AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
COMBINED SCIENCE: SYNERGY

F

Foundation Tier Paper 2 Life and Environmental Sciences

Thursday 25 May 2023 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a protractor
- a scientific calculator
- the periodic table (enclosed)
- the Physics Equations Sheet (enclosed).

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

Information
- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

Do not write outside the box

0 1 Bees feed on sugar solution produced by the flowers of plants.

Figure 1 shows a bee feeding on a flower.

Figure 1

0 1 . 1 Why do bees feed on sugar solution?

[1 mark]

Tick (✓) **one** box.

For gaseous exchange ☐

To obtain energy ☐

To provide proteins ☐

Do not write outside the box

Bees have a simple nervous system.

The bee nervous system has many similar features to the human nervous system.

0 1 . 2 The antenna is a sense organ.

The antenna contains specialised cells that detect stimuli.

What are cells that detect stimuli called?

[1 mark]

Tick (✓) **one** box.

Coordinators ☐

Effectors ☐

Receptors ☐

0 1 . 3 When an antenna of a bee touches sugar solution the bee automatically sticks out its tongue.

What type of action is automatic?

[1 mark]

Tick (✓) **one** box.

A conscious action ☐

A delayed action ☐

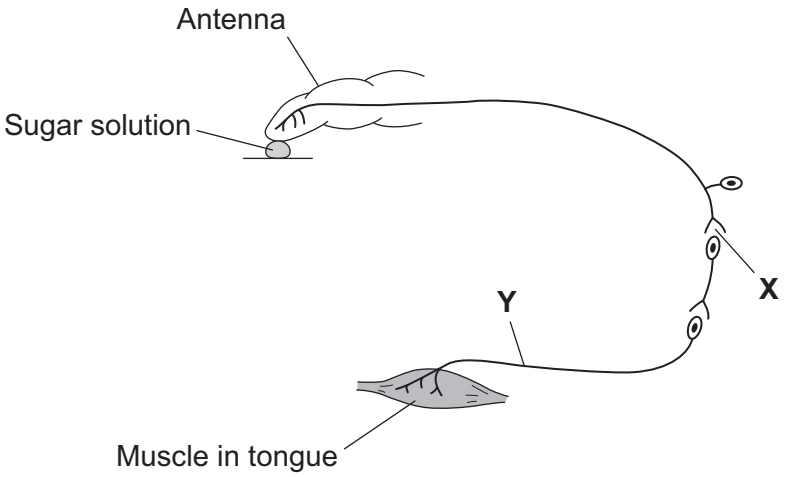
A reflex action ☐

Question 1 continues on the next page

Do not write outside the box

Figure 2 shows the nervous pathway taken when a bee antenna touches sugar solution.

Figure 2



0 1 . 4 What is the gap labelled **X**?

[1 mark]

Tick (✓) **one** box.

A gland ☐

A synapse ☐

An impulse ☐

Do not write outside the box

0 1 . 5 What type of neurone is **Y**?

[1 mark]

Tick (✓) **one** box.

Motor neurone ☐

Relay neurone ☐

Sensory neurone ☐

Eyes are sense organs that can detect electromagnetic radiation.

A bee's eye can detect ultraviolet radiation.

0 1 . 6 Detecting ultraviolet radiation allows the bee to see the parts of the flower that produce sugar solution.

Why is it an advantage for bees to see the parts of the flower that produce sugar solution?

[1 mark]

_____

_____

Question 1 continues on the next page

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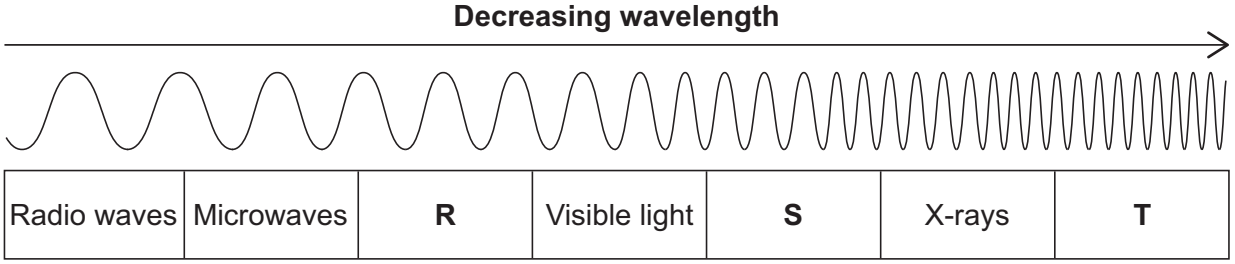
Figure 3 shows the electromagnetic spectrum.

Figure 3



0 1 . 7 Which letter shows the position of ultraviolet radiation in the electromagnetic spectrum?

[1 mark]

Tick (✓) **one** box.

R ☐

S ☐

T ☐

0 1 . 8 Which part of the electromagnetic spectrum in **Figure 3** has the lowest frequency?

[1 mark]

_____

8

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 2 The orca is a large animal that lives in the ocean.

Figure 4 shows an orca.

Figure 4

0 2 . 1 Complete the sentence.

Choose the answer from the box.

[1 mark]

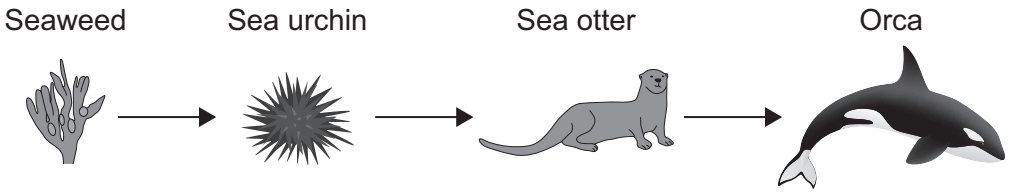
community	**habitat**	**population**

The ocean is the orca's _____ .

