

Paper Reference(s) **9BI0/03**

Pearson Edexcel Level 3 GCE

Biology B

Advanced

Paper 3: General and Practical Principles in Biology

Monday 17 June 2019 – Morning

Time: 2 hours 30 minutes plus your additional time allowance

INSTRUCTIONS TO CANDIDATES

Write your centre number, candidate number, surname, other names and your signature in the boxes below. Check that you have the correct question paper.

Centre No.					
Candidate No.					
Surname					
Other names					
Signature					
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- Use **BLACK** ink or ball-point pen.
- 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.

MATERIALS REQUIRED FOR EXAMINATION

Calculator, HB pencil, ruler

ITEMS INCLUDED WITH QUESTION PAPERS

Nil

INFORMATION FOR CANDIDATES

- The total mark for this paper is **120**.
- 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 TO CANDIDATES

- 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)

Answer ALL questions.

Write your answers in the spaces provided.

1 A student investigated the water potential of potato cells.

The student used this method.

- **six potato cubes of the same shape and size were cut from the same potato**
- **each cube was weighed**
- **each cube was then placed into a different concentration of sucrose solution**
- **each cube was removed from the sucrose solution after one hour**
- **each cube was then reweighed and the percentage change in mass was calculated**

(Question continues on next page)

The table below shows the results of the investigation.

Concentration of sucrose solution / mol dm ⁻³	Percentage change in mass (%)
0.0	+18.0
0.2	+5.0
0.4	-8.0
0.6	-16.0
0.8	-23.5
1.0	-24.0

- (a) The student was given a 1.0 mol dm⁻³ sucrose solution.

State how the student used this solution to make a 0.8 mol dm⁻³ sucrose solution. (1 mark)

(Question continues on next page)

(Turn over)

(b) Sketch a graph you could use to identify the water potential of potato cells. (2 marks)

(Question continues on next page)

(Turn over)

- (c) The method used by the student could be improved to obtain a more accurate value for the water potential of these potato cells.

Justify THREE improvements that could be made.
(3 marks)

(Continue your answer on next page)

(Turn over)

(TOTAL FOR QUESTION 1 = 6 MARKS)

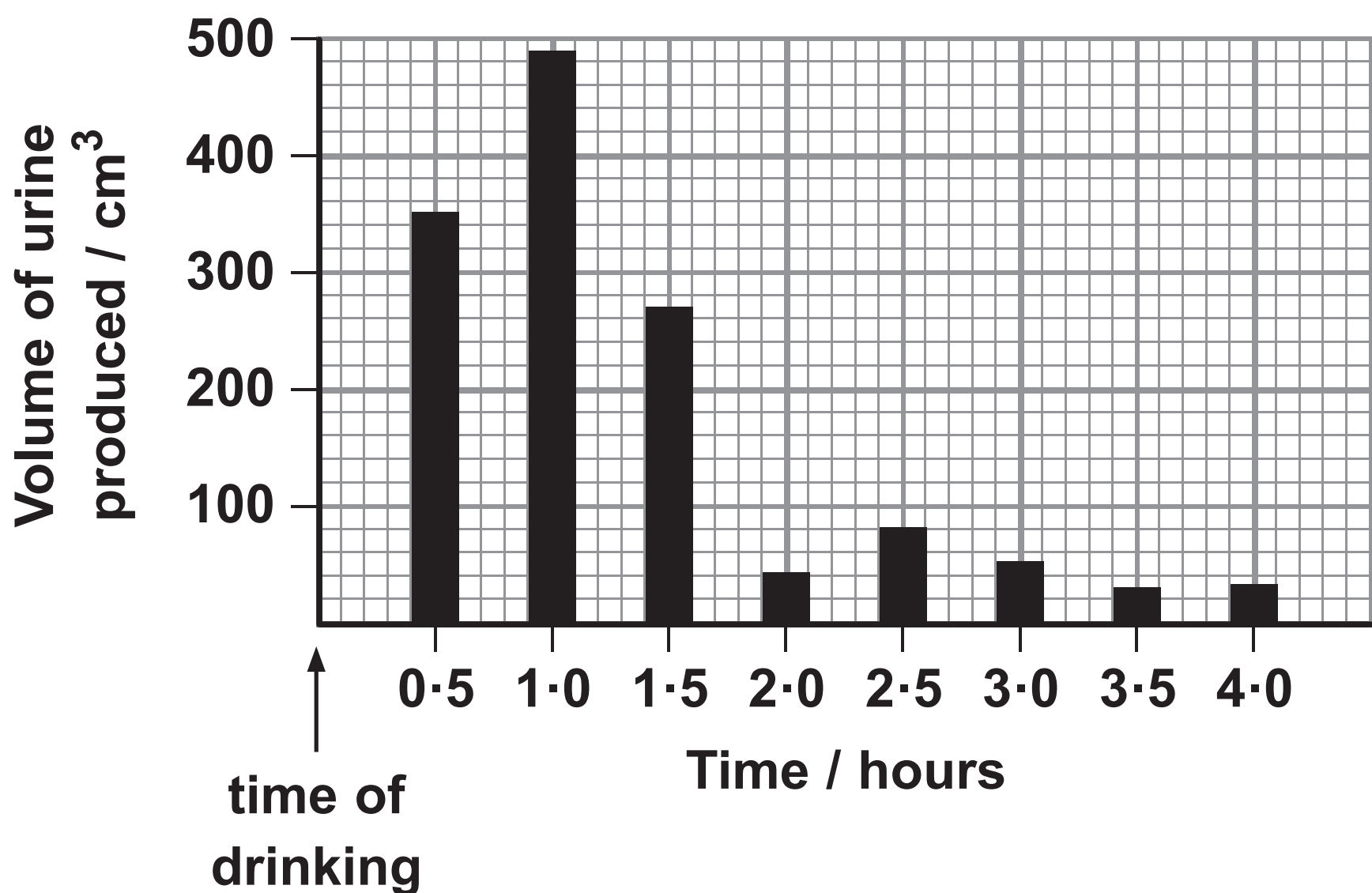
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2 Negative feedback control of blood plasma concentration is an example of homeostasis.

A student investigated the effect of drinking water on the volume of urine produced.

The student drank one dm^3 of water and waited for half an hour. The student then collected the urine produced every 30 minutes for four hours.

The graph shows the results of this investigation.



