OCR
Oxford Cambridge and RSA

H

Friday 26 November 2021 – Morning

GCSE (9–1) Biology B (Twenty First Century Science)

J257/04 Depth in Biology (Higher Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)

You can use:
- an HB pencil
- a scientific or graphical calculator

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J257704

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

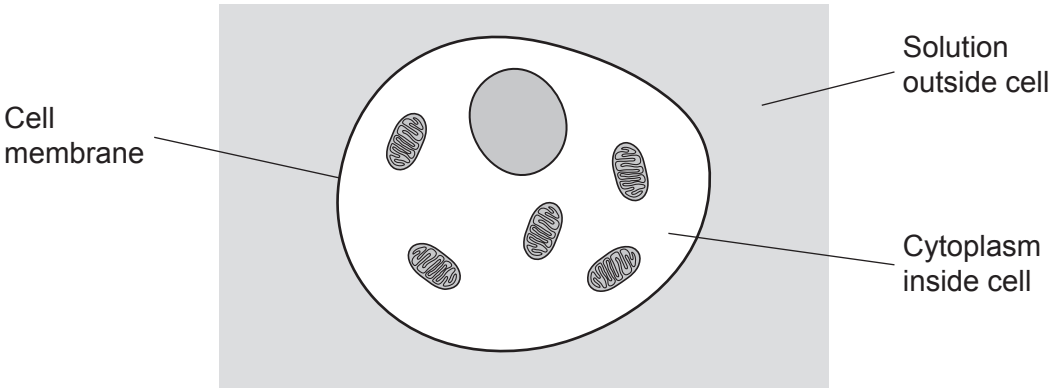
INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **20** pages.

ADVICE
- Read each question carefully before you start your answer.

Answer **all** the questions.

1 Substances can move into and out of cells.

(a) The diagram shows an animal cell.



(i) Osmosis is a type of diffusion.

Which type of particles move through the cell membrane by osmosis?

Tick (✓) **one** box.

Particles of all substances ☐

Particles of salt ☐

Particles of sugar ☐

Particles of water ☐

[1]

(ii) What would be the **net** movement of these particles by osmosis?

Draw **one** line to join the correct start of the answer to the correct end.

From where they are concentrated…	…to where they are less concentrated.
From where they are **not** concentrated…	…to where they are more concentrated.
	…to where they have the same concentration.

[1]

(iii) Explain how the cell's membrane is able to let some particles move through it but prevents other particles from doing so.

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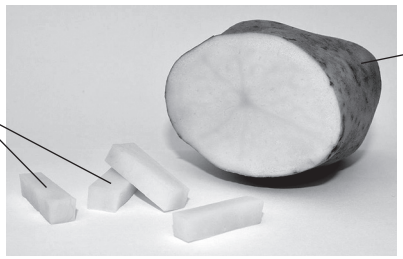
..... **[2]**

(b) Substances move into and out of plant cells.

A student investigated how the mass of raw pieces of potato is affected by soaking them in water containing different amounts of sugar.



The results of the investigation are shown in the table.

Volume of water (cm^3)	**Mass of sugar (g)**	**Mean percentage change in mass of soaked potato pieces (%)**
25	0	16
25	2	4
25	4	–11
25	6	–24

(i)* At the start of the investigation the student was given:

- four cut pieces of potato ready to use
- four beakers of water containing sugar, which were made using the volumes and masses stated in the table

Describe the apparatus **and** method the student could have used to collect the data in the final column of the table.

