



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2022

Centre Number

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Candidate Number

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Biology

StemUp Model Solution

Assessment Unit AS 3

assessing

Practical Skills in AS Biology



[SBY31]

SBY31

FRIDAY 10 JUNE, AFTERNOON

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete in black ink only. **Do not write with a gel pen.**

Answer **all seven** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 50.

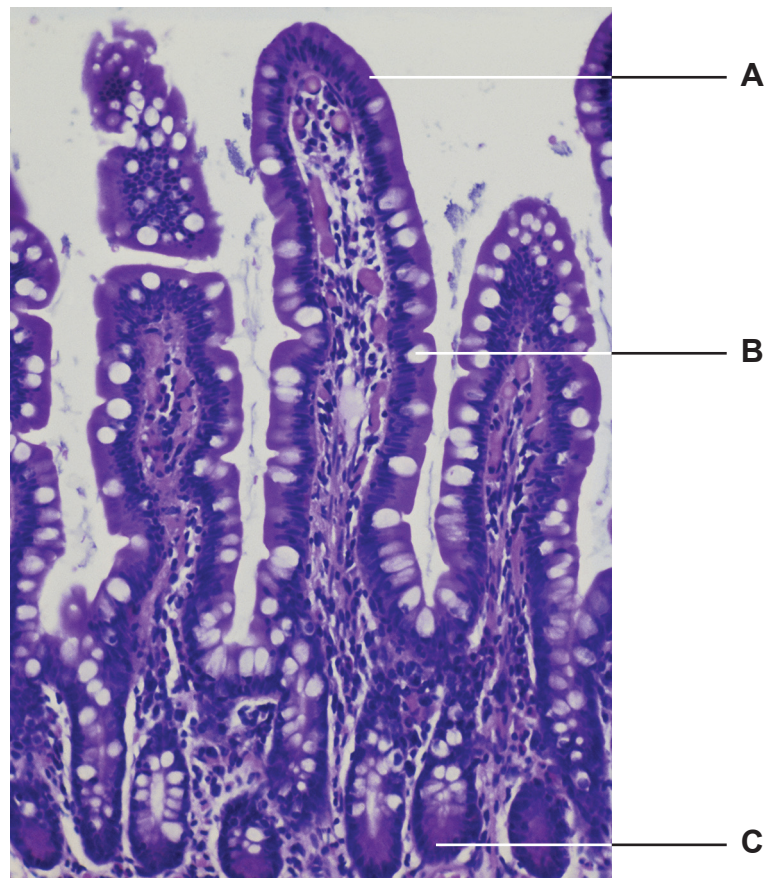
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

You are reminded of the need for good English and clear presentation in your answers.

Use accurate scientific terminology in all answers.



- 1 A photomicrograph of a transverse section through part of the ileum is shown below.



© Biophoto Associates / Science Photo Library

- (a) Identify the cells located at A–C.

A columnar epithelial cell

B goblet cell

C Paneth cell

[3]

