Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Time 2 hours 30 minutes

Paper reference **9BI0/03**

Biology B

Advanced

PAPER 3: General and Practical Principles in Biology

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.
- 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 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

- 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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P 6 7 0 8 9 R A 0 1 4 0

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Answer ALL questions.

Write your answers in the spaces provided.

1 Nerve impulses are transmitted along neurones.

(a) (i) In the time period between two nerve impulses, the potential difference across the membrane is –70 mV.

State the term given to this potential difference.

(1)

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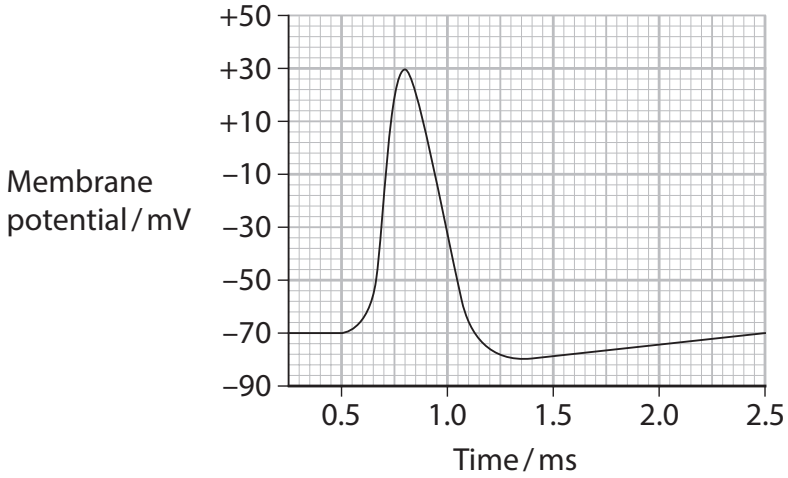
(ii) When the neurone is stimulated, an action potential may occur in the axon, due to the change in permeability of the membrane to ions.

The graph shows an action potential.



Describe what happens in the axon membrane to cause the change in potential difference between 0.55 ms and 0.80 ms.

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(b) Scientists investigated the effect of stimulating an axon with different voltages and measured the response.

The table shows the results of this investigation.

Stimulus voltage / mV	Response
25	No action potential
35	No action potential
45	No action potential
55	Action potential
65	Action potential
75	Action potential

Analyse the data to describe the conclusions which can be drawn.

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(Total for Question 1 = 7 marks)

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2 A student investigated the number of dividing cells in an onion root tip.

The student made a root tip squash and counted the number of cells at each stage of the cell cycle. The table shows the results.

Number of cells at each stage of the cell cycle				
Prophase	**Metaphase**	**Anaphase**	**Telophase**	**Interphase**
4	2	1	1	90

(a) (i) Calculate the mitotic index for these results using the formula

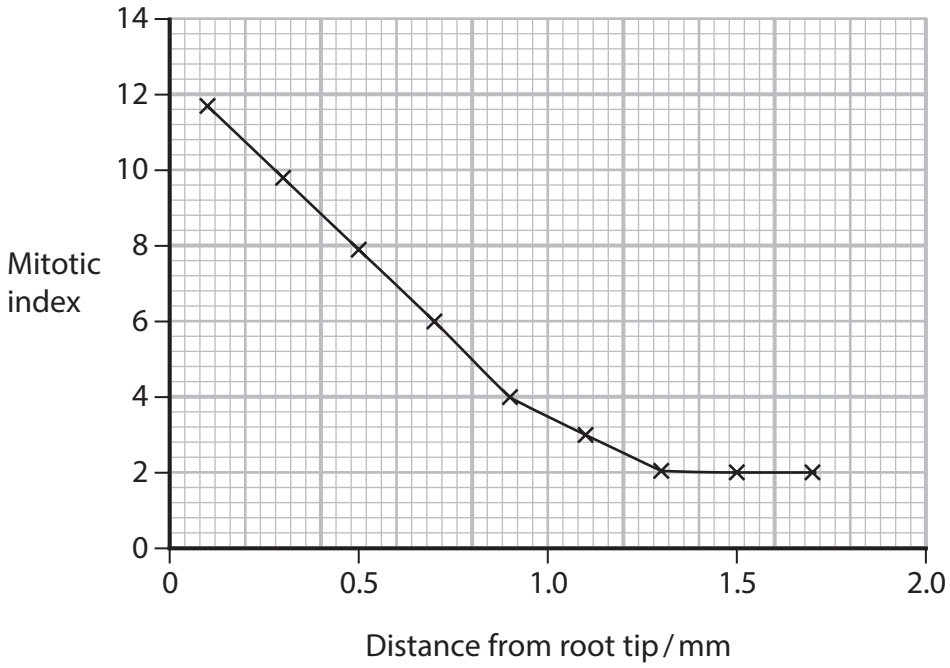
$$\text{Mitotic index} = \frac{\text{number of actively dividing cells}}{\text{total number of cells}} \times 100$$