Do not write outside the box

Figure 5 shows a food chain.

Figure 5



0 2 . 2 Draw **one** line from each organism to the description of that organism in the food chain.

Use information from **Figure 5**.

[3 marks]

Organism	Description
Orca	Primary consumer
Sea otter	Producer
Seaweed	Secondary consumer
	Tertiary consumer

Question 2 continues on the next page

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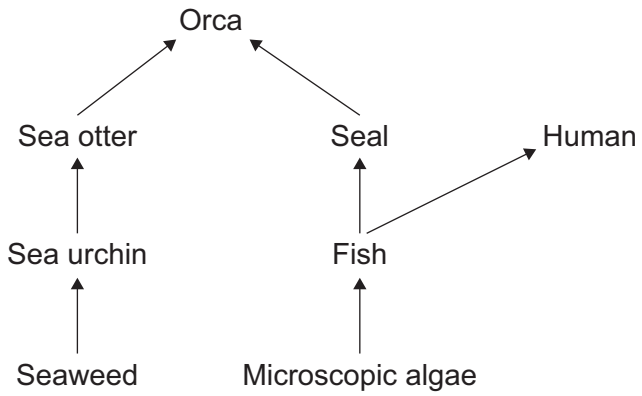
Figure 6 shows a food web.

Figure 6



0 2 . 3 Seaweed and microscopic algae photosynthesise.

Give **two** factors that affect the rate of photosynthesis.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

The number of fish in the oceans has decreased since 1990.

0 2 . 4 Suggest **one** way that human activity has caused the decrease in the number of fish.

[1 mark]

0 2 . 5 Explain how a decrease in the number of fish could affect the numbers of other organisms in the food web.

Use **Figure 6**.

[6 marks]

13

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0 3 Pollutants in the atmosphere can be harmful to the environment and to human health.

Four pollutants in the atmosphere are:

- carbon monoxide
- oxides of nitrogen
- particulates
- sulfur dioxide.

0 3 . 1 How is carbon monoxide produced?

[1 mark]

Tick (✓) **one** box.

By carbon dioxide dissolving in water ☐

From the incomplete combustion of hydrocarbon fuels ☐

When carbonates form sedimentary rocks ☐

0 3 . 2 What is formed when sulfur dioxide dissolves in moisture in the air?

[1 mark]

Tick (✓) **one** box.

Acid rain ☐

Methane ☐

Ozone ☐

Do not write outside the box

0 3 . 3 Complete the sentence.

[1 mark]

Oxides of nitrogen are produced when fuels are burnt in air

at a high _____ .

0 3 . 4 Give **one** way that oxides of nitrogen can be harmful to human health.

[1 mark]

_____

_____

Question 3 continues on the next page

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Particulates are classified into different groups depending on the diameter of the particulate.

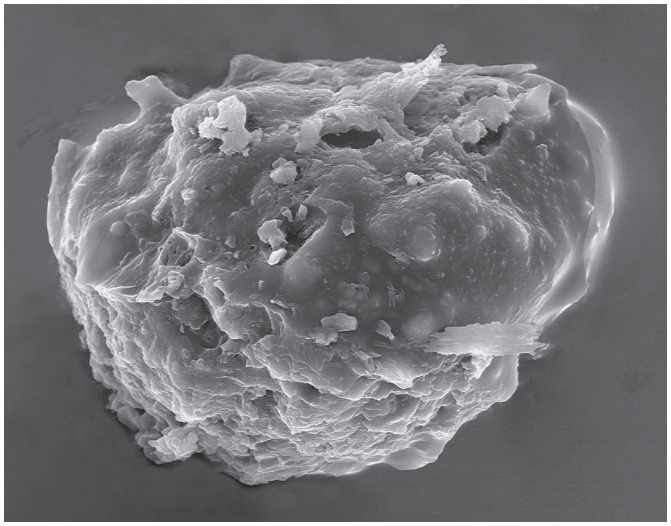
Table 1 shows information about the different groups.

Table 1

Particulate group	Particulate diameter in micrometres
PM_{10}	Less than 10 and more than 2.5
$PM_{2.5}$	Less than 2.5 and more than 0.1
$PM_{0.1}$	Less than 0.1

Figure 7 shows a soot particle viewed using an electron microscope.

Figure 7



Do not write outside the box

0 3 . 5 The diameter of the soot particle in **Figure 7** is 1.5 micrometres.

Which particulate group does the soot particle belong to?

[1 mark]

Use **Table 1**.

Tick (✓) **one** box.

PM_{10} ☐

$PM_{2.5}$ ☐

$PM_{0.1}$ ☐

0 3 . 6 Why is an electron microscope and **not** a light microscope used to view the soot particle?

[1 mark]