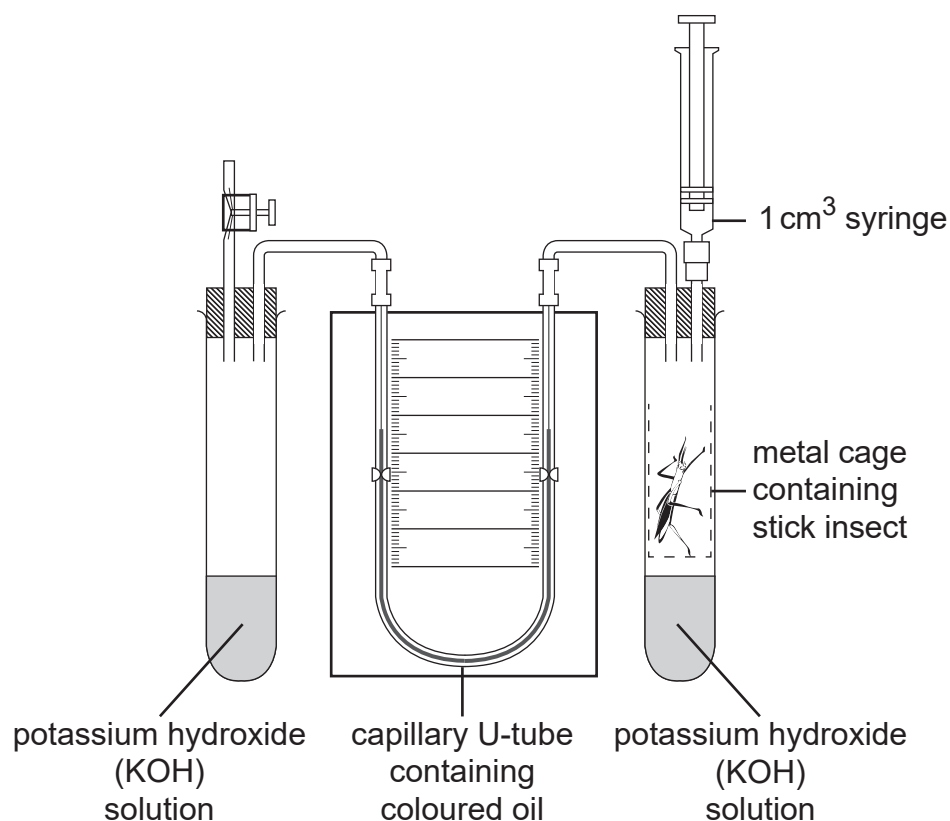
- (b) Name the tissue **layer** of the ileum immediately below the layer shown in this photomicrograph.

muscularis mucosa

[1]



- 2 (a) The apparatus shown below can be used to measure the rate of oxygen uptake in small organisms such as stick insects.



- (i) Name the apparatus shown.

respirometer

[1]

- (ii) State the function of the potassium hydroxide in this investigation.

Absorbs CO₂ so oil movement is only due to O₂ uptake.

[1]

- (iii) State **one** precaution necessary when using this apparatus to ensure valid results.

The apparatus must be airtight, with equal volumes of KOH solution in each tube.

[1]

[Turn over]



- (b) (i) Describe how you would use this apparatus to compare the rate of oxygen uptake in stick insects at 10°C and 25°C.

Place the respirometer in a thermostatically controlled water bath at

10°C and leave it to equilibrate with the tap open.

Close the tap and measure the distance the coloured oil moves

towards the insect in a set time, e.g. 10 minutes.

Reset the oil level using the syringe and repeat, then repeat the

whole procedure in a water bath at 25°C with the same insect.

Calculate the rate as distance moved per minute and find a mean of

three readings at each temperature.

[3]

- (ii) Predict the outcome of this investigation and suggest an explanation.

Prediction

The rate of oxygen uptake will be greater at 25°C than at 10°C.

Explanation

At 25°C the enzyme and substrate molecules have more kinetic

energy, so there are more successful collisions.

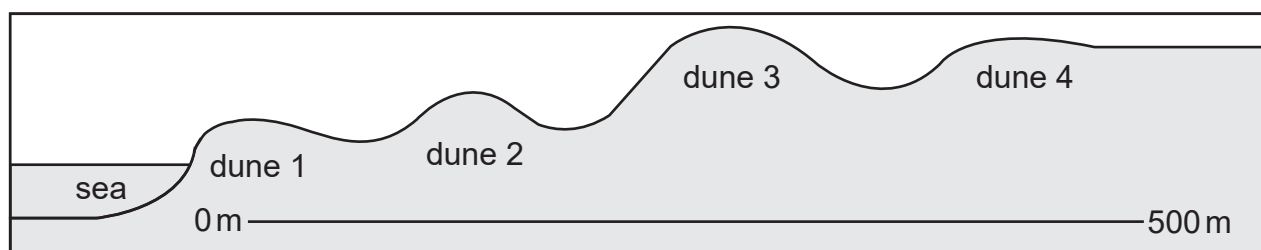
This gives a faster rate of respiration in the stick insect, so more

oxygen is used per minute.