(2)

Answer .....

(ii) The mitotic index depends on the distance from the root tip.

The graph shows the relationship between the mitotic index and the distance from the root tip.



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Explain the relationship shown in the graph.

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(b) The student used the following method to prepare the root tip squash.

1. Cut a small piece from the tip of a growing onion root and place it in weak acid.
2. Transfer the root tip to a microscope slide.
3. Add a drop of stain.
4. Use a mounted needle to flatten the piece of root and place a coverslip on top.
5. View using low power objective lens of a microscope.
6. Count the cells at each stage of the cell cycle.

Justify two improvements to this method.

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(Total for Question 2 = 6 marks)

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3 Single-celled algae can be trapped in gel beads and used to study photosynthesis.

The beads are placed in a test tube of hydrogencarbonate indicator.

The table shows the colour of the indicator when it contains different concentrations of carbon dioxide.

Colour of indicator	Relative carbon dioxide concentration
yellow	highest
orange	higher than atmospheric air
red	same as atmospheric air
magenta	lower than atmospheric air
purple	lowest

A student used the following method to investigate the effect of light intensity on the rate of photosynthesis.

1. Set up five test tubes, each half-filled with red hydrogencarbonate indicator.
2. Add a teaspoon of gel beads containing single-celled algae to each test tube and close with a bung.
3. Place each test tube at a different distance from a lamp in a dark room.
4. Leave the tubes for 30 minutes.
5. Record the colour of the hydrogencarbonate indicator in each tube and the position of the gel beads.

The table shows the results.

Distance from lamp / cm	5	15	25	35	45
Colour of indicator after 30 minutes	purple	purple	red	orange	orange
Position of gel beads in tube after 30 minutes	half-way up	less than half-way up	bottom	bottom	bottom

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(a) (i) Describe two control tubes that should be used in this investigation.

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(ii) Explain the changes in colour of the hydrogencarbonate indicator in this investigation.

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(b) The colour of the indicator and the position of the beads can be used to give a quantitative measure of the effect of light intensity.

Describe how the method could be modified to give valid, quantitative results.

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(Total for Question 3 = 8 marks)

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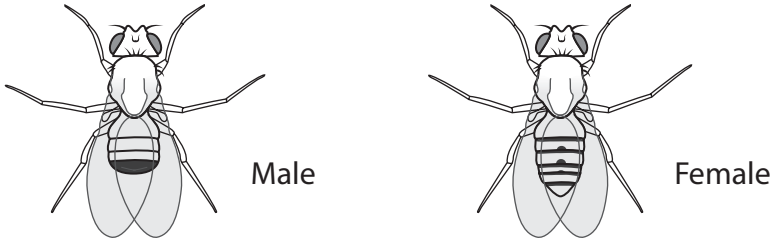
4 Fruit flies, *Drosophila melanogaster*, are often used in genetics investigations. The diagrams show male and female flies.



