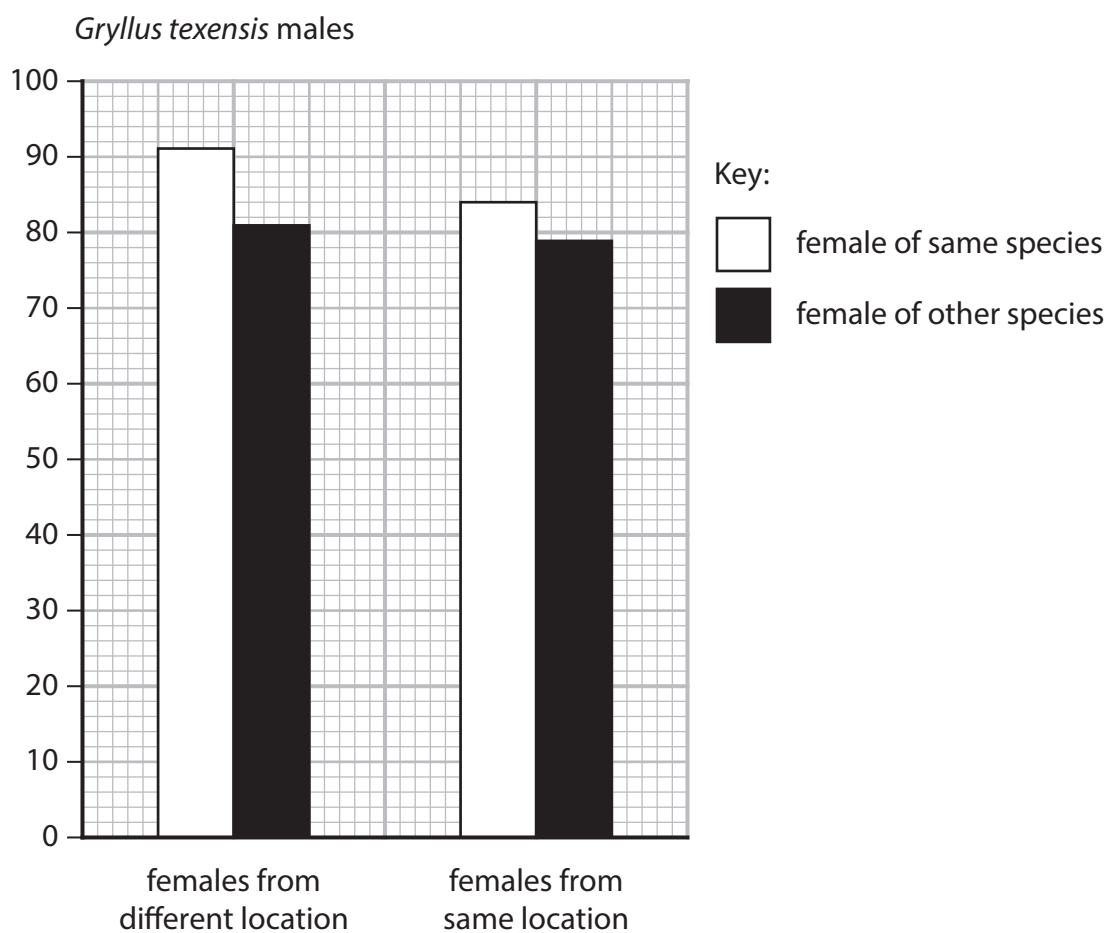
The percentage of males that began mating behaviour was calculated.

The results are shown in the graphs.

percentage of
males that
start courtship



percentage of
males that
start courtship



(a) Give the difference between allopatric and sympatric populations.

(1)

Sympatric populations live in the same geographical area, whereas allopatric populations live in different geographical areas (are geographically isolated).

(b) Explain how the courtship songs of male crickets may have evolved by natural selection.

(3)

A mutation causes variation in the courtship song between males.

Males with a louder, more distinct (different) song attract more females of the same species.

These males are more likely to mate (reproduce) successfully.

So they pass on the alleles coding for this courtship song to their offspring, and the frequency of these alleles increases over many generations.

*(c) Analyse the information and data to comment on how male courtship behaviour could affect speciation in these crickets.

(6)

Both species court females of their own species more than females of the other species, regardless of location, and *G. texensis* males court more overall than *G. rubens*.

G. texensis males court more than *G. rubens* in all conditions (e.g. 91% compared with 64% for females of the same species from a different location).