[3]



- 3 Sampling techniques can be used in a variety of ecological investigations. The distribution of plant species found on sand dune systems often shows a pattern, moving inland from the shore. The diagram below represents a typical sand dune system.



Source: Principal Examiner

- (a) Describe a sampling method which could be used to investigate the pattern of plant species distribution, from dune 1 to dune 4.

Use an interrupted transect running from dune 1 to dune 4, or carry out (random) sampling within each of the four dunes.

Within each dune, mark out a grid and use random numbers to choose coordinates for random sampling, or sample at regular intervals along the transect (systematic sampling).

At each sampling point place a quadrat (or a pin frame).

Record the number of each plant species, or their percentage cover or frequency, in each quadrat.

Identify the species using an identification key, and take several samples per dune to calculate a mean.

[5]

[Turn over]



In a separate investigation focusing on dune 4, the frequency of three plant species (**A**, **B** and **C**) was estimated.

Ten sample sites on dune 4 were used in this investigation. At each sample site, a pin frame with 20 pins was used. The number of pins touching each species (**A**, **B** and **C**) was recorded in the table below.

Species	Number of pins touching species									
A	0	1	1	2	3	3	1	0	2	0
B	14	5	0	8	11	6	0	10	4	8
C	9	8	3	1	5	2	1	1	0	2

The data was processed using the following formula to estimate percentage frequency.

$$\% \text{ frequency} = \frac{\text{total number of pins touching the species}}{\text{total number of pins in sample}} \times 100$$

(b) Use this formula to calculate the percentage frequency of species **B**.

(Show your working.)

$$\text{total pins touching B} = 14 + 5 + 0 + 8 + 11 + 6 + 0 + 10 + 4 + 8 = 66$$

$$\text{total pins in sample} = 10 \times 20 = 200$$

$$\% \text{ frequency} = 66/200 \times 100 = 33$$

33 % [2]



4 The photomicrograph below shows chromosomes during cell division.



© Dr. Juan F. Gimenez-Abian / Science Photo Library

(a) Identify the **type** of cell division taking place and give **two** pieces of evidence to support your answer.

Cell division meiosis

1. Homologous chromosomes are paired up as bivalents.

2. Chiasmata are visible where non-sister chromatids have crossed over.

[3]

(b) Name the **stage** of cell division in which chromosomes would appear as shown.

