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

H

Higher Tier Paper 2 Life and Environmental Sciences

Wednesday 22 May 2024 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.

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.

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

Do not write outside the box

0 1 Two students analysed water from four rivers.

Each student measured the pH of the river water using a different method.

Table 1 shows the results.

Table 1

River	pH of river water	
	Method **A**	Method **B**
W	7	7.4
X	6	6.5
Y	8	8.1
Z	7	7.6

0 1 . 1 Suggest what was used to measure the pH in each method.

[2 marks]

Method **A** _____

Method **B** _____

0 1 . 2 Why is it **not** valid to calculate a mean of the two pH values for each river?

[1 mark]

Tick (✓) **one** box.

A mean cannot be calculated from only two values. ☐

Each method gives values to a different resolution. ☐

The mean should be calculated for each method using all four samples. ☐

Do not write outside the box

0 1 . 3 Complete the sentence.

Choose the answer from the box.

[1 mark]

accurate	**repeatable**	**reproducible**

Method **A** and method **B** gave similar results.

This shows that the results are _____.

0 1 . 4 Which river is most likely to be in an area with a high concentration of sulfur dioxide in the air?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

W ☐ **X** ☐ **Y** ☐ **Z** ☐

0 1 . 5 Explain your answer to Question **01.4**.

[3 marks]

_____

_____

_____

_____

_____

_____

_____

Question 1 continues on the next page

Do not write outside the box

0 1 . 6 Describe a method to determine the mass of dissolved solids in 50 cm^3 of river water.

[4 marks]

12

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 2 Biodiversity is the variety of species within an ecosystem.

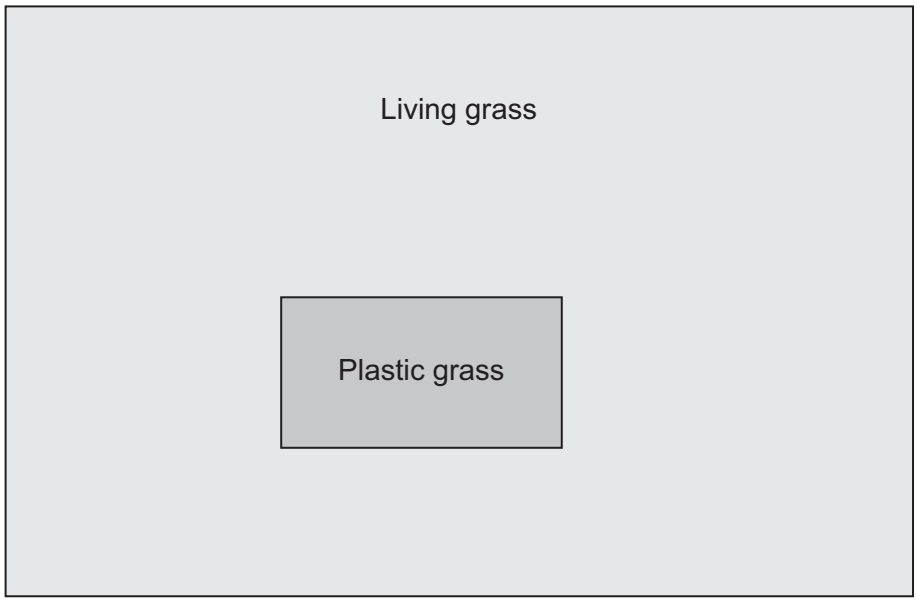
0 2 . 1 A student investigated the biodiversity in a field.

In part of the field, the living grass had been replaced with plastic grass.

Other plants grow between living grass plants and between pieces of plastic grass.

Figure 1 shows the field.

Figure 1



Do not write outside the box

The student used quadrats to randomly sample the biodiversity of plants in:

- the area with living grass
- the area with plastic grass.

Describe how the student could decide where to randomly place the quadrats in the area with plastic grass.

[2 marks]

0 2 . 2 How would a greater number of different plant species affect the biodiversity of animals in the area?

[1 mark]

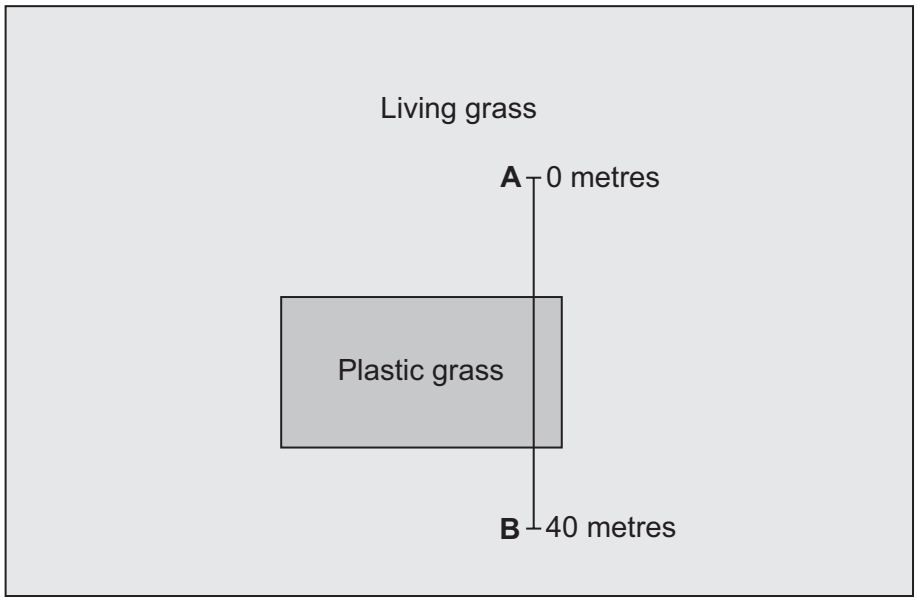
Question 2 continues on the next page

Do not write outside the box

Another student used a transect to place quadrats in the field.