_____

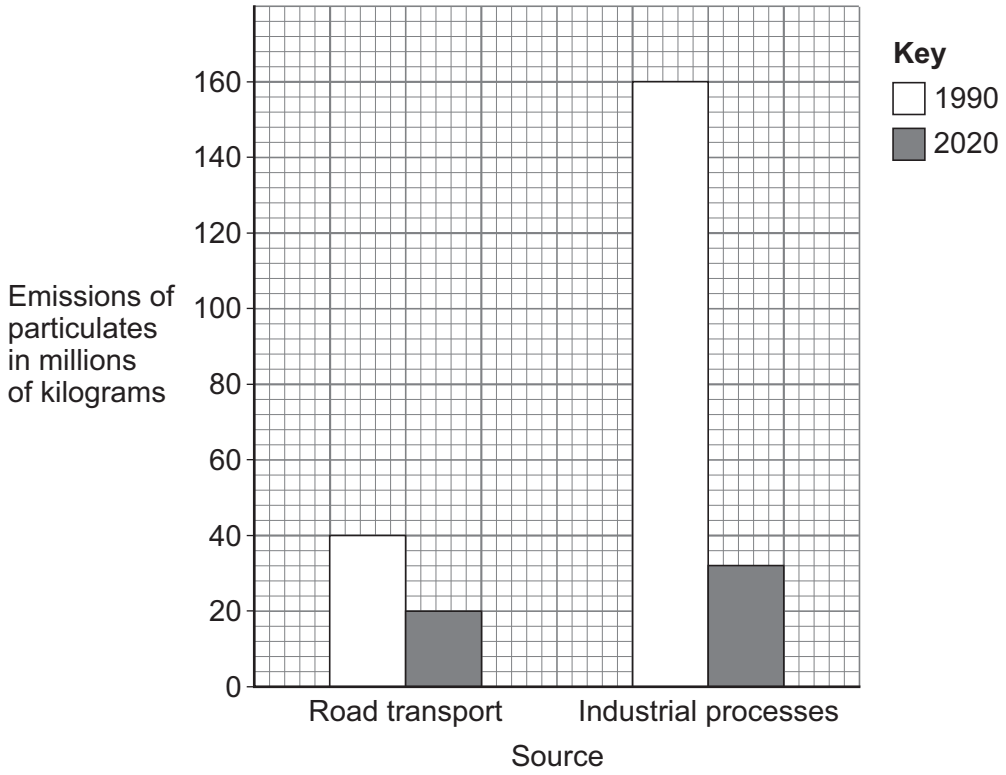
_____

Question 3 continues on the next page

Do not write outside the box

Figure 8 shows the emissions of particulates from two different sources in 1990 and in 2020.

Figure 8



0 3 . 7 Determine the difference between the emission of particulates from industrial processes and the emission of particulates from road transport in **1990**.

Use **Figure 8**.

[3 marks]

Emission of particulates from industrial processes = _____ millions of kilograms

Emission of particulates from road transport = _____ millions of kilograms

_____

_____

Difference in emissions of particulates in 1990 = _____ millions of kilograms

Do not write outside the box

0 3 . 8 Give **three** conclusions from **Figure 8**.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

0 3 . 9 Particulates can be harmful to people's health when breathed in.

Large particulates are prevented from getting into the lungs by the body's defences.

Complete the sentences.

Choose answers from the box.

[2 marks]

acids	**cilia**	**enzymes**
mucus	**sap**	

The cells in the trachea and bronchi produce sticky _____ .

The particulates are moved away from the lungs using _____ .

14

Turn over ▶

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There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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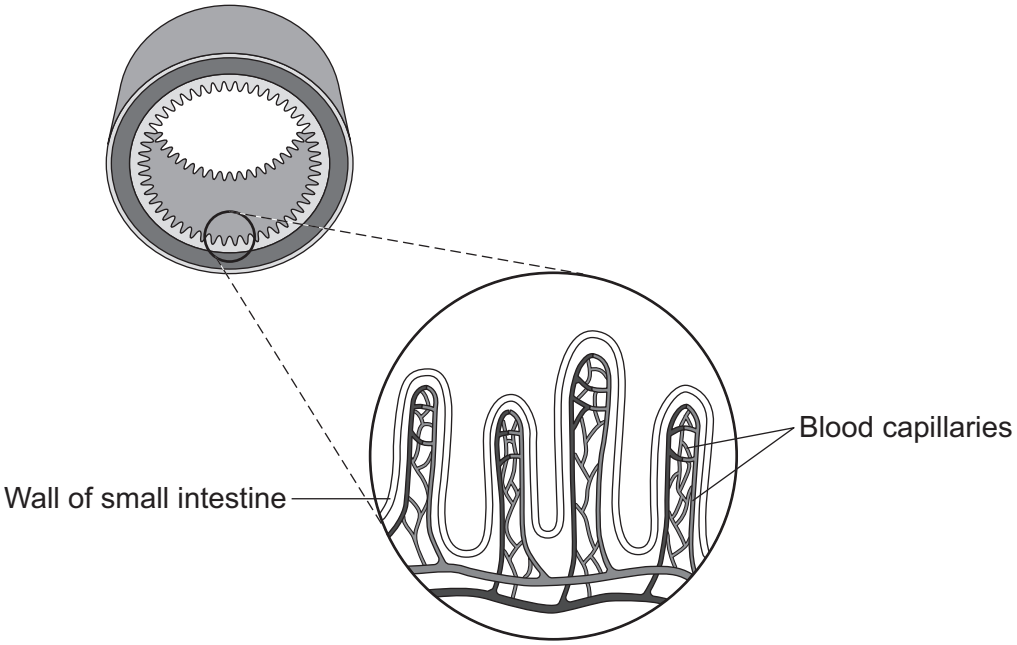
0 4 Starch molecules are broken down into glucose molecules in the small intestine (gut).

The glucose molecules are absorbed across the wall of the small intestine into the blood.

Figure 9 shows part of the wall of the small intestine.

Figure 9



0 4 . 1 Give **two** ways that the small intestine is adapted for the absorption of glucose into the blood.

Use **Figure 9**.