G. texensis males court females of the same species from a different location (91%) more than from the same location (84%), whereas *G. rubens* males court females of the same species from the same location (75%) more than from a different location (64%).

With females of the other species, *G. texensis* males court more (about 80%) than *G. rubens* (about 46%). *G. rubens* males court females of the other species from the same location slightly more (47%) than from a different location (46%), while *G. texensis* court them about equally (81% and 79%).

Links to speciation: *G. rubens* males are less likely to court the other species, so there is behavioural (prezygotic) isolation, fewer hybrids and less gene flow, so *G. rubens* could become a separate species even in sympatric populations. *G. texensis* males often court the other species, so *G. texensis* may need geographical (allopatric) isolation. The difference between sympatric and allopatric populations is not consistent, which suggests other mechanisms are involved in speciation.

Limitations: the role of the female (female choice) and of the courtship song itself is not considered, chemical or visual factors are not considered, and there is no idea of the sample size, and no statistical test.

(Total for Question 4 = 10 marks)



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- 5 The photograph shows a vicuna, *Lama vicugna*.



(Source: © Stefano Buttafoco/Shutterstock)

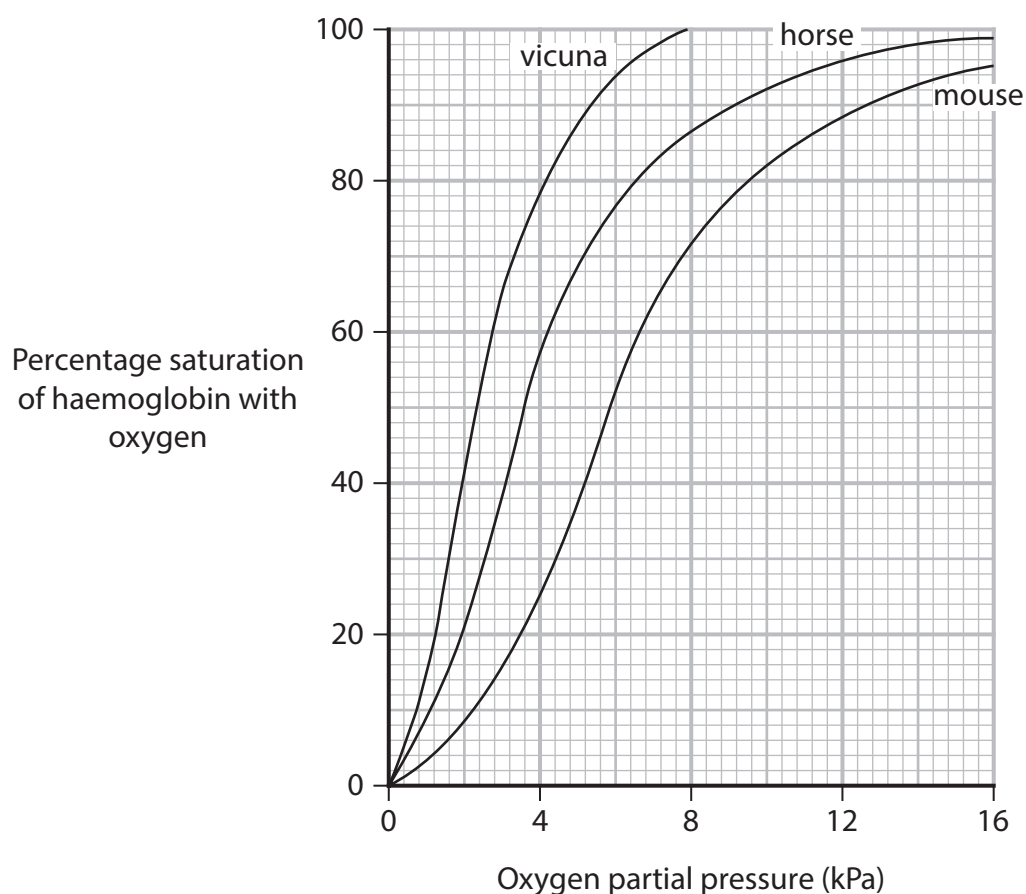
Vicunas live in high mountainous regions of South America. At high altitudes, the atmospheric pressure is low.

- (a) State the genus to which this animal belongs.

(1)

Lama

- (b) The graph shows the oxygen dissociation curve of haemoglobin from this animal, from a horse and from a mouse.



(i) Explain why the dissociation curves for all three animals are S-shaped.