(Question continues on next page)

- (a) (i) Determine the total volume of urine produced during the first two hours. (1 mark)**

Answer _____ **cm³**

- (ii) Explain the role of negative feedback in the control of blood plasma concentration during the first hour after drinking water. (4 marks)**

(Continue your answer on next page)

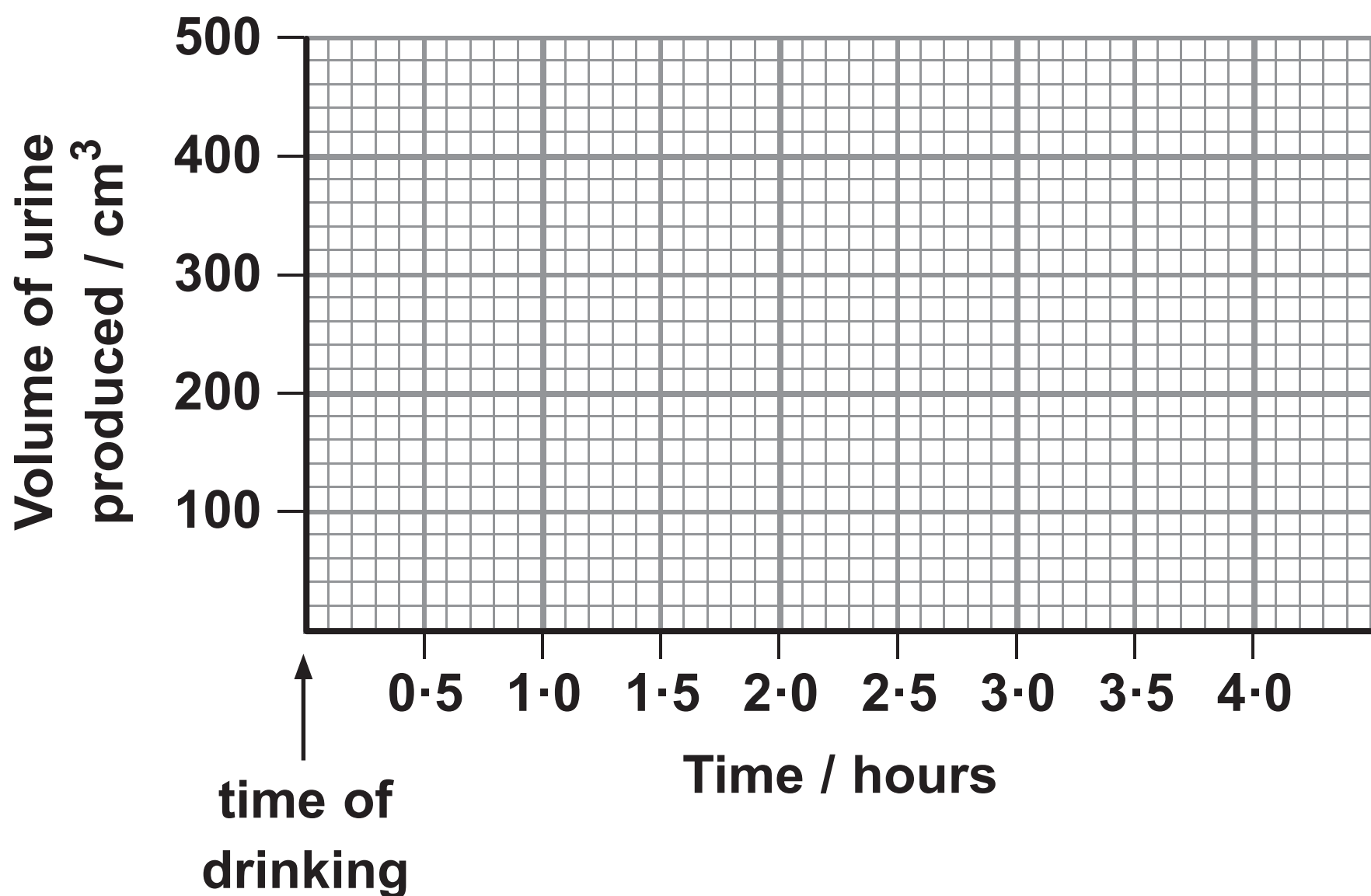
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- (b) The next day the student drank one dm^3 of dilute salt solution with the same water potential as blood plasma.

The student waited half an hour and collected the urine produced every 30 minutes for four hours.

Sketch a graph to predict the results. (1 mark)



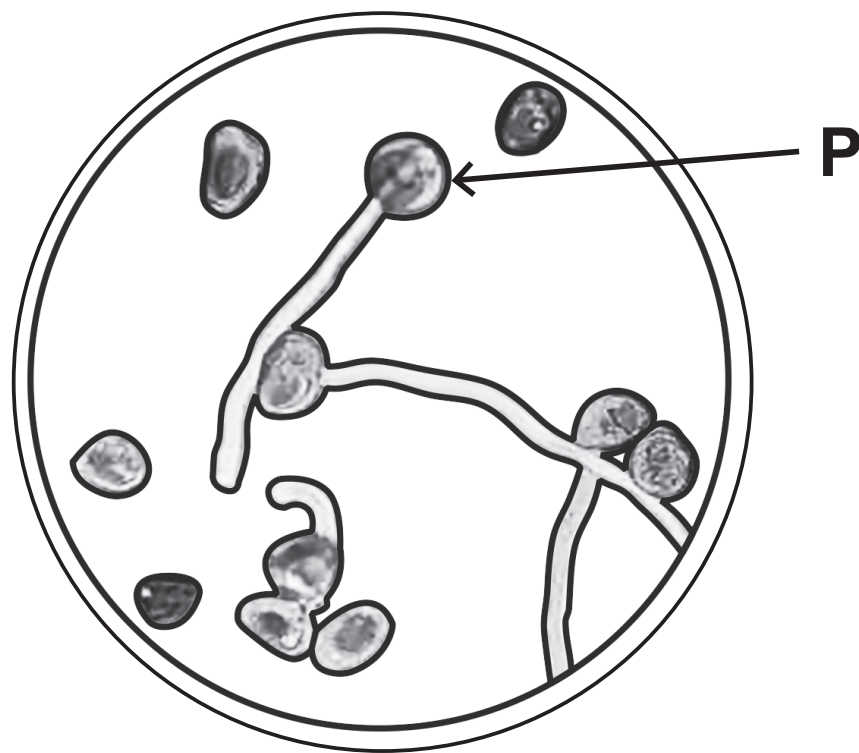
(TOTAL FOR QUESTION 2 = 6 MARKS)

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(Turn over)

- 3 A student used a light microscope to determine the mean percentage germination of pollen grains.

The photograph shows one high power field of view observed by the student.



- (a) The student used a paintbrush to obtain pollen grains from a flower.

Describe the steps taken by the student to see these pollen grains using a microscope. (3 marks)

(Continue your answer on next page)

(Turn over)

(b) The actual diameter of pollen grain P is $30\text{ }\mu\text{m}$.