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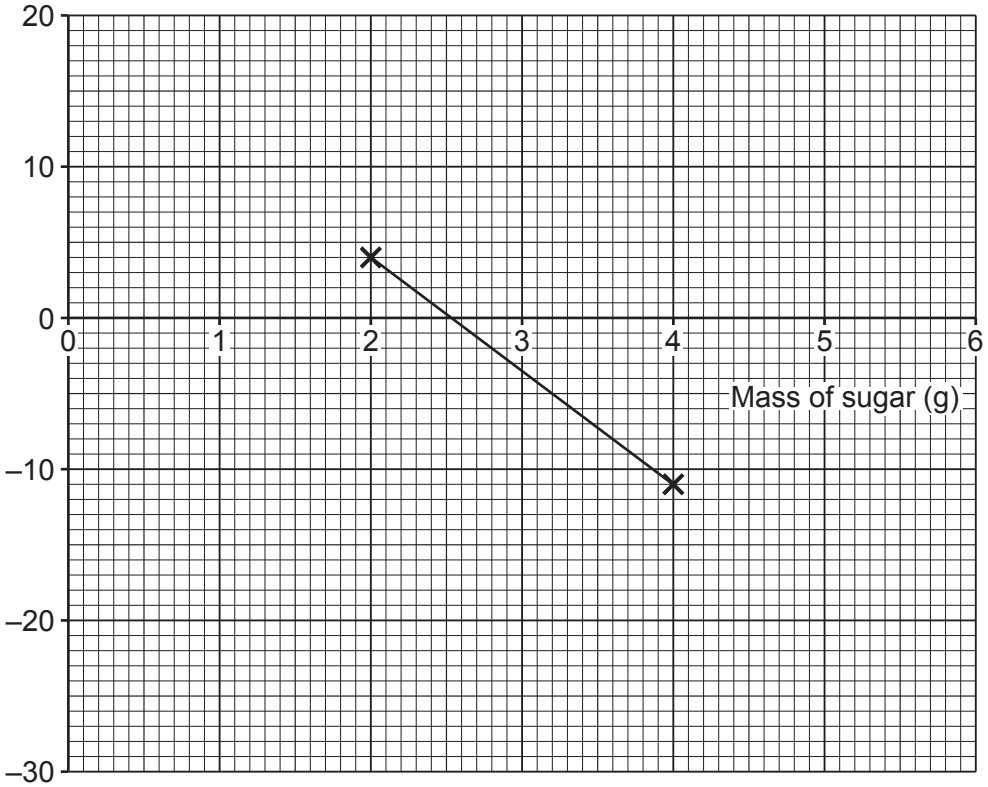
..... **[6]**

Some of the results of the investigation are shown in the graph.



(ii) Complete the graph by adding the missing axis name **and** plotting the missing results.
[2]

(iii) Describe **and** explain the results of the investigation.
Use data from the graph to support your answer.

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..... **[4]**

(iv) Estimate the **concentration** of sugar inside the potato cells, using the graph.
Use the equation: concentration = $\frac{\text{mass}}{\text{volume}}$
Give your answer in g / cm^3.

Concentration = ... g / cm^3 **[2]**

2 Plants can catch diseases.

(a) Complete the table to show which type of pathogen causes each plant disease.

Tick (✓) **one** box in each row.

Plant disease	**Type of pathogen that causes the disease**			
	Bacterium	**Fungi**	**Protist**	**Virus**
Ash dieback				
Crown gall				
Tobacco mosaic				

[3]

(b) Plants have defences against pathogens.

(i) Which **two** are **plant** defences against pathogens?

Tick (✓) **two** boxes.

Antibodies ☐

Antimicrobial substances ☐

Cell walls ☐

Stomach acid ☐

Red blood cells ☐

[2]

(ii) Give **one** more physical plant defence against pathogens.

..... **[1]**

(c) Humans can be vaccinated against some diseases.
Plants cannot be vaccinated against diseases. They do not have any white blood cells.

Explain why this means it is **not** possible to vaccinate plants against disease.

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..... **[2]**

3 Humans make gametes for use in sexual reproduction.

(a) Gametes are made by the process of meiosis.

(i) At the **start** of interphase a human cell has 46 chromosomes. The cell goes through interphase and meiosis to make gametes.

Complete the information in the table to explain what happens **during** and at the **end** of each stage of meiosis.

Stage	**What happens during the stage**	**Number of cells at the end of the stage**	**Number of chromosomes in each cell at the end of the stage**
Interphase	Each chromosome is copied	1	92
First stage of meiosis	Cell division	.....	.....
Second stage of meiosis	....	.....	.....

[2]

(ii) Explain why the number of chromosomes in each gamete is important during fertilisation.

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..... **[1]**

(b) Sexual reproduction in humans depends upon the menstrual cycle. The menstrual cycle is controlled by hormones.

(i) **Four** hormones interact to control the menstrual cycle.

Hormone A
- stimulates a follicle to mature in an ovary
- causes the ovary to release **hormone B**

Hormone B
- causes the uterus lining to thicken
- causes the pituitary gland to release **luteinising hormone (LH)**

Luteinising hormone (LH)
- causes ovulation from a mature follicle
- causes the follicle to break down in the ovary and release **hormone C**

Hormone C
- prepares the uterus lining to receive a fertilised egg
- stops the release of **hormone A** and **LH** by the pituitary gland

Write down the names of the three hormones **A**, **B** and **C**.

Hormone A .....

Hormone B .....

Hormone C .....

[3]

(ii) Sarah's ovaries cannot release any eggs.

Explain why it could be helpful for Sarah to take fertility medication which contains hormone A, and luteinising hormone (LH).