(2)

Because of the cooperative binding of oxygen to the four polypeptide chains (haem groups) of haemoglobin.

Binding of the first oxygen molecule changes the shape of the haemoglobin molecule, which increases its affinity and makes it easier for the other oxygen molecules to bind.

(ii) Calculate the difference in the percentage saturation of haemoglobin for the vicuna at a partial pressure of 6 kPa and a partial pressure of 2 kPa.

(1)

$$6 \text{ kPa} = 94\% \quad 2 \text{ kPa} = 40\%$$

$$94 - 40 = 54$$

Answer 54%

(iii) Explain the differences in the dissociation curves of the vicuna and the horse.

(2)

The vicuna curve is to the left of the horse curve, so vicuna haemoglobin has a higher affinity for oxygen at the same partial pressure.

Therefore vicuna haemoglobin is more saturated at low partial pressures and can absorb more oxygen at the low partial pressure found at high altitude.

- (c) Llamas are closely related to vicunas but are larger and are used as pack animals to transport materials. They have an oxygen dissociation curve that is similar to that of a vicuna.

Explain the advantage of using llamas to transport heavy loads at high altitude rather than using horses.

(3)

At high altitude there are lower partial pressures of oxygen, as the atmosphere is thinner.

Llama haemoglobin has a higher affinity for oxygen than horse haemoglobin (its curve is to the left), so it is more saturated at lower partial pressures.

So more oxygen is taken up in the lungs and more oxygen is available to the muscles for aerobic respiration, so llamas can carry heavy loads without tiring.

- (d) Give a reason why the dissociation curve for the mouse is located to the right of the dissociation curve for the horse.

(1)

The mouse is smaller, so it has a larger SA/Vol ratio and a higher metabolic (respiration) rate.

(Total for Question 5 = 10 marks)



6 Osmosis is affected by a number of factors, including temperature.

(a) State what is meant by the term **osmosis**.

(2)

The net movement of water from a region of higher water potential to a region of lower water potential, through a partially permeable membrane.

(b) The effect of temperature on the rate of osmosis in potato cylinders was investigated.

- Potato cylinders were cut from the same type of potato using a cork borer.
- Each cylinder was 5 cm long and had a diameter of 1 cm.
- Five cylinders were used at each temperature.
- The cylinders were first blotted dry, weighed and the masses recorded.
- The cylinders were immersed in distilled water at 10 °C for 10 minutes then removed, blotted dry, reweighed and the new masses were recorded.
- This was repeated at temperatures of 15 °C and 20 °C.

(i) The surface area of each potato cylinder is 17.3 cm².

Determine the surface area to volume ratio of one of these cylinders.

Use the formula:

$$\text{Volume} = \pi r^2 l$$

Give your answer to **one decimal place**.

(3)

$$r = 1 \div 2 = 0.5 \text{ cm} \quad l = 5 \text{ cm}$$

$$\text{volume} = \pi \times 0.5^2 \times 5 = 3.93 \text{ cm}^3$$

$$\text{SA} : V = 17.3 \div 3.93 = 4.40$$

Answer *4.4 : 1*



(ii) The table shows the results of this investigation.

Temperature / °C	Initial mass of potato cylinder / g	Final mass of potato cylinder / g	Change in mass / g	Percentage change in mass (%)	Mean percentage change in mass (%)	Standard deviation
10	5.1	5.2	0.1	2.0	2.0	1.4
	5.0	5.0	0.0	0.0		
	5.2	5.3	0.1	1.9		
	5.0	5.2	0.2	4.0		
	4.9	5.0	0.1	2.0		
15	5.1	5.2	0.1	2.0	2.8	1.1
	5.1	5.3	0.2	3.9		
	5.2	5.3	0.1	1.9		
	4.9	5.1	0.2	4.1		
	5.1	5.2	0.1	2.0		
20	4.9	5.1	0.2	4.1	3.6	0.94
	5.0	5.2	0.2	4.0		
	5.2	5.3	0.1	1.9		
	5.1	5.3	0.2	3.9		
	5.0	5.2	0.2	4.0		

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Calculate the standard deviation for percentage change in mass for the cylinders at 15 °C.

Use the formula:

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

Give your answer to **two significant figures**.