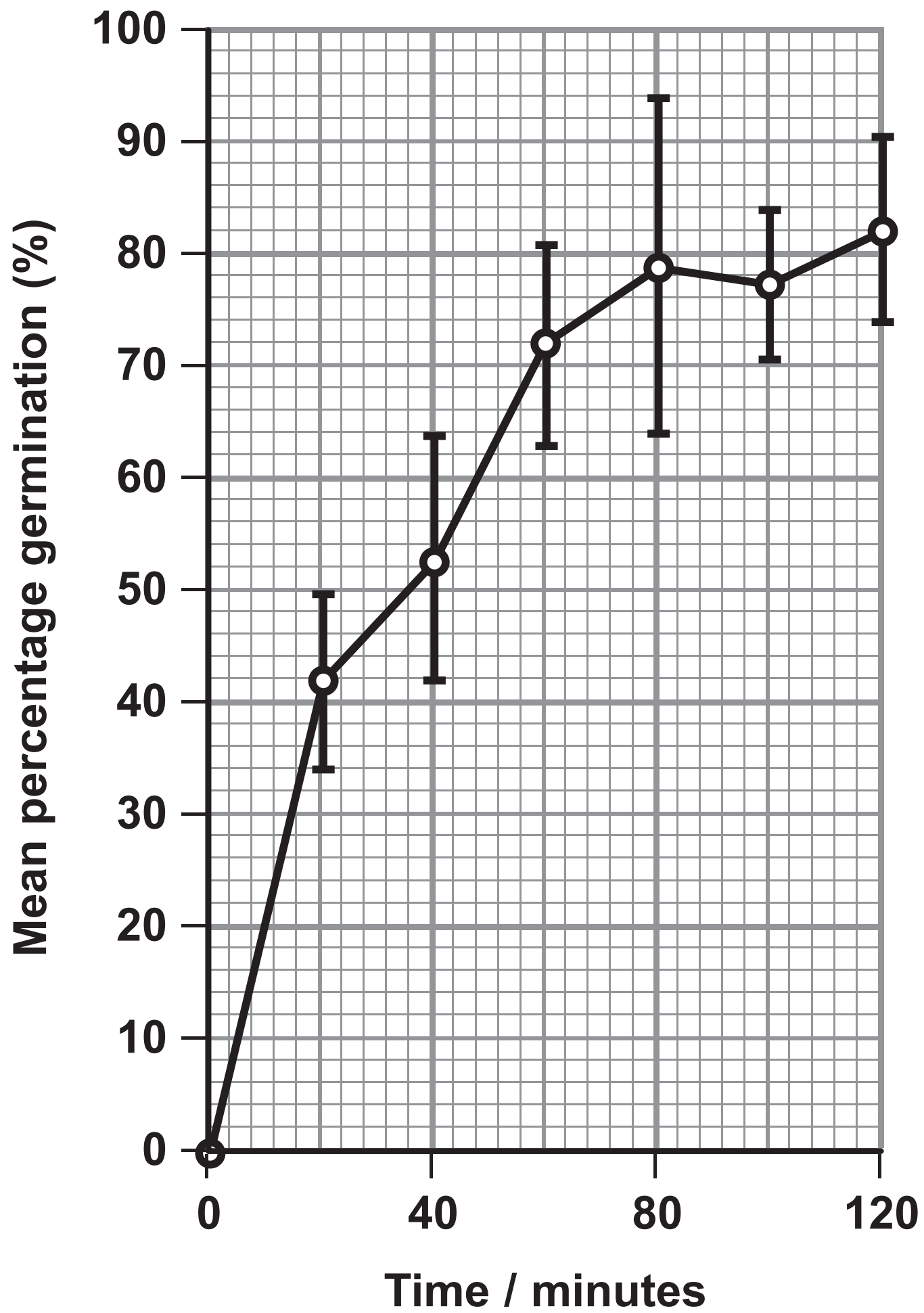
**Calculate the magnification of pollen grain P.
(2 marks)**

Answer _____

(Question continues on next page)

(Turn over)

(c) The graph shows the results of the investigation.



(Question continues on next page)

(Turn over)

- (i) Explain why the student plotted standard deviation bars on the graph. (2 marks)

(Question continues on next page)

- (ii) Determine the time when the photograph was taken. (2 marks)

Answer _____ minutes

(TOTAL FOR QUESTION 3 = 9 MARKS)

(Questions continue on next page)

(Turn over)

4 Plant pigments are involved in photosynthesis.

The action spectrum of chloroplasts and the absorption spectrum of the pigments can be determined.

- (a) (i) State the difference between an action spectrum and an absorption spectrum.
(1 mark)**

(Question continues on next page)

(Turn over)

- (ii) State how an action spectrum and an absorption spectrum show that chlorophyll is used in photosynthesis. (1 mark)

(Question continues on next page)

- (b) Cadmium is an environmental pollutant that affects the synthesis of plant pigments.**

A scientist investigated the effect of cadmium on the synthesis of chlorophyll and carotenoid pigments in plants.

The scientist used the following steps in the method.

Step 1: plants were grown in darkness for one week to produce yellow leaves

Step 2: leaf discs of the same diameter were taken from the first pair of these leaves

Step 3: a total of 25 discs was put into tubes containing different cadmium chloride concentrations

Step 4: these tubes were kept at 27 °C and exposed to the same source of light

(Question continues on next page)

The table shows information about the pigments chlorophyll a and chlorophyll b and the carotenoids present in the leaf discs after 48 hours.

Cadmium chloride concentration / a.u.	Mean concentration of chlorophyll / mg kg ⁻¹	Mean concentration of carotenoid / mg kg ⁻¹	Ratio of chlorophyll a : b	Ratio of carotenoid : chlorophyll
0·0	384 ± 4·2	444 ± 6·2	1·23	1·15
0·1	204 ± 4·9	270 ± 4·5	1·00	1·32
1·0	180 ± 3·6	207 ± 5·2	0·83	1·15
3·0	146 ± 4·1	140 ± 3·1	0·81	0·95
5·0	126 ± 2·7	91 ± 1·0	0·56	0·71
10·0	102 ± 1·9	64 ± 1·1	0·80	0·63

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(Turn over)

(i) Analyse the data to deduce the effect of cadmium on the synthesis of plant pigments. (3 marks)

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**(ii) Justify the method used by the scientist.
(5 marks)**

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(TOTAL FOR QUESTION 4 = 10 MARKS)