Hormone A: .....

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Luteinising hormone (LH): .....

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[2]

4 Scientists have created an image of a human female who lived 5700 years ago, as shown. The image is based on information in her genome.

(a) Describe what evidence her genome would have contained to show that she was female.

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..... **[1]**

(b) The scientists worked out that she had blue eyes.

Suggest how they could have worked this out from her genome.

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..... **[2]**

(c) Explain why scientists cannot be sure exactly what she looked like, even though they found her complete genome.

In your answer, include examples of other things, in addition to her genome, that could have affected her features.

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..... **[4]**

(d) The scientists investigated all parts of her genome, including her non-coding DNA.

Complete the sentences to explain why investigating her non-coding DNA helped the scientists to create their image of her.

Put a (ring) around the correct answers.

Chromosomes / Genes / Genetic variants in her non-coding DNA would have affected how her genes were expressed.

This would have affected her **chromosomes / genotype / phenotype**.

[2]

(e) The scientists found her complete genome in the remains of some of her cells. The cells were found in an ancient piece of tree gum that she had chewed.

The tree gum that she had chewed also contained DNA from a duck, probably from a meal she had eaten before she died.

Suggest how the scientists could have classified this extra DNA as duck rather than human.

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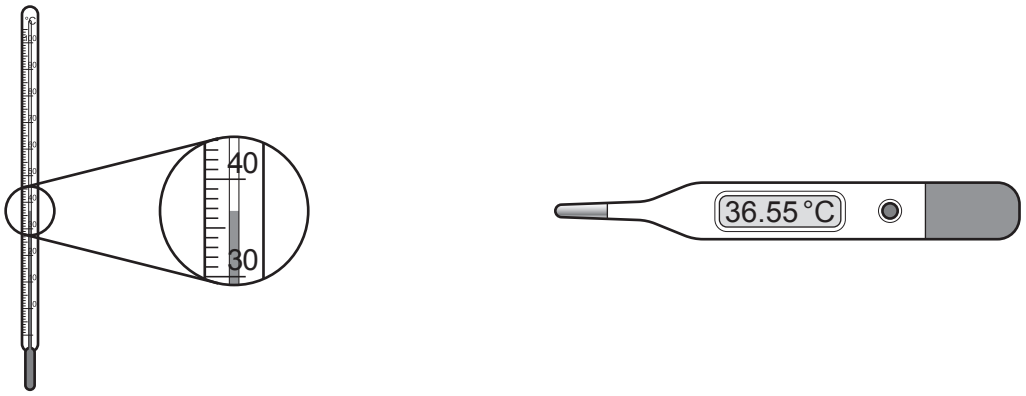
..... **[2]**

5 Beth and Leo plan to investigate the effect of exercise on body temperature.

Beth will exercise for 30 minutes. Leo will measure Beth's body temperature before, during and after exercise.

(a) **Fig. 5.1** shows two thermometers they could use to measure Beth's temperature.



Glass thermometer Digital thermometer

Fig. 5.1

They plan to use the glass thermometer to measure Beth's temperature.

Suggest **two** reasons why using the **digital** thermometer would improve the quality of the data they collect.

1. .....

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2. .....

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[2]

(b) **Fig. 5.2** shows the data they collected using a digital thermometer.