[2 marks]

1 _____

_____

2 _____

_____

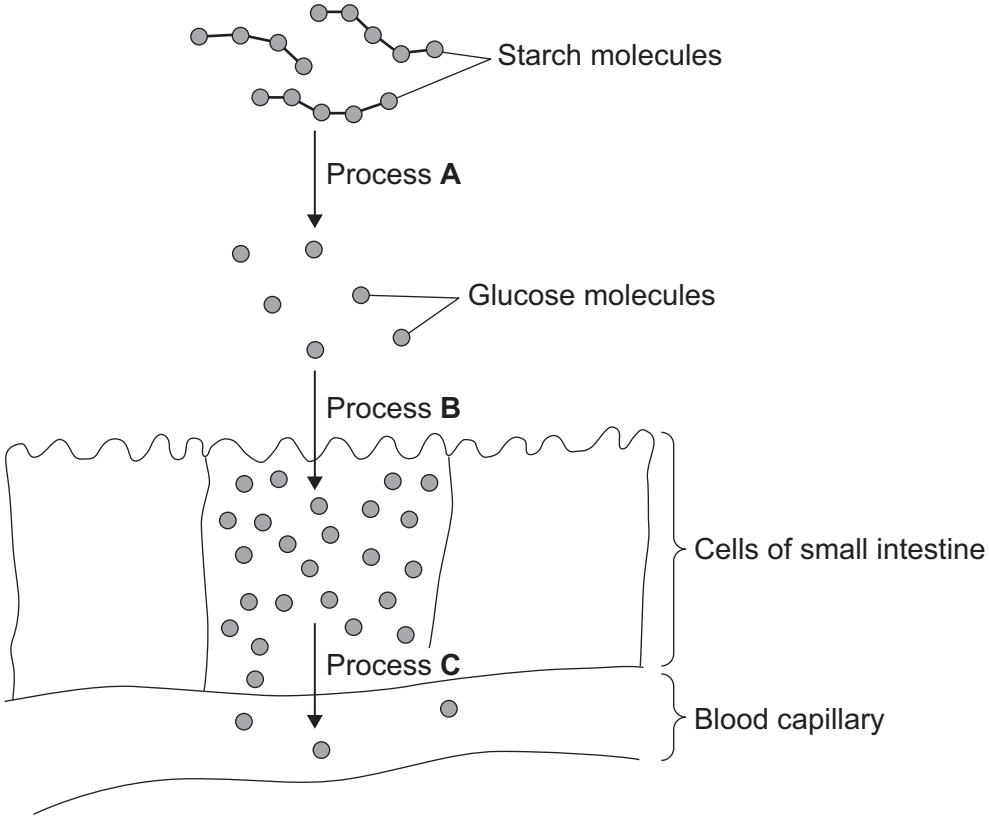
Question 4 continues on the next page

Do not write outside the box

Figure 10 shows:

- the breakdown of starch molecules
- the movement of glucose molecules across the wall of the small intestine.

Figure 10



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0 4 . 2 Look at processes **A**, **B** and **C** in **Figure 10**.

Complete the sentences.

Choose answers from the box.

[3 marks]

active transport	**evaporation**	**diffusion**
digestion	**transpiration**	

In process **A**, starch molecules are broken down into glucose by the process of _____ .

In process **B**, glucose molecules move into the cells of the small intestine by _____ .

In process **C**, glucose molecules move from the cells of the small intestine into the blood by _____ .

0 4 . 3 Give **one** reason why starch molecules **cannot** be absorbed into the blood.

Use **Figure 10**.

[1 mark]

_____

_____

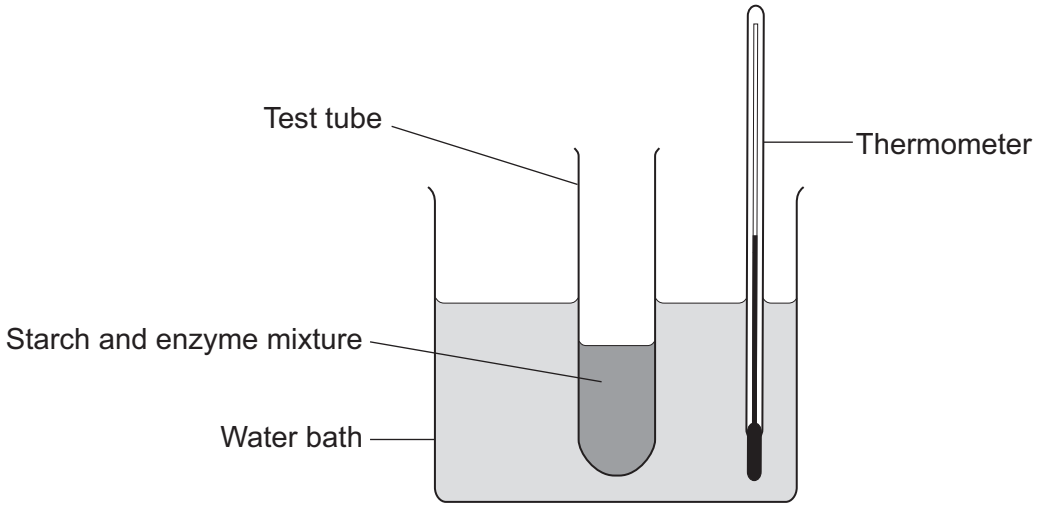
Question 4 continues on the next page

Do not write outside the box

A student investigated the breakdown of starch with an enzyme and without an enzyme.

Figure 11 shows the apparatus.

Figure 11



This is the method used.

1. Add 5 cm^3 of starch and enzyme mixture to a test tube.
2. Place the test tube into a water bath at 37 °C.
3. Remove one drop of the mixture every 60 seconds and test for starch using iodine solution.
4. Repeat step 3 until the starch is broken down or until 20 minutes is reached.
5. Repeat steps 1 to 4 another three times.
6. Repeat steps 1 to 5 using 5 cm^3 of starch solution with no enzyme.

Do not write outside the box

0 4 . 4 What colour will the iodine solution change to when starch is present?

[1 mark]

Tick (✓) **one** box.

Black ☐

Orange ☐

Red ☐

White ☐

0 4 . 5 What is the dependent variable in this investigation?

[1 mark]

Tick (✓) **one** box.

Temperature of the water bath ☐

Time taken for starch to break down ☐

Volume of the sample tested ☐

Question 4 continues on the next page

Do not write outside the box

Table 2 shows the results for the starch and enzyme mixture.

Table 2

Test	Time taken for starch to break down in seconds
1	300
2	420
3	60
4	360

0 4 . 6 One of the results in **Table 2** is anomalous.