Actual size = 3 mm

(a) Give one feature, visible in the diagrams, that you could use to distinguish between male and female flies and state how it differs between them.

(1)

Feature

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Difference

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(b) A scientist investigated the inheritance of several genes in fruit flies.

(i) A grey-bodied fly was crossed with a black-bodied fly.

All the offspring in the F_1 generation were grey-bodied.

Two of the grey-bodied flies from the F_1 generation were then crossed.

Determine the expected ratio of phenotypes of the offspring in the resulting F_2 generation by using a genetic diagram.

(2)

Answer .....

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(ii) Normal fruit flies have long wings but some flies have very short wings called vestigial wings.

The allele for long wing (L) is dominant to the allele for vestigial wing (l).

The gene for wing length is located on chromosome 2.

The allele for normal antennae (A) is dominant to the allele for bushy antennae (a).

The gene for antennae shape is located on chromosome 3.

Two flies which are heterozygous for both characteristics are crossed.

Determine the ratio of phenotypes that you would expect in the next generation, using a genetic diagram.

(3)

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(iii) The allele for red eyes (R) is dominant to the allele for white eyes (r).

The scientist investigated the inheritance of eye colour.

The crosses used were:

cross 1 – a red-eyed female fly was crossed with a white-eyed male fly: half of the offspring were red-eyed females and half were red-eyed males

cross 2 – a white-eyed female fly was crossed with a red-eyed male fly: half of the offspring were red-eyed females and half were white-eyed males.

Explain the results of these crosses.

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(Total for Question 4 = 10 marks)

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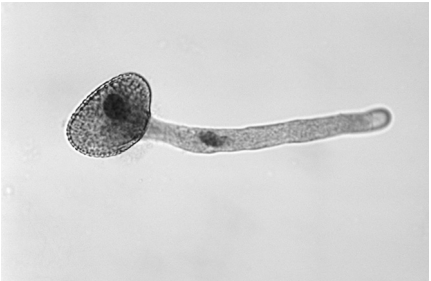
5 (a) The photograph shows a germinating pollen grain as seen through a light microscope.



(Source: © CAROLINA BIOLOGICAL SUPPLY COMPANY/SCIENCE PHOTO LIBRARY)

The actual length of this pollen tube is 136 μm.

Calculate the magnification of this photograph.

(2)

Answer .....

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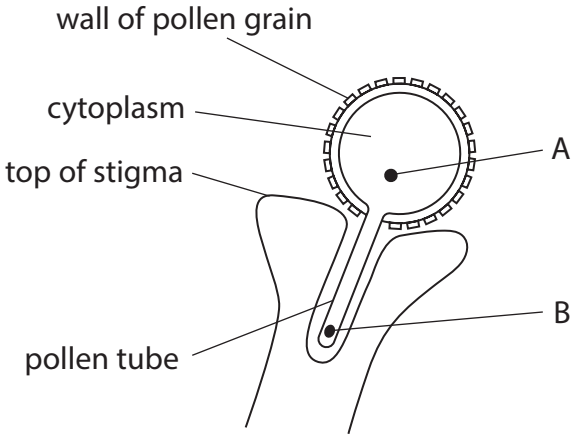
(b) (i) The diagram shows a pollen grain that has begun to germinate after landing on the surface of the stigma of a flower.



Identify the structures labelled A and B.

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A .....

B .....

(ii) Describe the process of double fertilisation in flowering plants.

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(c) Devise an investigation to determine the effect of pH on the rate of growth of pollen tubes.