prophase I

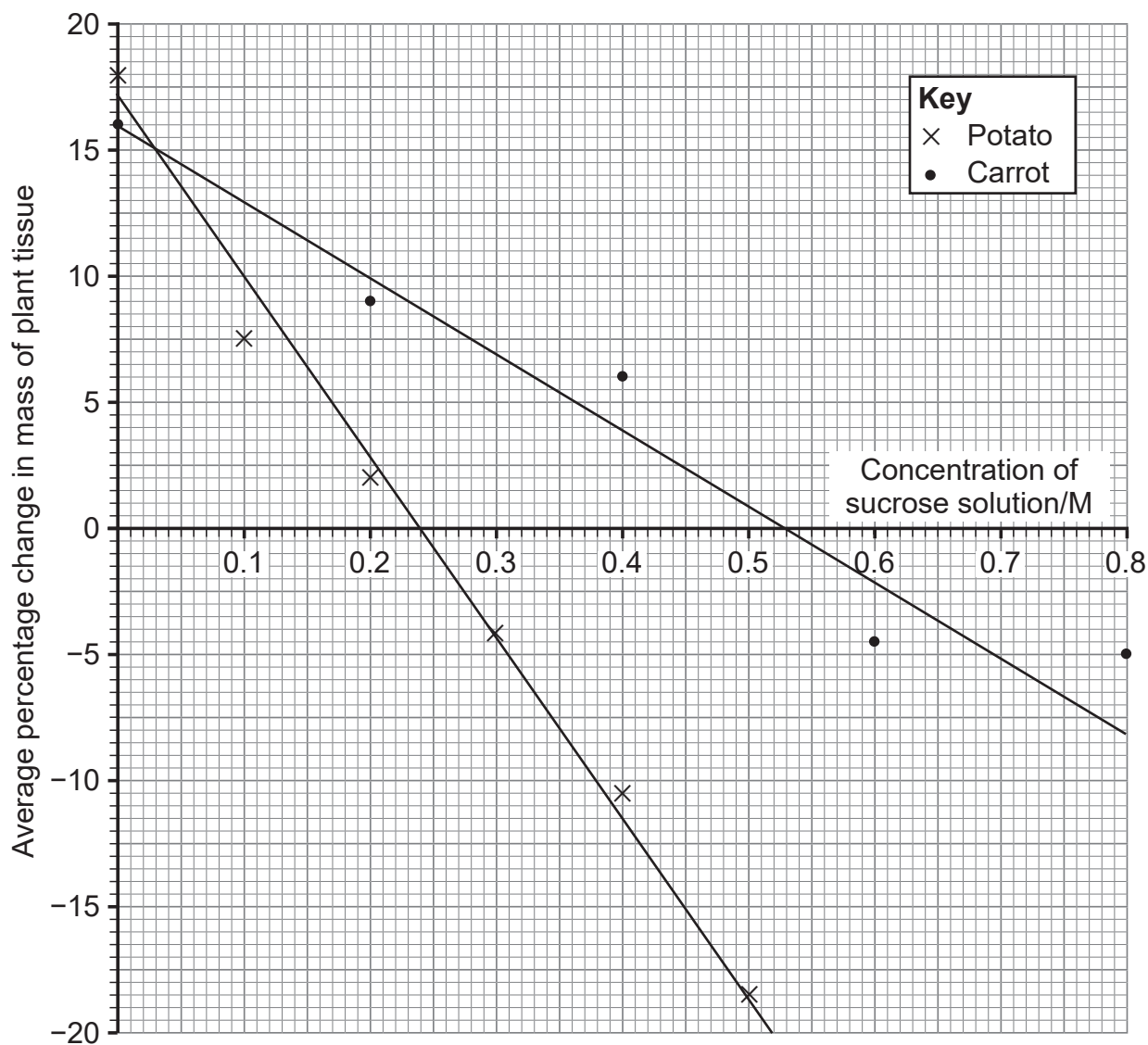
[1]

[Turn over]



- 5 (a) An investigation was carried out to determine the water potential of two plant tissues, potato and carrot. Potato cells store carbohydrate in the form of starch, while carrot cells store carbohydrate as sucrose.

Pieces of each plant tissue were weighed and placed into a range of sucrose solutions for 24 hours. They were then reweighed and the average percentage change in mass was calculated. The results are shown in the graph below.



- (i) Describe precisely the trend shown for the potato tissue in sucrose solutions of 0–0.2 M.

*As the concentration of sucrose solution increases from 0 to 0.2 M,
the average % gain in mass decreases (from 18% to about 2%).*

[1]

- (ii) Explain the result for potato tissue at 0.4 M.