[1 mark]

Which result is anomalous?

Tick (✓) **one** box.

300 s ☐ 420 s ☐ 60 s ☐ 360 s ☐

0 4 . 7 What should the student do with the anomalous result?

[1 mark]

_____

_____

Do not write outside the box

0 4 . 8 The student removed one drop of the mixture every 60 seconds and tested the drop for starch.

[1 mark]

How could the student improve the method?

Tick (✓) **one** box.

Test for starch every 30 seconds ☐

Test for starch every 3 minutes ☐

Test for starch every 10 minutes ☐

0 4 . 9 Another student repeated the investigation.

Table 3 shows the results.

Table 3

Starch solution	Mean time taken for starch to break down
With enzyme	300 seconds
With **no** enzyme	Starch not broken down after 20 minutes

Give **one** conclusion that can be made from the results.

[1 mark]

_____

_____

12

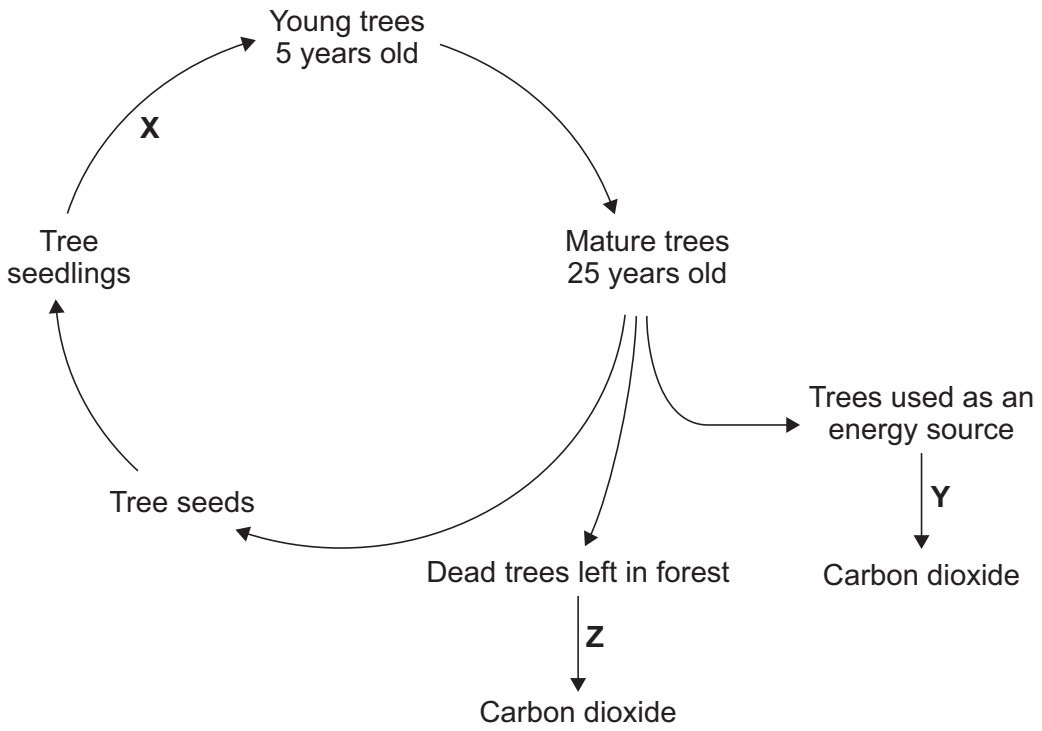
Do not write outside the box

0 5 In a managed forest:

- tree seedlings are regularly planted
- some trees are regularly removed.

Figure 12 shows information about the managed forest.

Figure 12



Do not write outside the box

0 5 . 1 Name the processes **X**, **Y** and **Z** in **Figure 12**.

Choose answers from the box.

[3 marks]

combustion	**decomposition**	**evaporation**
fertilisation	**growth**	

X _____

Y _____

Z _____

0 5 . 2 The dead trees are broken down during process **Z**.

What type of organism breaks down the dead trees?

[1 mark]

_____

_____

Question 5 continues on the next page

Do not write outside the box

0 5 . 3 When dead trees are broken down:

- carbon dioxide is released into the atmosphere
- mineral ions are released into the soil.

Tree seedlings take in the carbon dioxide and the mineral ions.

Complete the sentences.

Choose answers from the box.

[2 marks]

meristems	**phloem**	**root hairs**
stomata	**xylem**	

Carbon dioxide enters the tree seedlings through _____ .

Mineral ions enter the tree seedlings through _____ .

A farmer removes some of the young trees from the managed forest every year.

0 5 . 4 Explain why removing some of the young trees allows the remaining trees to grow faster.

[2 marks]

_____

_____

_____

_____

Do not write outside the box

0 5 . 5 Suggest **one** advantage to the farmer if the remaining trees grow faster.

[1 mark]

0 5 . 6 Explain how growing trees reduces climate change.

You should refer to carbon dioxide in your answer.

[3 marks]

Question 5 continues on the next page

Do not write outside the box

0 5 . 7 A scientist investigated the number of tree species in two forests in 1970 and 2000.

Table 4 shows the results.

Table 4

Forest	Number of tree species	
	1970	**2000**
A	26	24
B	28	22

Give **two** conclusions about the number of tree species in the forests in 1970 and 2000.

[2 marks]

1 _____

_____

2 _____

_____

14

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 6 The genetic material in a cell is made of DNA.

0 6 . 1 A DNA molecule is made from two strands twisted around each other.

What scientific term describes the structure of DNA?