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(Total for Question 5 = 12 marks)

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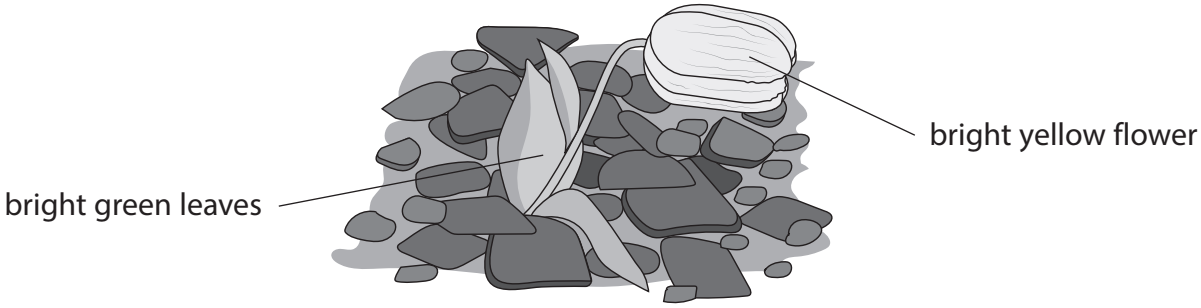
6 *Fritillaria delavayi* is a small plant (height 7 cm), that grows on rocky slopes on mountains in China.

The image shows *Fritillaria delavayi*.



For at least 2 000 years, this plant has been collected and used in Chinese medicine. It is not known to be eaten by animals.

In less accessible regions, where few humans go, the plants are bright green with bright yellow flowers.

In locations where bulbs are collected in high numbers, most plants have greyish-brown leaves and flowers.

Scientists believe that the greyish-brown plants are the same species as the brightly-coloured plants.

(a) Explain why most of the plants in areas where bulbs are collected in high numbers have greyish-brown leaves and flowers.

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(b) (i) Describe how scientists can use gel electrophoresis to show that these plants belong to the same species.

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(ii) Explain why the features of the brightly-coloured plants enable them to grow successfully in the areas where they are not collected by humans.

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(Total for Question 6 = 10 marks)

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7 Plants require mineral ions from the soil for healthy growth.

(a) (i) Describe how mineral (inorganic) ions are taken up by active transport.

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(ii) Describe the function of a named mineral ion that is vital for the growth of plants.

(2)

Mineral ions

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Function

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(b) The photograph shows *Galium verum* (Lady's bedstraw), a plant that grows in meadows, hedges, road verges and sand dunes.

(Source: © Alfio Scisetti/Alamy Stock Photo)

This plant grows to between 15 cm and 60 cm in height.

A student investigated whether *Galium verum* growing in meadows was taller than *Galium verum* growing on sand dunes.

(i) Give a suitable null hypothesis for this investigation.

(1)

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(ii) Devise a method that can be used to collect valid results to test this null hypothesis.

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(iii) Explain which statistical test would be most suitable to test this null hypothesis.

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(Total for Question 7 = 13 marks)

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8 The activity of enzymes is affected by a number of factors.

(a) Explain why increasing the temperature of an enzyme-controlled reaction changes the rate of reaction.

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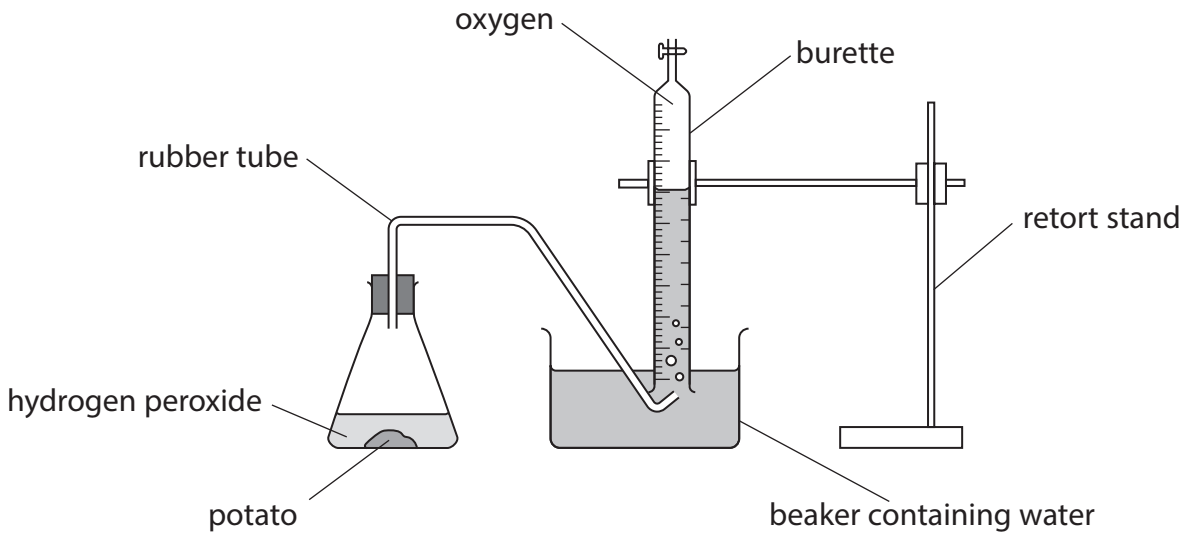
(b) A student investigated the activity of the enzyme catalase in potato.