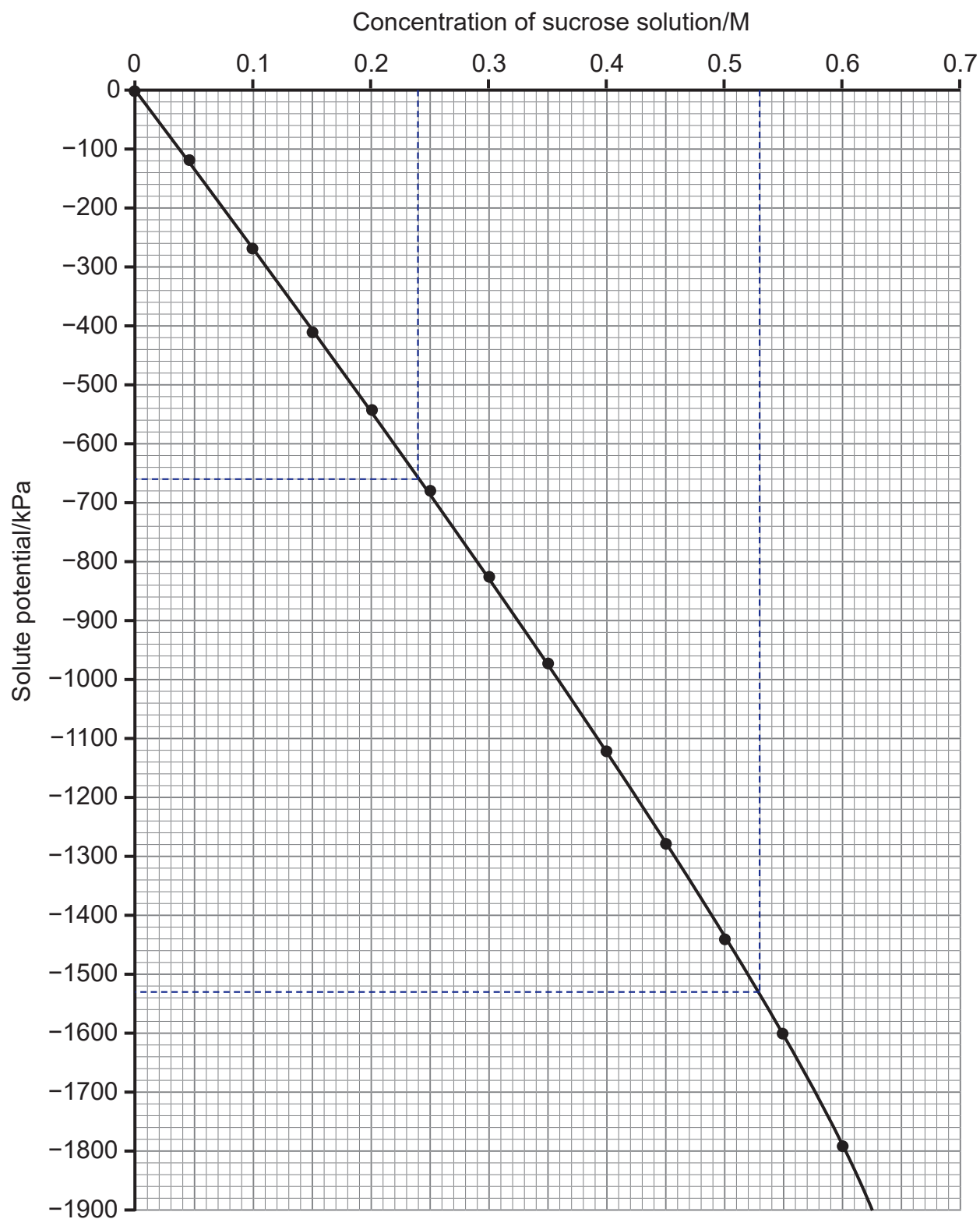
*The potato tissue loses mass (about -10%).
Water leaves the potato cells by osmosis, because the water potential
(ψ) of the 0.4 M solution is more negative (lower) than that of the
potato tissue, so water moves down the water potential gradient.*

[2]

[Turn over]



Below is a calibration graph which shows the relationship between concentration and solute potential of sucrose solution.



13144



(b) Using both graphs, determine the water potential (Ψ) of each tissue.

no change in mass: potato at 0.24 M, carrot at 0.53 M

0.24 M $\rightarrow$ -660 kPa; 0.53 M $\rightarrow$ -1530 kPa

Ψ of potato -660 kPa

Ψ of carrot -1530 kPa [2]

(c) Using the information provided, and your answers to (b) above, describe and explain the difference in the water potential of potato and carrot tissue.