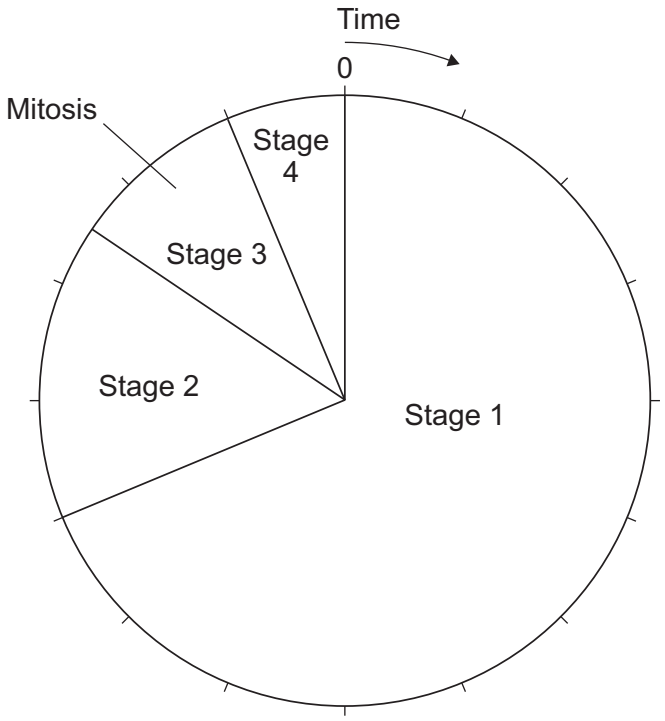
[1 mark]

_____

Cells divide in a series of stages called the cell cycle.

Figure 13 shows a cell cycle for a human cell.

Figure 13



Do not write outside the box

0 6 . 2 What happens during the mitosis stage of the cell cycle?

[1 mark]

Tick (✓) **one** box.

Chromosomes move to opposite ends of the cell. ☐

Copies of the organelles are made. ☐

The cell increases in size. ☐

0 6 . 3 Before a cell divides by mitosis, the mass of DNA in the cell is 6 picograms.

What mass of DNA will be in each of the new cells at the end of cell division?

[1 mark]

Tick (✓) **one** box.

3 picograms ☐

6 picograms ☐

12 picograms ☐

Question 6 continues on the next page

Do not write outside the box

0 6 . 4 One cell takes 16 hours to divide and form two new cells.

Estimate the total number of cells produced from one cell at the end of 48 hours.

Use the following steps.

[3 marks]

Calculate the number of divisions in 48 hours

_____

_____

Calculate the number of cells after 48 hours

_____

_____

Number of cells = _____

0 6 . 5 Give **one** factor that can cause a mutation in DNA.

Do **not** refer to ionising radiation in your answer.

[1 mark]

_____

_____

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Question 6 continues on the next page

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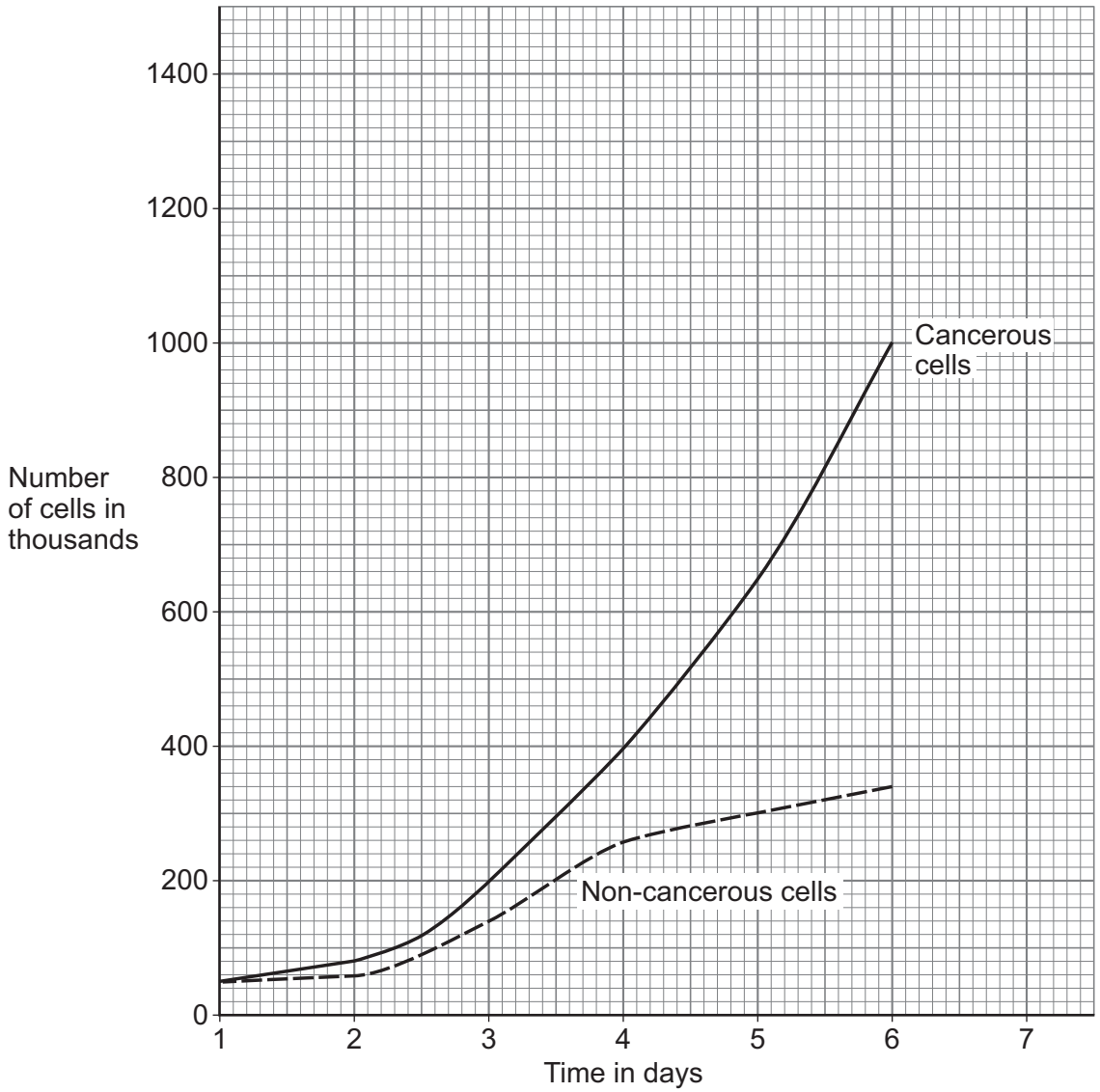
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

A mutation in DNA may cause cells to become cancerous.