(3)

$$\text{mean} = (2.0 + 3.9 + 1.9 + 4.1 + 2.0) \div 5 = 2.78$$

$$(x - \text{mean})^2 = 0.6084, 1.2544, 0.7744, 1.7424, 0.6084$$

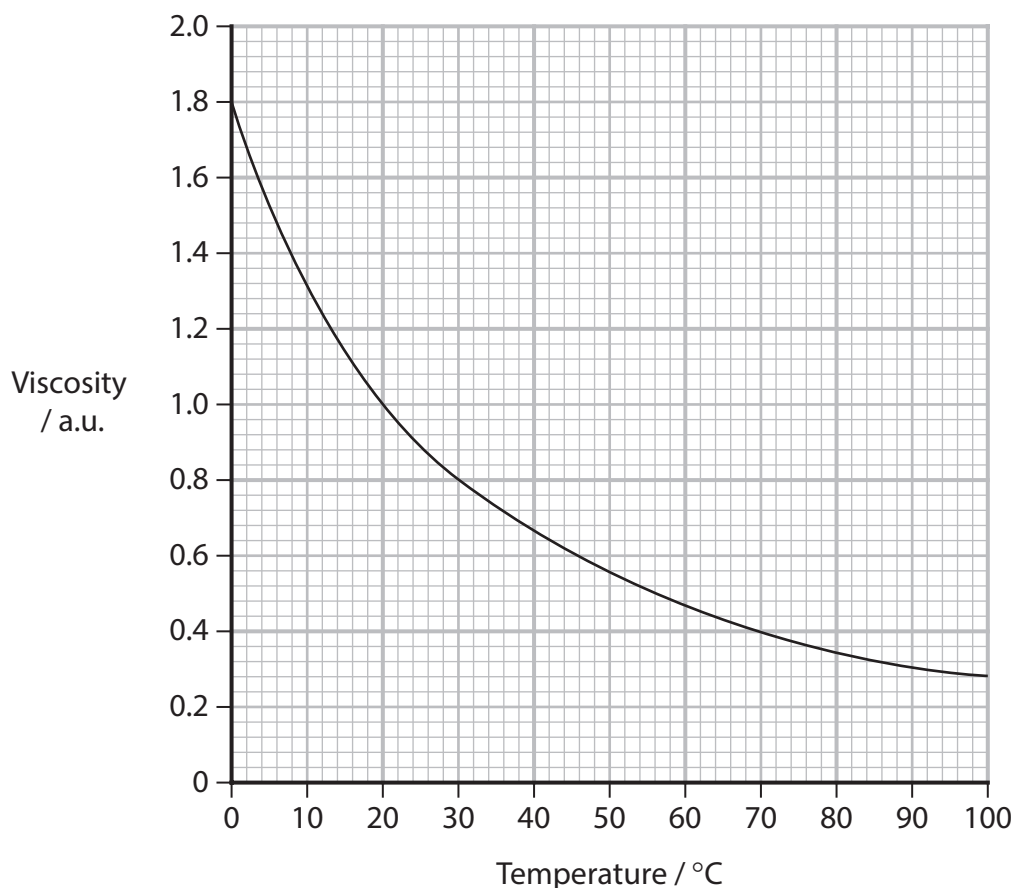
$$\Sigma(x - \text{mean})^2 = 4.988$$

$$\div (n - 1) = 4.988 \div 4 = 1.247$$

$$s = \sqrt{1.247} = 1.117$$

Answer 1.1.....

- (iii) The graph shows the effect of increasing temperature on the viscosity of water. Viscosity is a measure of how quickly liquids flow. A liquid with low viscosity flows more quickly than a liquid with high viscosity.



Analyse the data in the table of results and the graph to explain the effect of temperature on the movement of water into the potato cylinders.

(5)

As temperature increases, the mean percentage change in mass of the cylinders

increases, from 2.0% at 10 °C to 2.8% at 15 °C and 3.6% at 20 °C.

This is because water molecules have more kinetic energy at higher temperatures, so they move faster and water diffuses by osmosis into the potato cells faster.

At higher temperatures there are fewer intermolecular (hydrogen) bonds between the water molecules, as the increased kinetic energy breaks the hydrogen bonds.

This is shown by the decrease in the viscosity of water with increasing temperature, from about 1.3 a.u. at 10 °C to 1.0 a.u. at 20 °C, so water flows more quickly.

Higher temperatures also change the membrane structure: the phospholipids move more, which increases the permeability of the membrane to water.

However, the standard deviations are large (1.4 at 10 °C) compared with the differences in the means, so the differences may not be significant.