This enzyme is found in potato cells. It catalyses the conversion of hydrogen peroxide to oxygen and water.

The diagram shows the apparatus used to collect the data.



(i) Describe how two named variables, other than the potato, can be controlled in order to obtain valid results.

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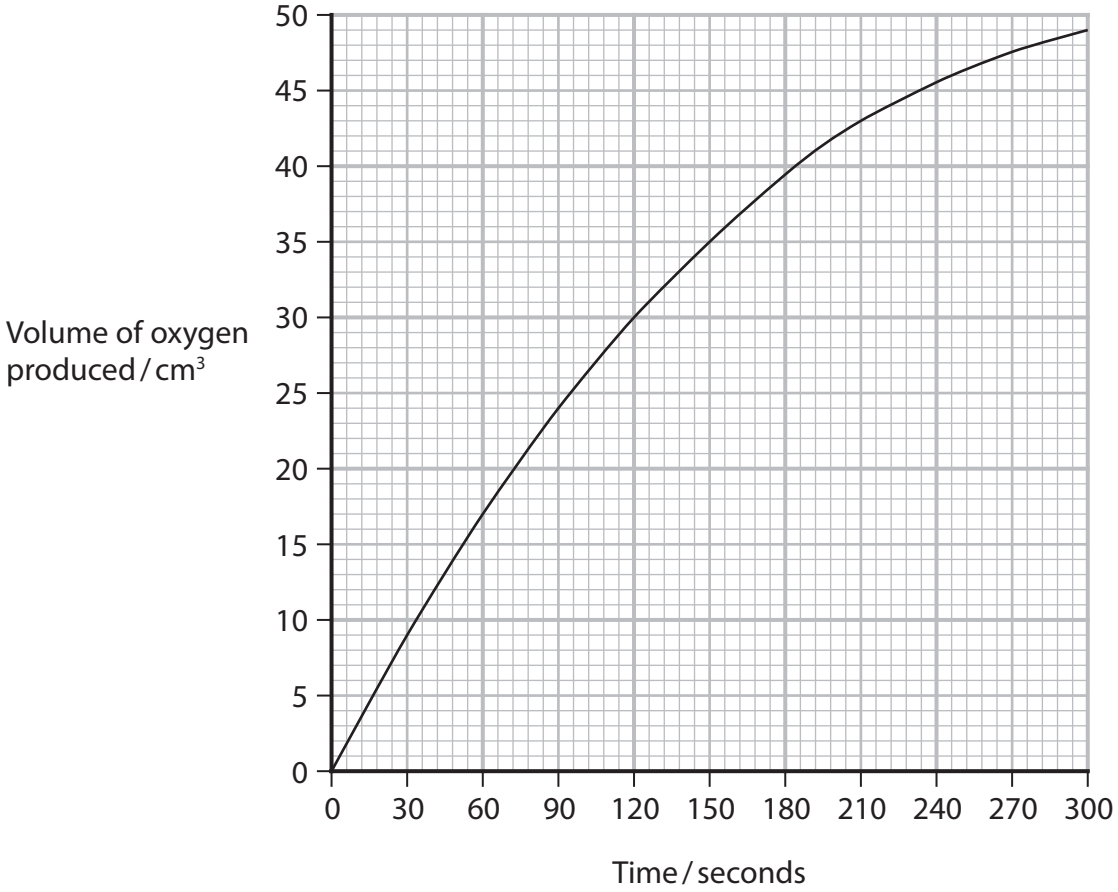
(ii) The graph shows the results of the investigation.