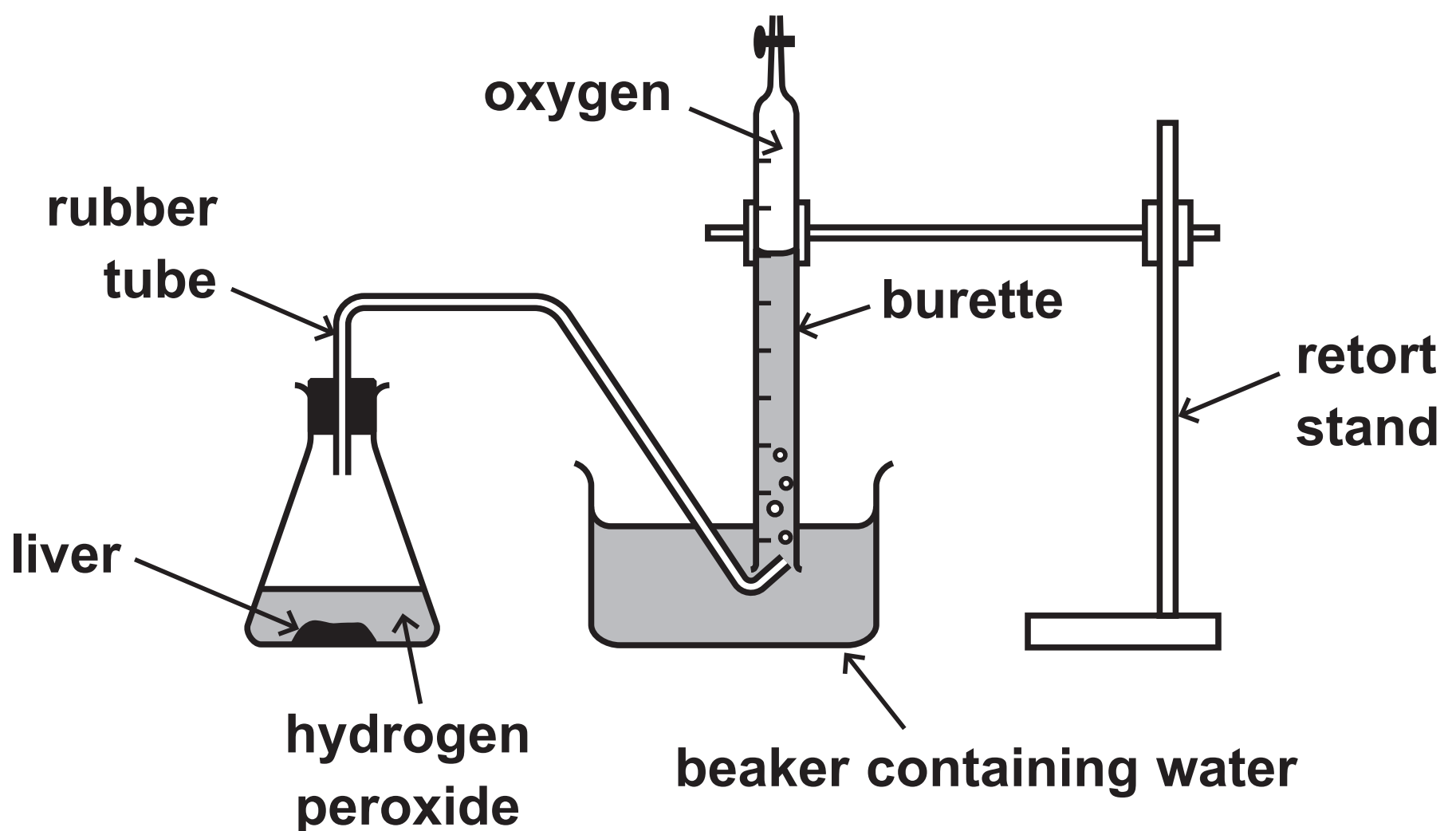
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5 Liver cells contain an enzyme called catalase.

This enzyme changes hydrogen peroxide in the liver cells into water and oxygen.

A group of students used the apparatus shown to compare the activity of catalase in raw liver tissue and in boiled liver tissue.



(Question continues on next page)

The students used the following method.

- **a burette filled with water is placed in a beaker containing water**
- **add hydrogen peroxide to the conical flask**
- **open the conical flask and drop 0.1g of raw liver into the hydrogen peroxide**
- **replace the bung on the conical flask**
- **after 10 seconds pinch the rubber tube to stop any more oxygen entering the burette**
- **measure the volume of oxygen collected in the burette**
- **repeat this method for boiled liver**

(Question continues on next page)

The table shows the results obtained by each student.

Student	Volume of oxygen collected in 10 seconds / cm ³	
	Raw liver	Boiled liver
1	19	0
2	40	0
3	28	0
4	38	0
5	42	0
6	29	0
7	34	0
8	46	0
9	38	0

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(Turn over)

(a) Explain why no oxygen was produced when boiled liver was added to the hydrogen peroxide. (3 marks)

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**(b) Explain why it was important to measure the volume of oxygen in the first 10 seconds.
(2 marks)**

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(Question continues on next page)

(Turn over)

- (c) The results for the volume of oxygen collected by each student using raw liver were different.

Give FOUR possible improvements to the method used by these students that would reduce the variability of the results. (4 marks)

(Continue your answer on next page)

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(TOTAL FOR QUESTION 5 = 9 MARKS)

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(Turn over)

- 6 A student measured the distribution of two plant species at the coast.**

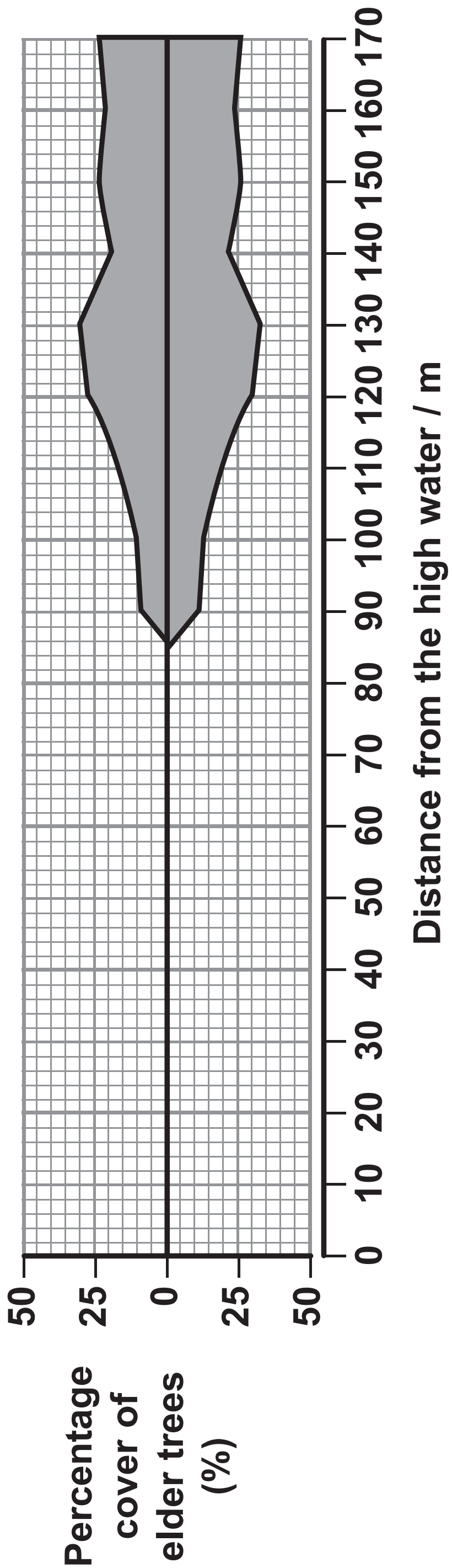
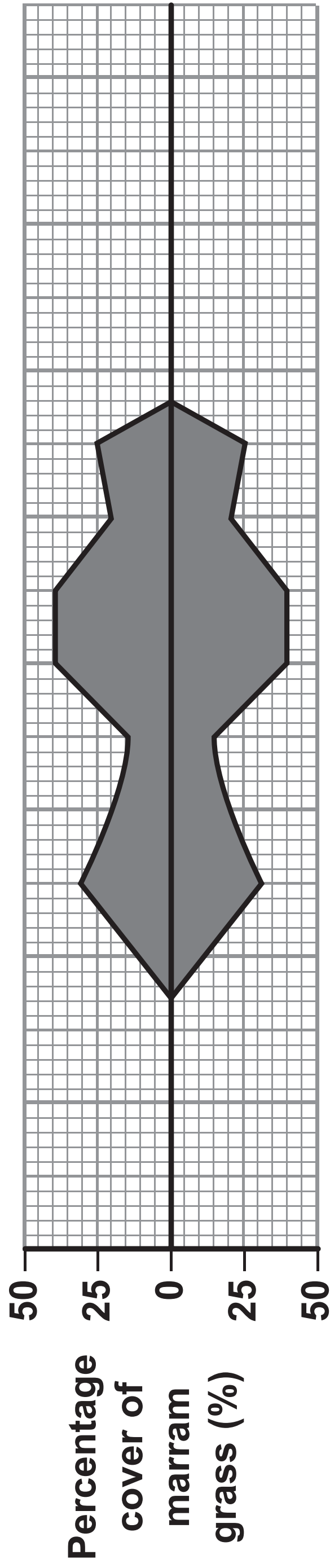
The distribution was measured from the high water line to 170 m inland.