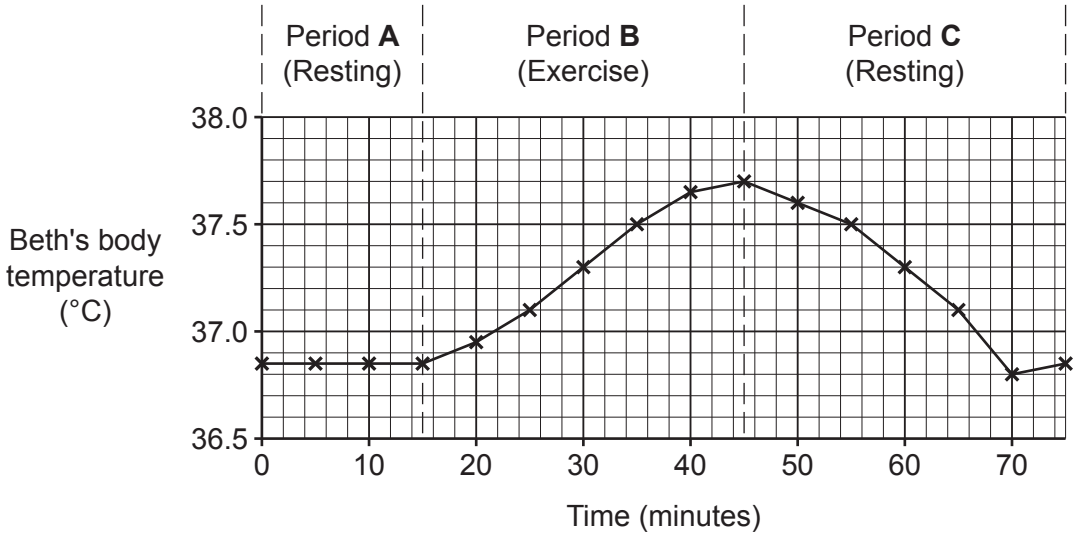

Fig. 5.2

Calculate the difference between the highest and lowest body temperatures for Beth, using **Fig. 5.2**.

Difference = ... °C **[1]**

(c) Beth and Leo wrote a prediction before starting the investigation:

Prediction: Body temperature in all humans will increase during exercise.

(i) Give **one** way in which the results in **Fig. 5.2** support the prediction.

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..... **[1]**

(ii) Give **one** way in which the results in **Fig. 5.2** do **not** support the prediction.

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..... **[1]**

(iii) How could Beth and Leo increase their confidence in their prediction?

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..... **[1]**

(d) Complete the sentences to explain the results in **period B** in **Fig. 5.2**.

Beth's muscles were contracting more during period B. This requires more .....

from a process called ..... in Beth's cells.

This process is described as ..... because it warms the surrounding body tissues.

[3]

(e)* Describe the results shown in period **C** in **Fig. 5.2** and explain what happened in the student's body to cause these results.

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..... **[6]**

6 In the 1800s, Darwin and Wallace suggested natural selection as an explanation for evolution.

(a) What can happen as a result of natural selection?

Tick (✓) **two** boxes.

New species can be formed.	☐
Species can become less well adapted to their environment.	☐
Species can choose how they evolve.	☐
The characteristics of individuals can change during their lifetime.	☐
The characteristics of species can change over generations.	☐

[2]

(b) Darwin and Wallace observed variation in the characteristics of individuals of the same species.

(i) This variation in observable characteristics exists because of genetic variation.

Explain what causes genetic variation.

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..... **[2]**

(ii) Describe **one other** type of evidence observed by Darwin and Wallace that helped them to develop their explanation.

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..... **[2]**

(c) Darwin and Wallace's explanation is still useful today. It can help us to explain why some serious problems have happened, such as the spread of antibiotic-resistant bacteria.

(i) Explain why using antibiotics on bacteria can cause antibiotic-resistant bacteria to become more common.

Use ideas about natural selection in your answer.

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..... **[4]**

(ii) Scientists have suggested that we should reduce our widespread use of antibiotics and only use them when absolutely necessary.

Give **two** ways in which this could help to slow the spread of antibiotic-resistant bacteria.

1. .....

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2. .....

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[2]

7 Layla is setting up a compost bin, as shown in **Fig. 7.1**.

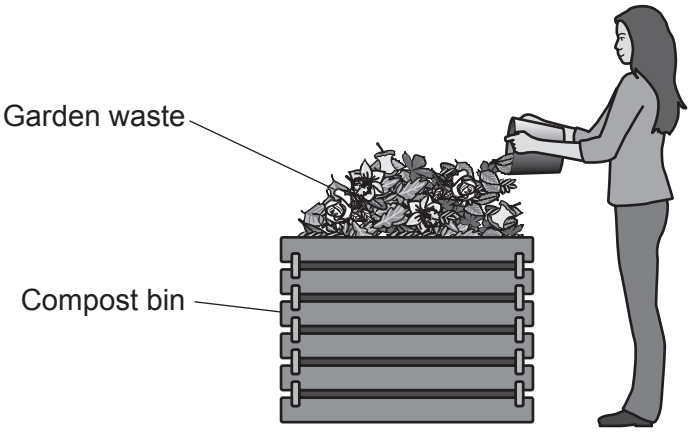

Fig. 7.1

(a) To make good compost, the waste added to the bin should be 50% green (such as grass cuttings) and 50% brown (such as dead leaves).

Today, Layla has added 1.1 kg of grass cuttings and 1.4 kg of dead leaves.

Calculate the percentage of green waste that she added today.

Percentage = ... % **[1]**

(b) Layla adds waste plant material from the garden to the bin, where it will be broken down to make compost.

She is worried that the compost bin might become full of bacteria from the waste.

Explain why the presence of bacteria in the bin will actually be helpful.