Determine the initial rate of reaction from this graph.

(1)

Answer .....

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(iii) Explain why the rate of reaction decreases over time.

(2)

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(c) The student used this apparatus to investigate the effect of using increasing numbers of potato cubes on the rate of reaction.

The potato was cut into 1 cm^3 cubes to be used in five trials.

In the first trial, one cube was added to the flask and the volume of oxygen produced in 30 seconds was measured.

The hydrogen peroxide was then replaced.

This was repeated in the other four trials using 2, 3, 4 and 5 cubes of potato.

Explain the results you would expect from this investigation.

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(Total for Question 8 = 13 marks)

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9 Water moves through xylem vessels in a plant during transpiration.

Phloem tissue is responsible for transport of organic materials such as sucrose.

(a) Compare and contrast the structure of xylem tissue and phloem tissue.

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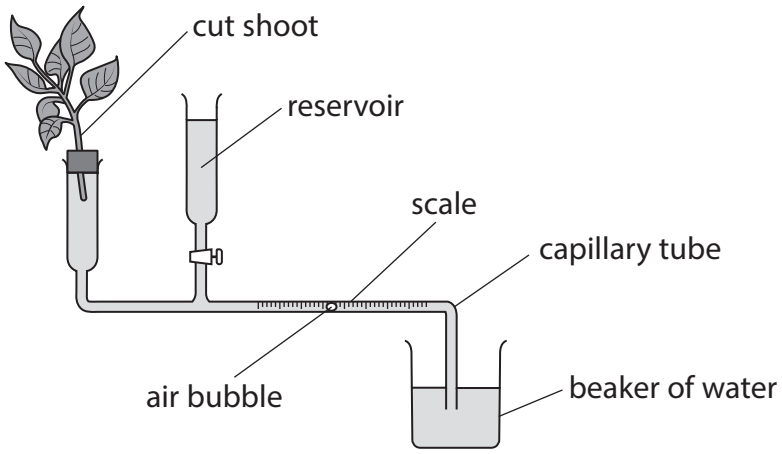
(b) A student used the potometer shown in the diagram to investigate the rate of water uptake in a leafy shoot.



The student investigated the effect of a combination of environmental conditions on the rate of water uptake.

The table shows the results of this investigation.

Conditions	Distance moved by the bubble in 5 minutes / cm					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Mean
Still air, in light	2.4	2.2	2.2	2.2	2.1	2.2
Moving air, in light	6.5	6.7	6.4	6.2	6.3	6.4
Still air, in dark	0.9	0.4	0.0	0.0	0.0	0.3
Moving air, in dark	1.7	0.8	0.0	0.0	0.0	0.5

(i) The internal diameter of the capillary tubing is 0.3 mm.

The volume of a cylinder is calculated using the formula

$$\pi r^2 h$$

Calculate the mean rate of water uptake for the shoot in moving air, in the light.

Give your answer in $mm^3\ min^{-1}$ to two significant figures.

(3)

Answer ..... $mm^3\ min^{-1}$

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(ii) Analyse the data to explain the results of this investigation.

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(iii) Describe how this investigation could be modified to make a valid comparison of water loss from the upper and lower surfaces of the leaves.

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10 Grassland is an important habitat for grazing animals such as cattle.

(a) Fields used for grazing cattle must have a high gross primary productivity.

State what is meant by the term gross primary productivity and include the units in which it is measured.

(2)

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(b) Cattle graze on the plants on grassland.