Figure 14 shows the change in the number of cancerous cells and non-cancerous cells during 6 days.

Figure 14



Do not write outside the box

0 6 . 6 Describe **three** patterns shown in **Figure 14**.

Use data from **Figure 14**.

[3 marks]

1 _____

_____

_____

2 _____

_____

_____

3 _____

_____

_____

0 6 . 7 Predict the number of non-cancerous cells on day 7 if the pattern from day 4 continued.

You should extend the line for non-cancerous cells on the graph in **Figure 14**.

[2 marks]

Number of cells = _____ thousand

12

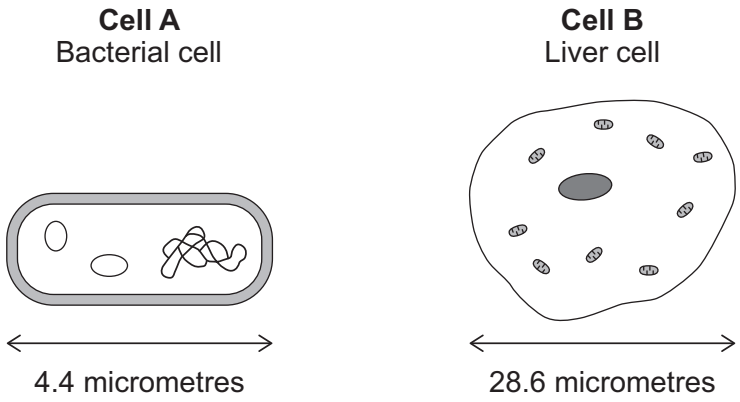
Turn over for the next question

Do not write outside the box

0 7 All living organisms are made of cells.

Figure 15 shows two types of cell.

Figure 15



Not to scale

0 7 . 1 Calculate how many times longer the liver cell is than the bacterial cell.

[2 marks]

_____

_____

Number of times longer = _____

Do not write outside the box

0 7 . 2 Compare the structure of cell **A** with the structure of cell **B**.

You should include similarities and differences in your answer.

Do **not** refer to cell size.

[4 marks]

0 7 . 3 In multicellular organisms, cells are organised into tissues.

What is meant by a 'tissue'?

[1 mark]

Question 7 continues on the next page

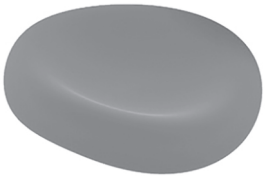
Do not write outside the box

A scientist investigated the effect of different concentrations of sugar solution on red blood cells.

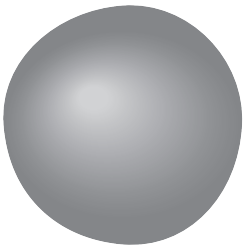
Figure 16 shows the effect of placing a red blood cell into a sugar solution.

Figure 16

Red blood cell **before** being placed in sugar solution



Red blood cell **after** being placed in sugar solution



0 7 . 4 What conclusion can be made from the result in **Figure 16**?

[1 mark]

Tick (✓) **one** box.

The sugar solution was less concentrated than inside the cell. ☐

The sugar solution was the same concentration as inside the cell. ☐

The sugar solution was more concentrated than inside the cell. ☐

Do not write outside the box

A student investigated the effect of different concentrations of sugar solution on the change in mass of plant tissue.

The student used pieces of potato.

0 7 . 5 Describe a method the student could use to produce valid results.

[6 marks]

Question 7 continues on the next page

Do not write outside the box

The student used a valid method.

The student calculated the percentage change in mass of the pieces of potato.

Table 5 shows the results.

Table 5

Concentration of sugar solution in mol/dm^3	Percentage (%) change in mass
0.0	28
0.1	15
0.2	3
0.3	–5
0.4	–10
0.5	–12

0 7 . 6 Complete **Figure 17**.

You should:

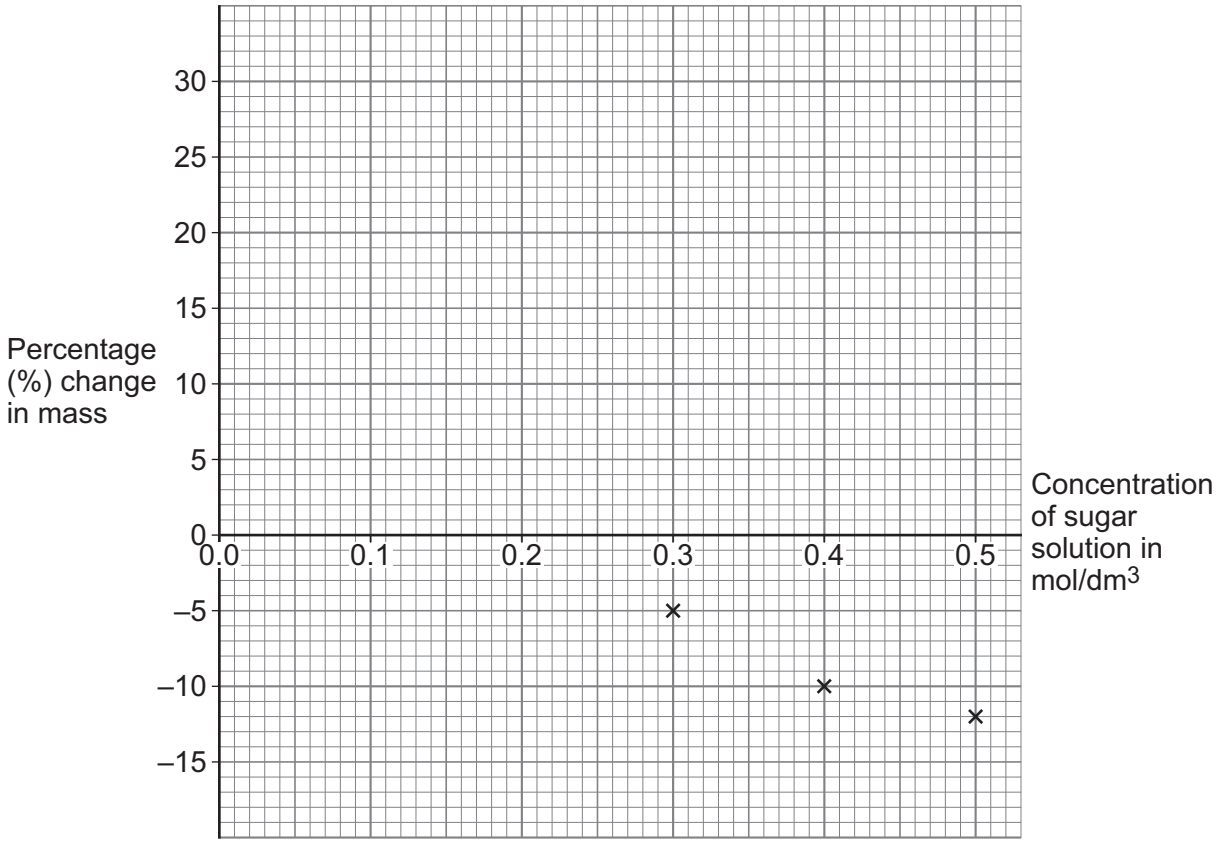
- plot the data from **Table 5**
- draw a line of best fit.

Some of the results have been plotted for you.

[2 marks]

Do not write outside the box

Figure 17



0 7 . 7 Determine the concentration of sugar solution that would cause no change in the mass of a piece of the potato.

Use **Figure 17**.

[1 mark]

Concentration of sugar solution = _____ mol/dm^3

17

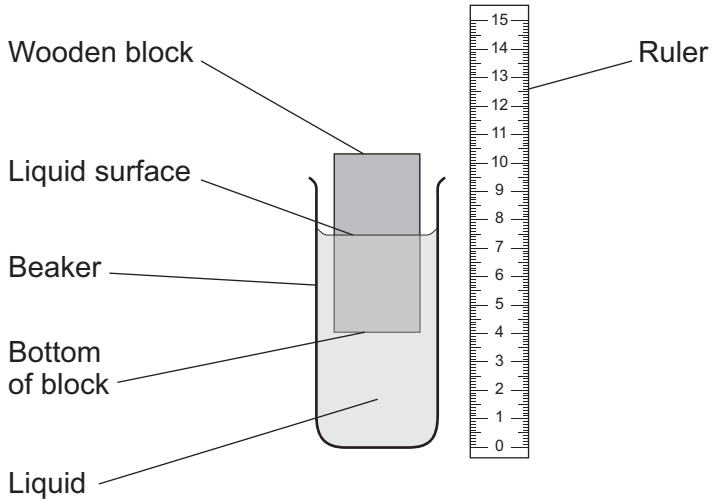
Turn over for the next question

Do not write outside the box

0 8 A student investigated how the density of a liquid affects the position of a wooden block floating in the liquid.

Figure 18 shows the apparatus.

Figure 18



This is the method used.

1. Put the wooden block in the beaker of liquid.
2. Allow the wooden block to come to rest so that it is floating in the liquid.
3. Measure the distance between the liquid surface and the bottom of the block.
4. Repeat steps 1 to 3 with liquids of different densities.

0 8 . 1 Give the independent variable in the investigation.

[1 mark]

Do not write outside the box

0 8 . 2 Give **one** control variable for the investigation.

[1 mark]

_____

_____

0 8 . 3 Give **one** possible source of error when the student measured the distance between the liquid surface and the bottom of the block.

[1 mark]

_____

_____

0 8 . 4 **Table 6** shows the results.

Table 6

Liquid	Density of liquid in g/cm^3	Distance between liquid surface and bottom of the block in cm
A	1.4	5.5
B	1.2	6.4
C	1.0	7.7
D	0.9	8.5

Give **one** conclusion from the results.

[1 mark]

_____

_____

Question 8 continues on the next page

Do not write outside the box

Use the Physics Equations Sheet to answer questions **08.5** and **08.6**.

0 8 . 5 Which equation links density (ρ), mass (m) and volume (V)?

[1 mark]

Tick (✓) **one** box.

$\rho = m \times V$ ☐

$\rho = \frac{m}{V}$ ☐

$\rho = m \times V^3$ ☐

$\rho = \frac{V}{m}$ ☐

0 8 . 6 The density of the wooden block was 0.85 g/cm^3.

The mass of the wooden block was 30.6 g.

Calculate the volume of the wooden block in cm^3.

[3 marks]

Volume of wooden block = _____ cm^3

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0 8 . 7 Liquid **C** is water.

When liquid water is heated to its boiling point the water changes state.

What happens to the density of the liquid water as it changes state?

[2 marks]

Tick (✓) **one** box.

The density decreases ☐

The density stays the same ☐

The density increases ☐

Give a reason for your answer.

_____

_____

10

END OF QUESTIONS

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