The carrot has a more negative (lower) water potential than the potato

(-1530 kPa compared with -660 kPa).

Potato stores carbohydrate as starch, which is insoluble, so it does not

affect the water potential of the potato cells.

Carrot stores sucrose, which is soluble, so it lowers the solute potential

and makes the water potential of the carrot cells more negative.

[3]

[Turn over]



- (d) Other than immersing all tissues for 24 hours, state **one other** variable that should be controlled to ensure the results are valid. Explain your answer.

Variable

The size of the tissue pieces (same length and diameter, cut with a cork borer).

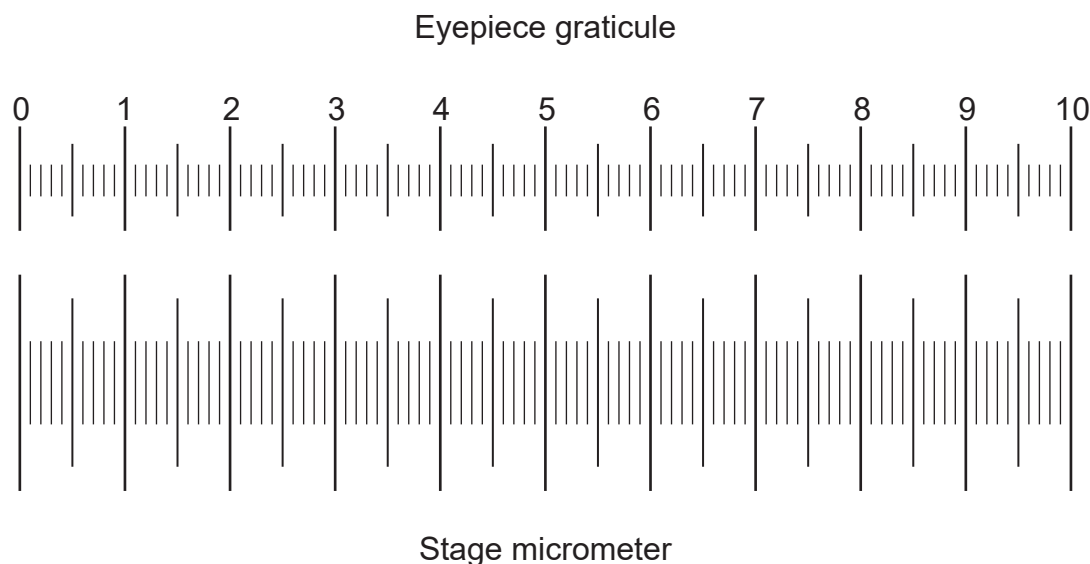
Explanation

Surface area affects the rate of osmosis, so pieces of different sizes would gain or lose mass at different rates.

[2]



- 6 Estimates of cell size can be made using a microscope, an eyepiece graticule and a stage micrometer. The eyepiece graticule is inserted into the microscope's eyepiece lens. This can then be calibrated by lining up a stage micrometer, as seen in the diagram below. This stage micrometer is 1 mm in length and is divided into 100 smaller divisions.



- (a) When using the microscope, describe what you could do to confirm which scale is the stage micrometer.

Rotate the eyepiece lens: the eyepiece graticule rotates but the stage micrometer does not move.

[1]