Describe what happens to the energy in the plants that are not eaten by cattle.

(2)

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*(c) When grazing animals such as cattle, sheep and horses are kept in fields, their faeces are left on the ground, and are known as dung.

The dung is eaten by dung beetles, which in turn are eaten by other animals.

Dung beetles bury dung up to one metre underground in tunnels they have made. This removes the dung from the surface of the field.

A cow can produce over eight tonnes of dung per year.

There are around 60 species of dung beetle in the UK. In 2016, 50% of these were identified as being scarce or threatened.

The photograph shows a dung beetle.

(Source: © Simon Webster/Alamy Stock Photo)

Scientists believe factors causing the decline of dung beetles include:

- farmers using more land to grow crops, and using more land for building and development
- keeping some grazing animals in sheds over the winter, rather than them spending the winter in fields
- fewer habitats for dung beetles, leading to populations of dung beetles becoming isolated and preventing outbreeding
- grazing animals routinely being treated with anti-parasitic drugs that can kill dung beetles.

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Some scientists have stated that farming practices need to change to conserve the species of dung beetle, and to maintain biodiversity and the stability of ecosystems.

Discuss the validity of this statement.

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11 Yeast, *Saccharomyces cerevisiae*, is a single-celled organism used in brewing and baking.

The photograph shows yeast cells seen using a light microscope.

(Source: © Kateryna Kon/Shutterstock)

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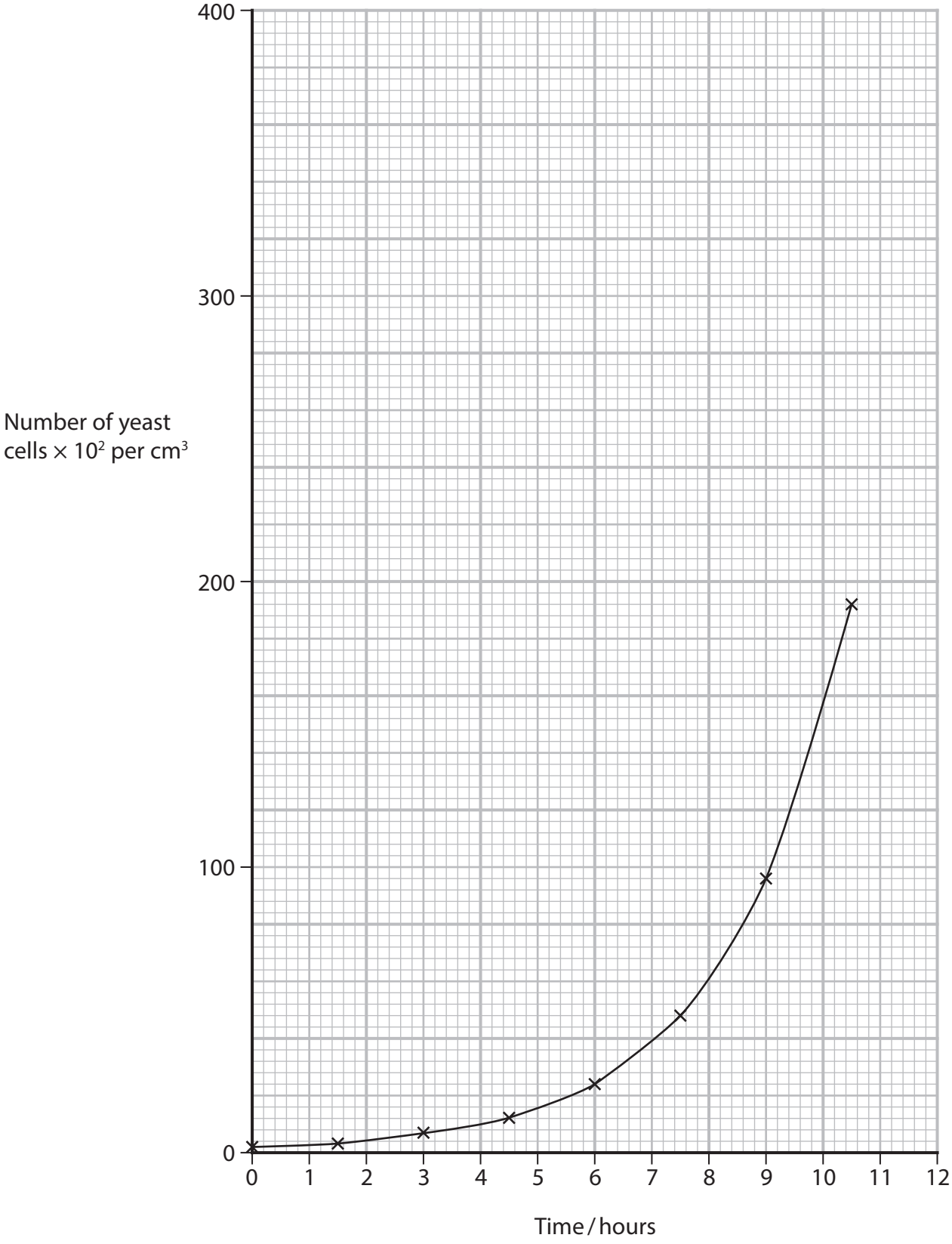
A student counted the number of yeast cells, at 90-minute intervals, growing in a liquid culture at 30°C.