- (a) State what is meant by the term species. (1 mark)**

- (b) The student represented the distribution of the two plant species in a kite diagram as shown on page 34.**

The height of each kite diagram represents the percentage cover of plant species at different distances from the high water line.

(Question continues on next page)



(Question continues on next page)

(Turn over)

- (i) Compare and contrast the distribution of marram grass and elder trees. (2 marks)

- (ii) Explain how the student could have collected the data shown in the diagram. (3 marks)

(Continue your answer on next page)

(Turn over)

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(Turn over)

- (c) The student measured the water content of the soil from the high water line to 170 m inland.**

Describe how the student could have carried out these measurements. (3 marks)

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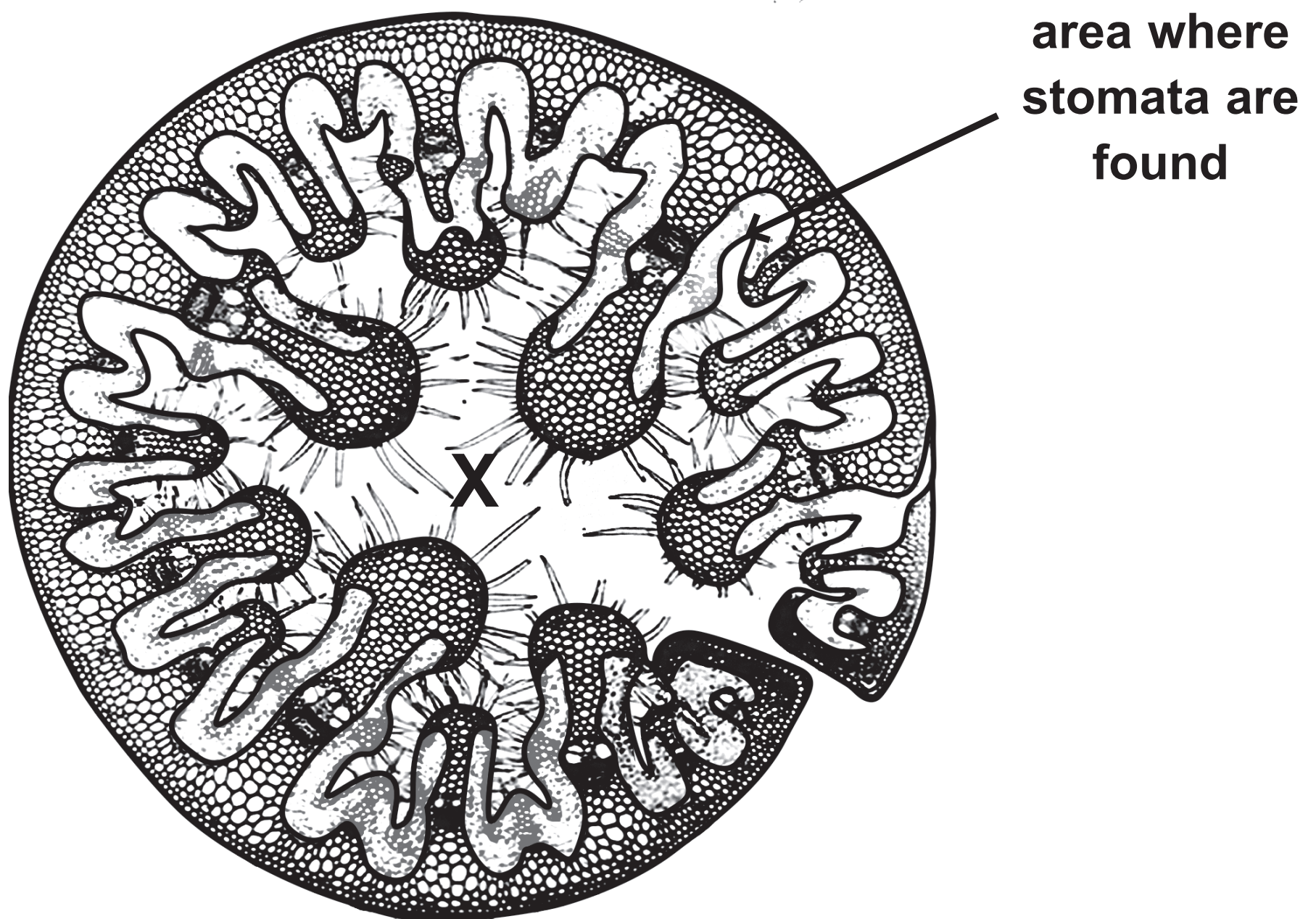
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(Question continues on next page)

- (d) Marram grass leaves are adapted to enable the plants to survive in dry soil.

The photograph shows a section of a marram grass leaf, as seen using a light microscope.



Explain how the structure of this leaf ensures that the water potential at X remains high. (3 marks)

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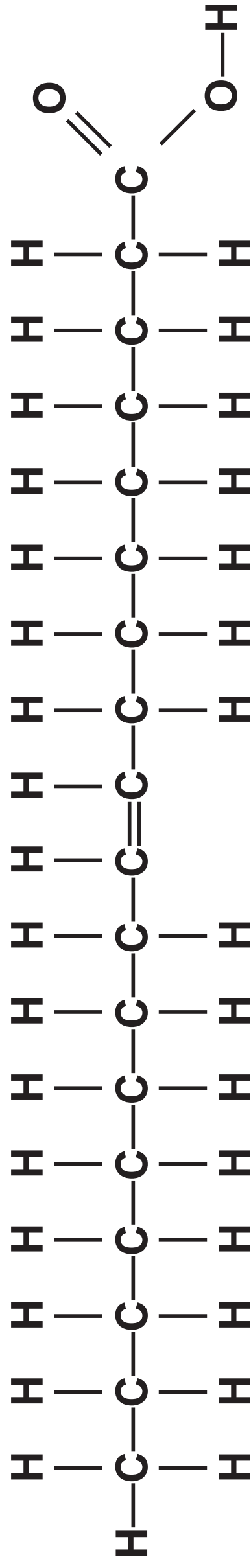
(TOTAL FOR QUESTION 6 = 12 MARKS)

(Questions continue on next page)

(Turn over)

7 Soya bean plants have been genetically modified (GM) to increase the concentration of certain organic molecules.

The diagram shows one of these molecules.