(Total for Question 6 = 13 marks)



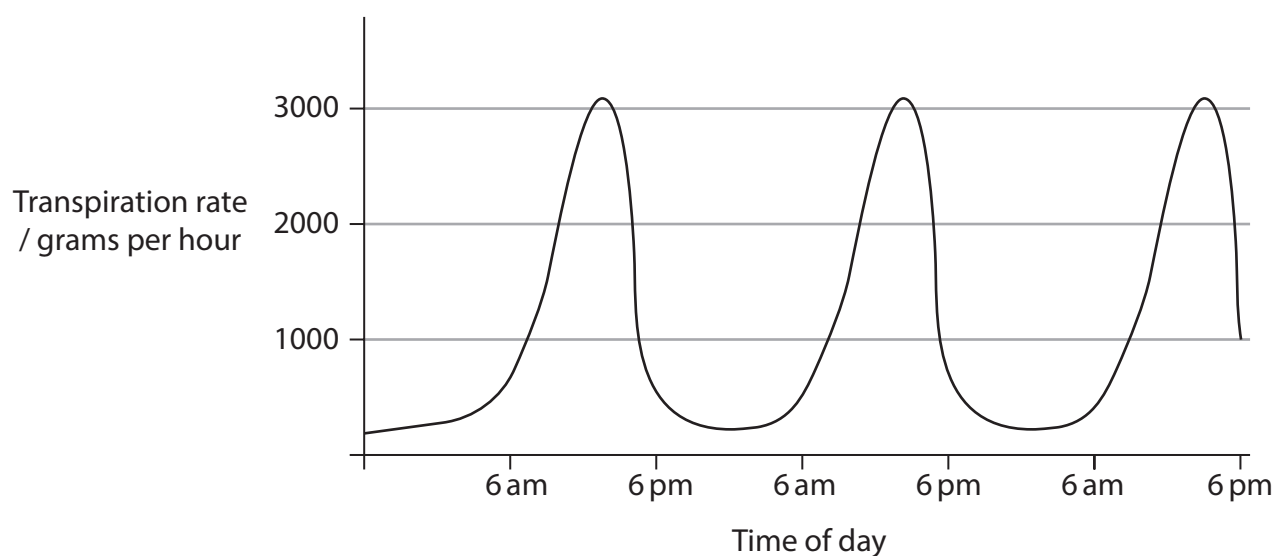
7 Scientists measured the transpiration rate of alfalfa plants.

(a) State what is meant by the term **transpiration**.

(1)

The loss of water vapour by evaporation from the leaves (and stem) of a plant.

(b) The graph shows the change in transpiration rate, measured in grams per hour, for three successive days.



(i) Explain the changes in transpiration rate from 6 am to 6 pm.

(3)

During the day transpiration increases from early morning (about 6 am), rising after midday to a peak in the afternoon, then decreases sharply before 6 pm.

This is due to an increase in light intensity causing more stomata to open, or stomata to open wider; stomata close as light reduces in the afternoon.

Temperature also increases during the day, which increases the kinetic energy of the water molecules, increasing the rate of evaporation.

- (ii) The scientists also examined the effects of soil temperature, relative humidity and air temperature on transpiration rate.

Soil temperature / °C	Relative humidity	Transpiration rate at different air temperatures / grams per hour			
		22 °C	27 °C	32 °C	Mean
10					
	35%	13.7	13.3	12.3	13.1
	53%	10.5	13.5	13.5	12.5
	65%	13.2	13.3	19.2	15.2
	Mean	12.5	13.4	15.0	13.6
25	Relative humidity	Transpiration rate at different air temperatures / grams per hour			
		22 °C	27 °C	32 °C	Mean
	35%	19.7	27.5	31.2	26.1
	53%	23.0	27.5	28.5	26.3
	65%	22.5	24.7	29.5	25.6
	Mean	21.7	26.6	29.7	26.0

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Analyse the data in the table to comment on the factors that influence transpiration rate.

(4)

As soil temperature increases so does transpiration rate: the mean rises from 13.6 at 10 °C to 26.0 grams per hour at 25 °C.

This is true across all air temperatures and all relative humidities.

Relative humidity has little and an inconsistent effect (means 26.1, 26.3 and 25.6 at 25 °C).

Air temperature increases the rate at a soil temperature of 25 °C (21.7 to 29.7) but not consistently at 10 °C (12.5 to 15.0).

Relative humidity and air temperature had little effect when soil temperature was low, so soil temperature is the major factor determining transpiration rate in this experiment.