The graph shows the results.



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(a) (i) Calculate the percentage increase in the number of yeast cells from 2 hours to 6 hours.

(2)

Answer ..... %

(ii) Predict the number of cells per cm^3 of the culture at 12 hours.

Assume that the culture continues to grow at the same rate.

(1)

Answer ..... $\times 10^2$ per cm^3

(b) Describe two precautions that would prevent the yeast culture becoming contaminated with bacteria.

(2)

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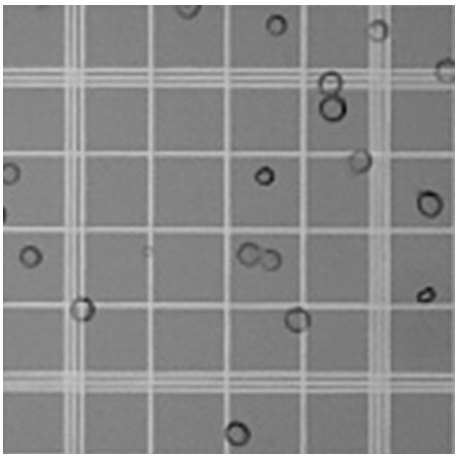
(c) The student counted the yeast cells using a haemocytometer.

This is a slide with chambers containing a known volume of liquid. The yeast cells are counted when viewed using a light microscope.

Any yeast cells totally within the counting square should be counted, along with those which overlap the top or left-hand side of the square.

(i) The volume of liquid in the counting square shown is 0.004 mm^3.



(Source: © Joseph Elsbernd/Flickr)

Calculate the number of yeast cells per mm^3.

Give your answer in standard form.

(2)

Answer ..... per mm^3

(ii) Identify two causes of inaccuracy in this method of counting cells.

(2)

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(d) The table shows the number of cells counted using a haemocytometer.

Time / hours	Number of cells						
	1	2	3	4	5	Mean	Standard deviation (SD)
0.0	1	2	2	1	2	1.6	0.5
1.5	2	3	3	3	2	2.6	0.5
3.0	4	9	9	3	7	6.4	
4.5	13	10	12	9	16	12.0	2.7
6.0	43	31	18	14	15	24.2	12.5

(i) The student calculated the standard deviations using the following formula.

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

Calculate the standard deviation for the sample at 3 hours.

(3)

Answer .....

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(ii) The student concluded that the yeast population doubles every 90 minutes.

Comment on the validity of this conclusion.

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(Total for Question 11 = 15 marks)

TOTAL FOR PAPER = 120 MARKS

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