(Question continues on next page)

(a) Explain what type of molecule is shown in the diagram. (2 marks)

(b) Describe how soya bean plants can be genetically modified to produce large numbers of GM soya bean plants. (4 marks)

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(Turn over)

- (c) Some plants have been genetically modified to express viral antigens.**

These plants are used as edible vaccines and stimulate immunity when eaten.

**Devise an investigation that a scientist could use to measure the effectiveness of this vaccine in mice.
(5 marks)**

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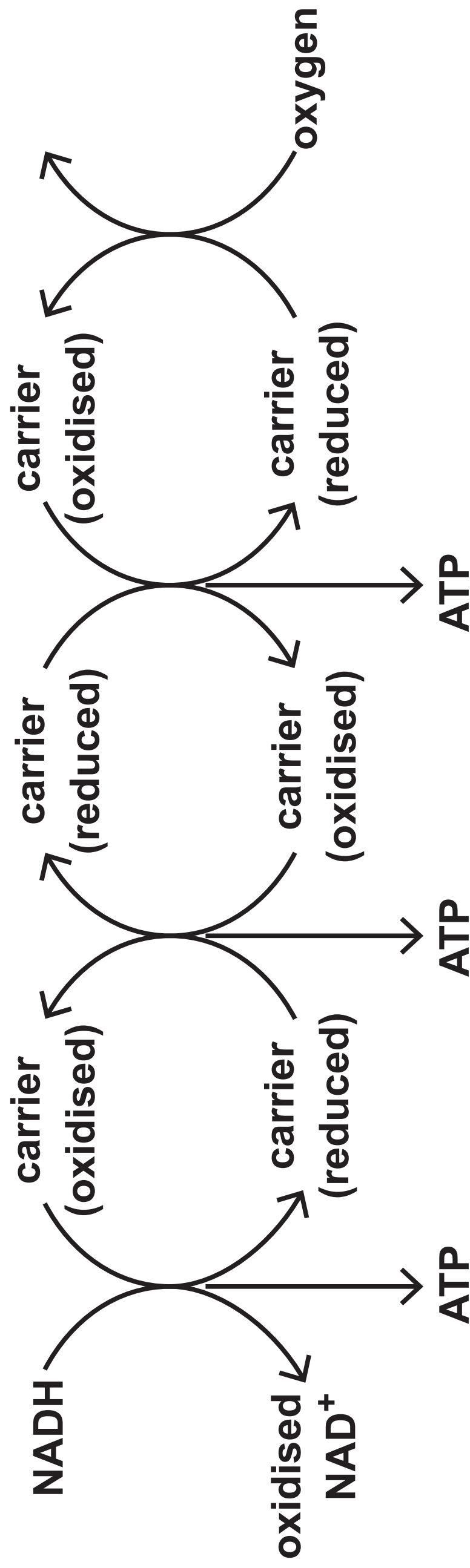
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(TOTAL FOR QUESTION 7 = 11 MARKS)

(Questions continue on next page)

8 The electron transport chain requires oxygen and synthesises ATP.

The diagram below shows part of the electron transport chain.



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(Turn over)

(a) Describe what happens to oxygen at the end of the electron transport chain. (2 marks)

(Question continues on next page)

(b) A scientist investigated the oxygen consumption of four different mammals.

The table shows the results of this investigation.

Mammal	Body mass / kg	Oxygen consumption / dm³ h⁻¹	Oxygen consumption / dm³ kg⁻¹ h⁻¹
Shrew	0·002	0·0216	1·08 × 10¹
Cat	3	1·5	5·00 × 10⁻¹
Human	80	24	3·00 × 10⁻¹
Elephant	4000	50	

(Question continues on next page)

- (i) Calculate the oxygen consumption of the elephant.

Convert your answer into standard form.
(2 marks)

Answer _____ $\text{dm}^3 \text{ kg}^{-1} \text{ h}^{-1}$

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

(Continue your answer on next page)

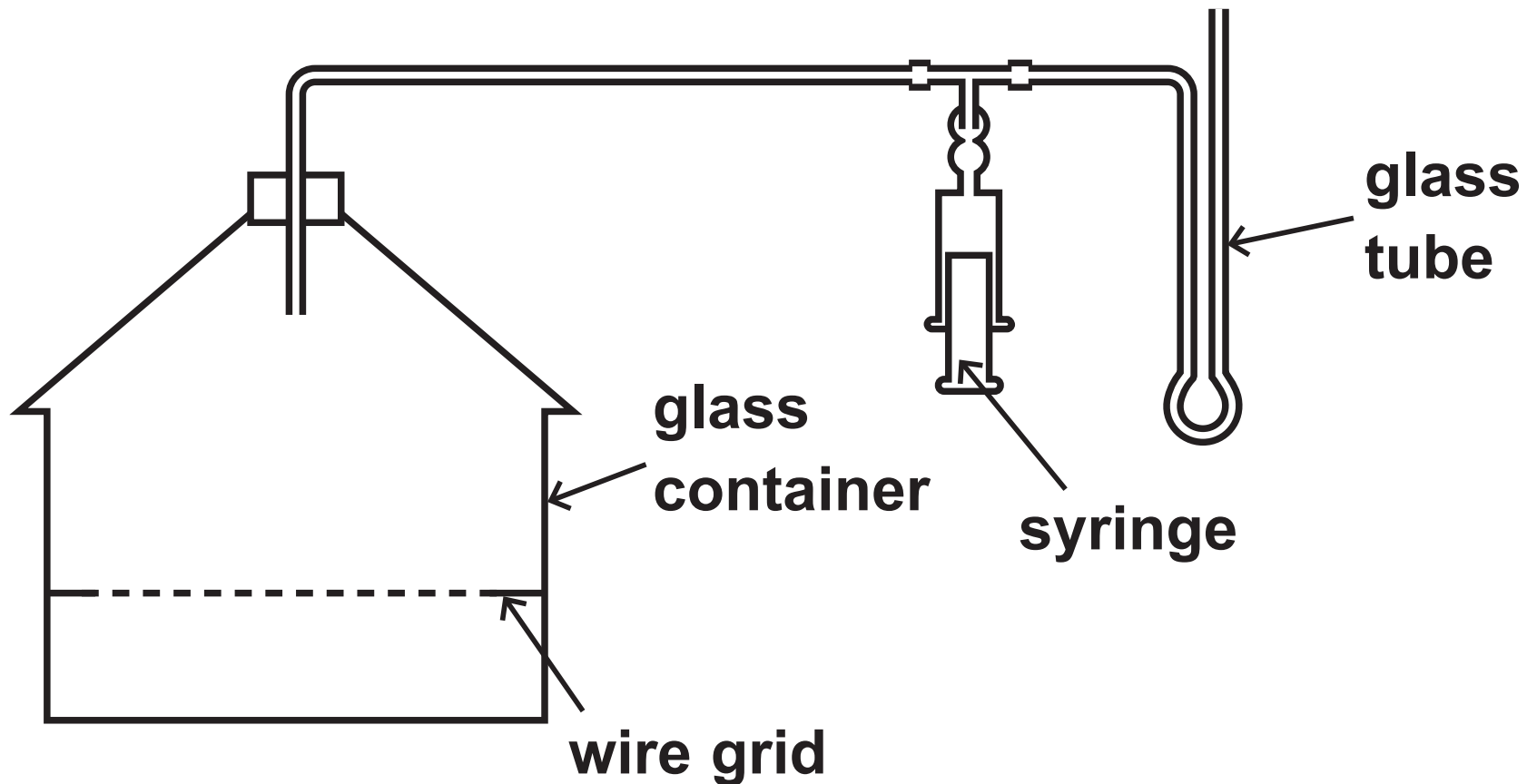
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(Turn over)

(c) The diagram shows a respirometer.