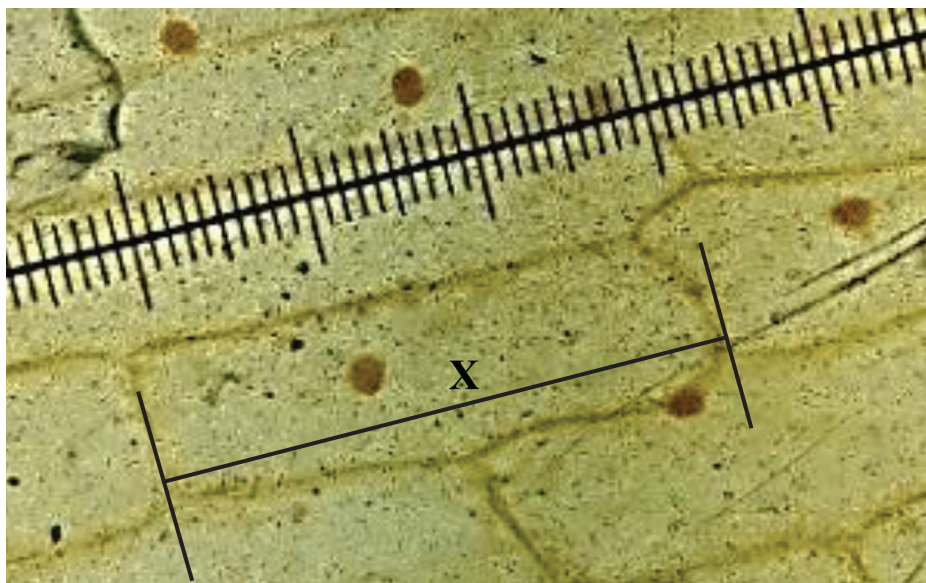
- (b) Using the stage micrometer, determine the size represented by each small division on the eyepiece graticule, as shown above.

10 μm [1]

[Turn over]



- (c) The calibrated eyepiece graticule illustrated on the previous page was used to estimate the length of onion epidermal cells. The photomicrograph below is a view of onion epidermal tissue.



Source: Principal Examiner

- (i) Use your answer to (b) and the line bars provided to estimate the length of an onion epidermal cell along the line **X**.

(Show your working.)

length of line X = 33 eyepiece units

$$33 \times 10 \mu\text{m} = 330 \mu\text{m}$$

330 μm [2]



- (ii) Describe precisely how a reliable estimate of onion cell length in the epidermal tissue could be obtained.

Measure the length of several (at least 10) randomly chosen cells

along their long axis and calculate the mean.

[1]

[Turn over]



- 7 An investigation was carried out to determine the effect of pH on the action of the enzyme maltase on maltose.

Equal volumes of 1% maltase solution were added to each of five test tubes. A different pH buffer was then added to each test tube.

Equal volumes of 1% maltose solution were added to five additional test tubes. All test tubes were placed in a water bath at 35°C and allowed to equilibrate for five minutes.

After this time, the maltose was added to the test tubes of maltase and buffer and the time taken for complete hydrolysis of maltose at each pH was measured.

The rate of reaction of the enzyme was calculated using the following formula.

$$\text{rate of reaction} = \frac{1}{\text{time for complete hydrolysis}} \times 100$$

The results are shown in the table below.

pH	Time for complete hydrolysis/minutes	Rate of reaction/ arbitrary units
3	8.5	11.8
5	3.9	25.6
7	1.8	55.6
9	6.4	15.6
12	11.2	8.9

- (a) (i) **Complete the table** by calculating the rate of reaction at pH5 and pH9. [2]