(c) Transpiration can be measured in the laboratory using a cut leafy shoot.

Describe how you could accurately measure the effect of changing light intensity on the rate of transpiration of a cut leafy shoot in the laboratory.

(3)

Cut the shoot under water and set it up in a bubble potometer, sealed with petroleum jelly so it is airtight.

Measure the change in position (distance moved) of the air bubble along the capillary tube over a stated time, e.g. 5 minutes.

Vary light intensity by placing a lamp at different stated distances from the shoot, e.g. 10, 20, 30, 40 and 50 cm.

Repeat readings at least three times at each distance and calculate a mean.

Control temperature using a heat shield (beaker of water) between the lamp and the shoot, and keep humidity and air movement constant.

(Total for Question 7 = 11 marks)



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8 Gas exchange systems in a mammal and in an insect are different.

(a) Explain why larger species of animal need specialised gas exchange surfaces.

(3)

Larger organisms have a smaller surface area to volume ratio.

Many cells are far from the body surface, so the diffusion distance is long.

Diffusion across the body surface would be too slow to supply oxygen or remove carbon dioxide, and larger animals may have a higher metabolic demand.

(b) Compare and contrast the gas exchange systems in insects and in mammals.

(3)

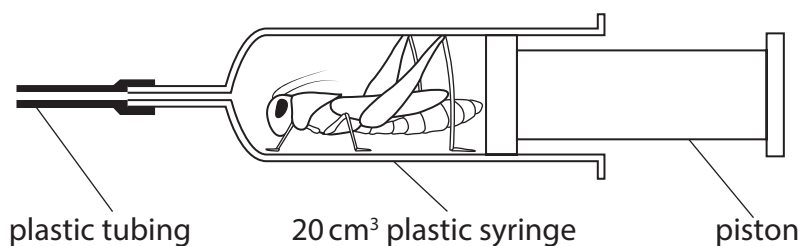
Similarities: both have a large surface area and a thin, moist gas exchange surface.

Differences: mammals have a transport (circulatory) system to carry gases but insects do not; in mammals the gas exchange surface is the alveoli, but in insects it is the junction between the tracheoles and the respiring tissues. Mammals have cartilage supporting the airways, whereas insects have chitin.



- (c) The effect of gas composition on the ventilation rate of a locust was investigated using the following method.

Step 1 A locust was placed in a 20 cm³ clear plastic syringe, as shown in the diagram. The piston was inserted gently to hold the locust in place.



Step 2 Different mixtures of gases were added to the syringe through the plastic tubing.

Step 3 For each mixture of gases, the number of pumping movements of the locust's abdomen was counted for one minute. This was repeated two more times.

Step 4 Between each mixture of gases used, the piston was moved in and out ten times to replace the mixture with laboratory air.

Step 5 The locust was then left for five minutes before the next mixture of gases was added.

- (i) State the independent variable in this investigation.

(1)

The mixture (composition) of gases.

(ii) The table shows the results of this investigation.

Gas mixture		Ventilation rate / movements per minute			Mean ventilation rate / movements per minute
Oxygen (%)	Carbon dioxide (%)				
100.0	0.0	10	24	12	15.3
21.0	0.1	52	44	62	52.7
16.4	4.1	106	98	102	102.0
94.0	6.0	96	84	92	90.7
88.0	12.0	82	92	102	92.0
83.0	17.0	108	98	99	101.7

Analyse the data to comment on the effect of the different gas mixtures on the ventilation rate of the locust.

(4)

Ventilation rate is lowest in 100% pure oxygen (15.3 movements per minute).

The highest rates are at 4.1% and 17% carbon dioxide (102.0 and 101.7).

Carbon dioxide has a greater effect than oxygen: there is a stronger correlation with carbon dioxide than with oxygen, but there is little increase in rate above 4% carbon dioxide.

The results are most variable at 88% oxygen and 12% carbon dioxide (82 to 102), and only three readings were taken on one locust, so this is a small sample with high variability.

There is no mention of the other gas in mixtures 2 and 3, as they do not add up to 100%.



- (iii) Describe how the method could be modified to investigate the effect of temperature on the ventilation rate of a locust.

(2)

Keep the gas mixture (composition) the same, e.g. use laboratory air each time.

Vary the temperature by placing the syringe in a thermostatically controlled water bath

at five temperatures, e.g. 10, 15, 20, 25 and 30 °C.

(Total for Question 8 = 13 marks)

TOTAL FOR PAPER = 80 MARKS



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