Explain how a student could modify this respirometer and use it to measure the mean oxygen consumption of a rat. (4 marks)

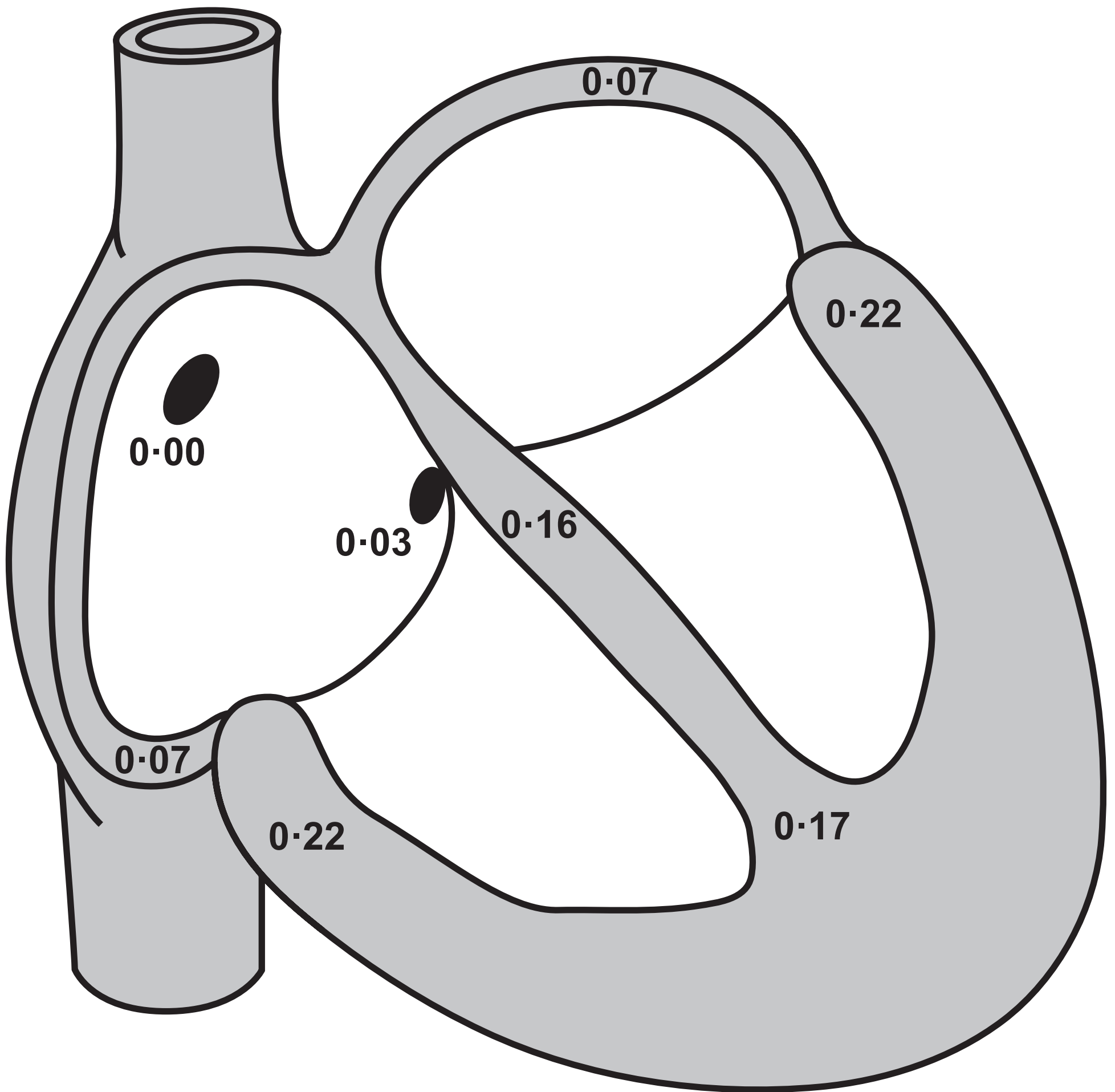
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(Questions continue on next page)

(Turn over)

- 9 The diagram shows the time taken in seconds for an impulse to travel through the human heart.



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(Turn over)

(a) Analyse the information to explain how the times shown in the diagram relate to the cardiac cycle. (5 marks)

[illegible]

(Continue your answer on next page)

(Turn over)

(Question continues on next page)

- (b) The mean heart rate of this heart was 72 beats per minute.

Calculate how long the ventricles are relaxed during one cardiac cycle. (2 marks)

Answer _____ s

- (c) The effect of exercise on the pH of blood plasma and heart rate was investigated.

The investigation used a sample of three people.

The table shows the results of the investigation before and after exercise.

Activity	Mean pH of blood plasma	Mean heart rate / beats min ⁻¹
Rest	7.4	72
Exercise	7.2	94

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(Turn over)

(i) Analyse the data to explain how the pH of blood plasma affects heart rate. (4 marks)

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- (ii) There were errors in the design of this investigation that reduced the validity of the data.**

Explain how this investigation should have been designed to ensure the data was valid. (4 marks)

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(TOTAL FOR QUESTION 9 = 15 MARKS)

(Questions continue on next page)

- 10 When a mouse is put in a new environment, it will move around to find a safe place to live.**

This is called exploratory behaviour.

A student investigated exploratory behaviour by putting a mouse into a large box.

The bottom of the box was marked into squares. There were four corner squares (C), two middle squares (M) and six side squares (S).

The marked bottom of the box is shown in the diagram.

C	S	S	C
S	M	M	S
C	S	S	C

The mouse moved about on the bottom of the box. The square occupied by the mouse was recorded every 10 seconds for 10 minutes.

(Question continues on next page)

The table shows the results of this investigation.

Total number of times square occupied by the mouse		
Corner square	Middle square	Side square
42	6	12

The student tested the null hypothesis that mice show no significant preference for corner, middle or side squares.

- (a) (i) Calculate the Chi squared value using the formula shown. (2 marks)

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Answer _____

(Question continues on next page)

(Turn over)

(ii) The table shows some critical values of Chi squared at different degrees of freedom.

Degrees of freedom	p value				
	0·900	0·500	0·100	0·050	0·010
1	0·016	0·455	2·706	3·841	6·635
2	0·211	1·386	4·605	5·991	9·210
3	0·584	2·366	6·251	7·815	11·345
4	1·064	3·357	7·779	9·488	13·277

Use your calculated Chi squared value and this table to comment on the conclusion the student should make about the null hypothesis. (4 marks)

(Continue your answer on next page)

(Turn over)

(Question continues on next page)

(b) The method used by the student had limitations.