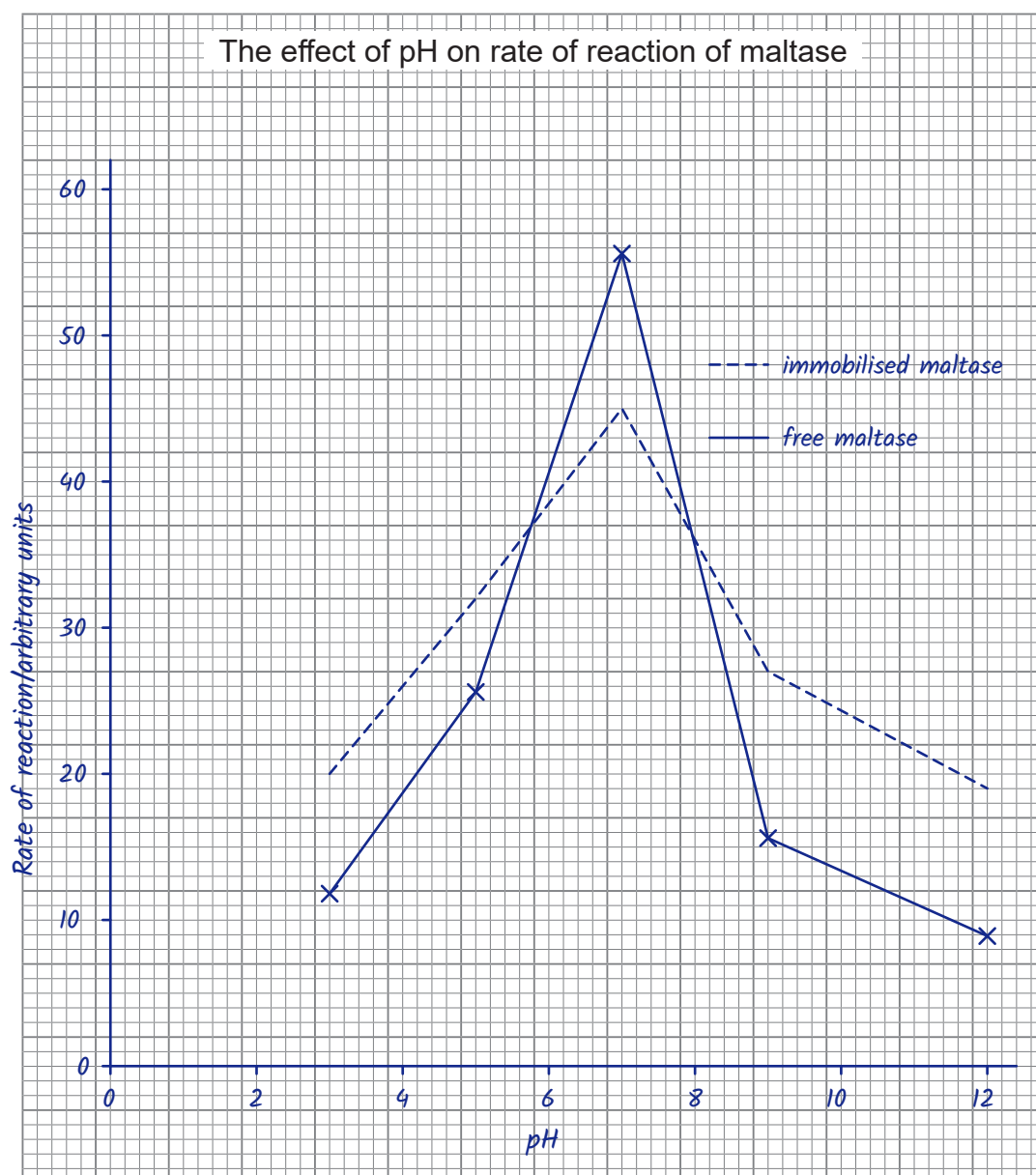
- (ii) Identify the dependent variable in this investigation.

time for complete hydrolysis of maltose

[1]



- (b) Using an appropriate graphical technique, plot the data in the table to show the effect of **pH** on the **rate of reaction** of maltase. [3]



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- (c) (i) Suggest the optimum pH of maltase, from the results of this investigation.

pH 7

[1]

- (ii) Compare and contrast the effects of increasing acidity and alkalinity on the rate of reaction of maltase in this investigation.

Compare

Increasing both acidity and alkalinity away from pH 7 decreases the
rate of reaction, as maltase is denatured.

Contrast

Alkalinity has a more detrimental effect: 2 units above pH 7 (pH 9)
the rate falls to 15.6, but 2 units below (pH 5) only to 25.6.

[2]

- (d) The experiment was repeated using immobilised maltase. On your graph, sketch a line to show how the rates of reaction would be expected to differ. [2]

THIS IS THE END OF THE QUESTION PAPER



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For Examiner's use only	
Question Number	Marks
1	
2	
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4	
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Total Marks	
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Examiner Number

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