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..... **[2]**

(c) Compost that is made in the bin can be added to the soil in the garden.

Explain why it is useful to turn garden waste into compost that is added to the soil, rather than throwing the garden waste away.

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..... **[4]**

(d) Layla plans to add a piece of wood to the compost bin.

The length, width and thickness of the wood is shown in **Fig. 7.2**.

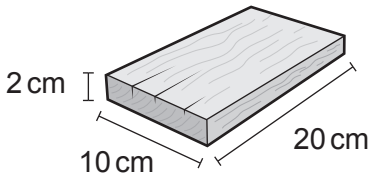

Fig. 7.2

The surface area of the wood is 520 cm^2.

(i) Calculate the surface area to volume ratio of the wood.

Surface area to volume ratio = ... **[3]**

(ii) Explain why the wood will be broken down into compost more quickly if Layla chops it up into small pieces before putting it in the compost bin.

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..... **[2]**

(e) Layla did an experiment to investigate how the rate at which garden waste is broken down changes with temperature.

- She weighed out equal masses of garden waste into six beakers.
- Each beaker contained 50% green waste and 50% brown waste, well mixed together.
- Each beaker was kept at a different temperature for 28 days.

The rate at which the waste in each beaker was broken down is shown in the table.

Beaker	Temperature (°C)	Rate at which the waste was broken down (g / day)
1	5	0.6
2	10	0.8
3	15	1.9
4	20	3.0
5	25	3.2
6	30	2.2

The results have been plotted in **Fig. 7.3**.

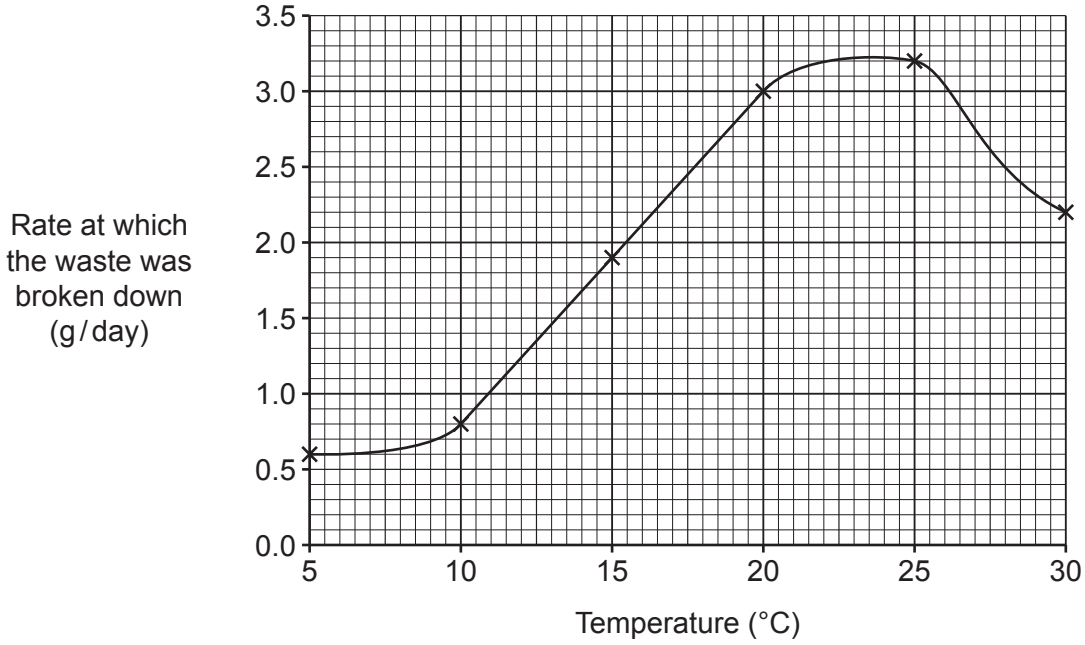

Fig. 7.3

(i) Explain why the rate shown in **Fig. 7.3** was highest at the optimum temperature of approximately 23.5 °C but was lower at temperatures below and above the optimum.

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..... **[3]**

(ii) Which part of the line in **Fig. 7.3** could be represented by the relationship y = mx + c?

Tick (✓) **one** box.

The line between 5 °C and 15 °C.	☐
The line between 10 °C and 20 °C.	☐
The line between 15 °C and 25 °C.	☐
The line between 20 °C and 30 °C.	☐

[1]

(iii) Calculate the **change** in the rate **per °C** between 10 °C and 20 °C, using **Fig. 7.3**.

Change in rate = ... g / day per °C **[2]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).