Justify how the student could modify the investigation to address these limitations. (3 marks)

(Continue your answer on next page)

(Turn over)

(Question continues on next page)

(c) The mouse uses its eyes when exploring in the box.

Describe the role of rod cells in initiating action potentials to the brain of the mouse. (5 marks)

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(TOTAL FOR QUESTION 10 = 14 MARKS)

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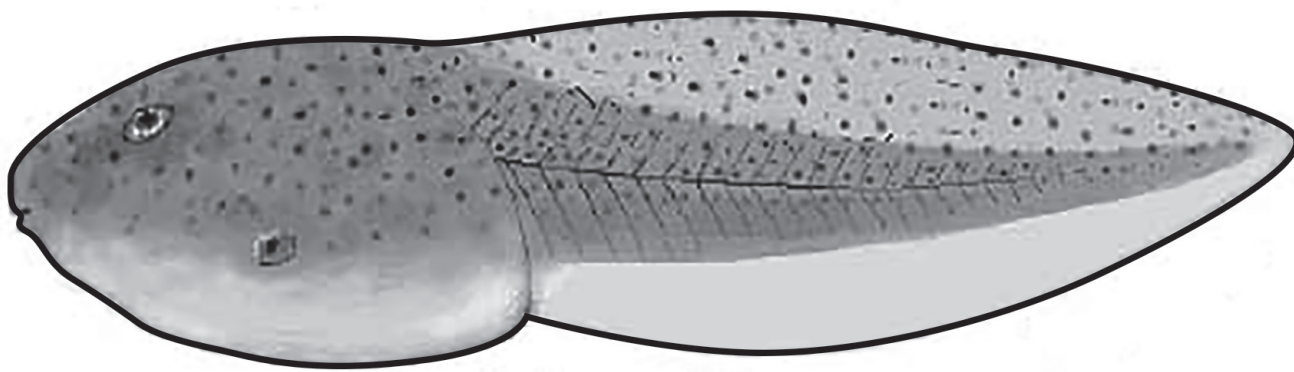
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- 11 The adult American bullfrog, *Rana catesbeiana*, can live in water or on land.

Adult frogs lay eggs in water where they are fertilised.

The fertilised eggs develop into tadpoles that live only in water.

The photograph shows a tadpole.



- (a) State the domain to which *Rana catesbeiana* belongs. (1 mark)

(Question continues on next page)

(b) Adult frogs use lungs for gas exchange but tadpoles use gills.

**Explain how gills are adapted for gas exchange.
(3 marks)**

[illegible]

(Continue your answer on next page)

(Turn over)

(Question continues on next page)

- (c) (i) Human activity can cause pollution that reduces the oxygen concentration in water.**

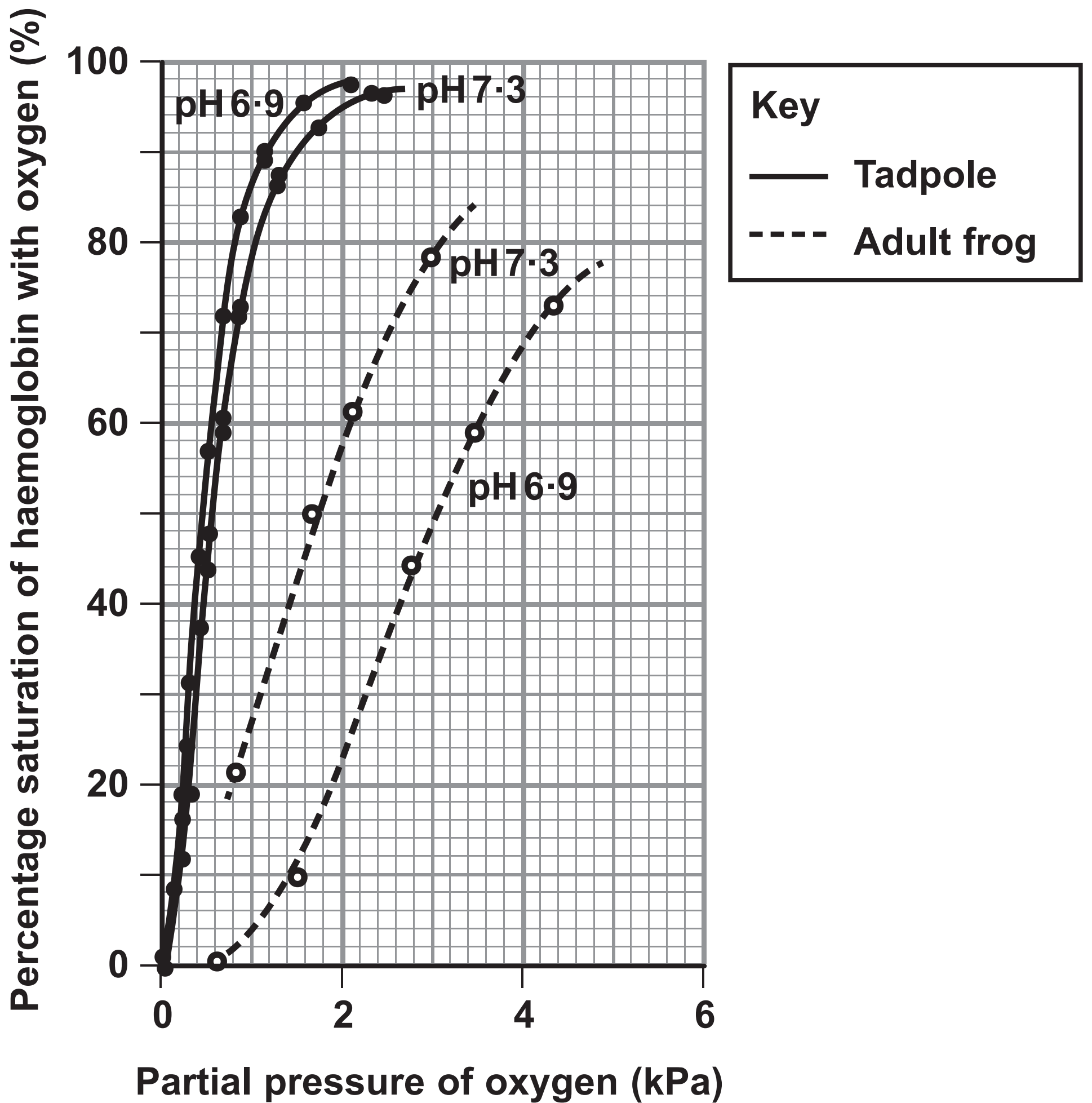
Explain why a low oxygen concentration in the water would lower the pH of the blood of the tadpole. (3 marks)

(Continue your answer on next page)

(Turn over)

(Question continues on next page)

- * (ii) The graph shows the effect of pH on the oxygen dissociation curves of haemoglobin for adult frog blood and tadpole blood.**



(Question continues on next page)

(Turn over)

**The adult frog can either live on land or in water.
The tadpole always lives in water.**

**Discuss how the shape and position of the
dissociation curves reflect the habitat in which
these animals live. (9 marks)**

(Continue your answer on next page)

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