Figure 2 shows the position of the transect.

Figure 2



The student placed a quadrat every 5 metres from point **A** to point **B**.

Table 2 shows the results.

Table 2

Distance from point A in metres	Type of grass	Number of plant species
0	Living	4
5	Living	6
10	Living	5
15	Plastic	1
20	Plastic	0
25	Plastic	2
30	Plastic	2
35	Living	4
40	Living	5

Do not write outside the box

0 2 . 3 Complete the sentence.

[1 mark]

The relationship between the distance from point **A** and the number of plant species **cannot** be represented by the equation:

$$y = mx + c$$

This is because the relationship is **not** _____.

0 2 . 4 Describe the relationship between the type of grass and the number of plant species.

[1 mark]

_____

_____

0 2 . 5 Which of the following are **two** improvements to the investigation that used a transect?

[2 marks]

Tick (✓) **two** boxes.

- Decrease the length of the transect to 20 metres. ☐
- Increase the distance between quadrats from 5 metres to 10 metres. ☐
- Record the number of plants of each species as well as the number of species. ☐
- Repeat three times at different times of the same day. ☐
- Repeat using three different transects that cross the two types of grass. ☐

Question 2 continues on the next page

Do not write outside the box

0 2 . 6 Small pieces of plastic break off plastic grass and enter rivers and oceans.

Leaves from trees take longer to decompose on plastic grass than on living grass.

Other plants can grow between pieces of plastic grass.

Plastic grass **cannot** be recycled.

Explain how plastic grass affects biodiversity of ecosystems.

[6 marks]

Do not write outside the box

0 2 . 7 Ecosystems with low biodiversity may have small populations of some species.

Why are small populations more likely to become extinct than large populations?

[1 mark]

Tick (✓) **one** box.

A small population may be more varied genetically than a large population. ☐

Large populations in the same habitat interact to form communities. ☐

Less genetic variation is a greater risk if the ecosystem changes. ☐

0 2 . 8 Suggest **two** ways biodiversity in and around fields can be increased.

Do **not** refer to plastic grass.

[2 marks]

1 _____

_____

2 _____

_____

16

Turn over for the next question

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 3 The electromagnetic spectrum is grouped into different types of wave.

Each type of wave has different uses.

0 3 . 1 Complete the table.

[3 marks]

Use	**Type of wave**
Satellite communications	
Sterilising surgical instruments	
Sun tanning	

Question 3 continues on the next page

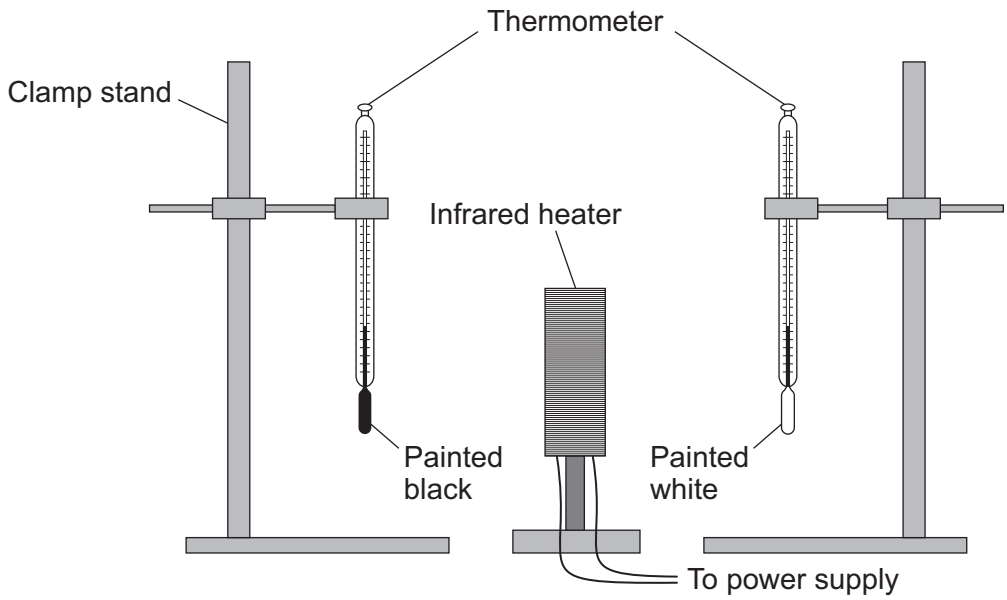
Do not write outside the box

A student investigated the absorption of infrared radiation by a black surface and by a white surface.

The student painted the bulb of one thermometer black and the bulb of another thermometer white.

Figure 3 shows some of the equipment used.

Figure 3



This is the method used.

1. Ensure that the initial temperature shown on the thermometers is the same.

2. Switch on the infrared heater.

3. Record the temperature shown on each thermometer every 30 seconds for 5 minutes.

Do not write outside the box

0 3 . 2 Explain why the distance between the infrared heater and each thermometer should be the same.

[2 marks]

_____

_____

_____

_____

0 3 . 3 The infrared heater was a hazard in this investigation.

Describe the risk to the student **and** one precaution that the student should have taken.

[2 marks]

Risk _____

_____

Precaution _____

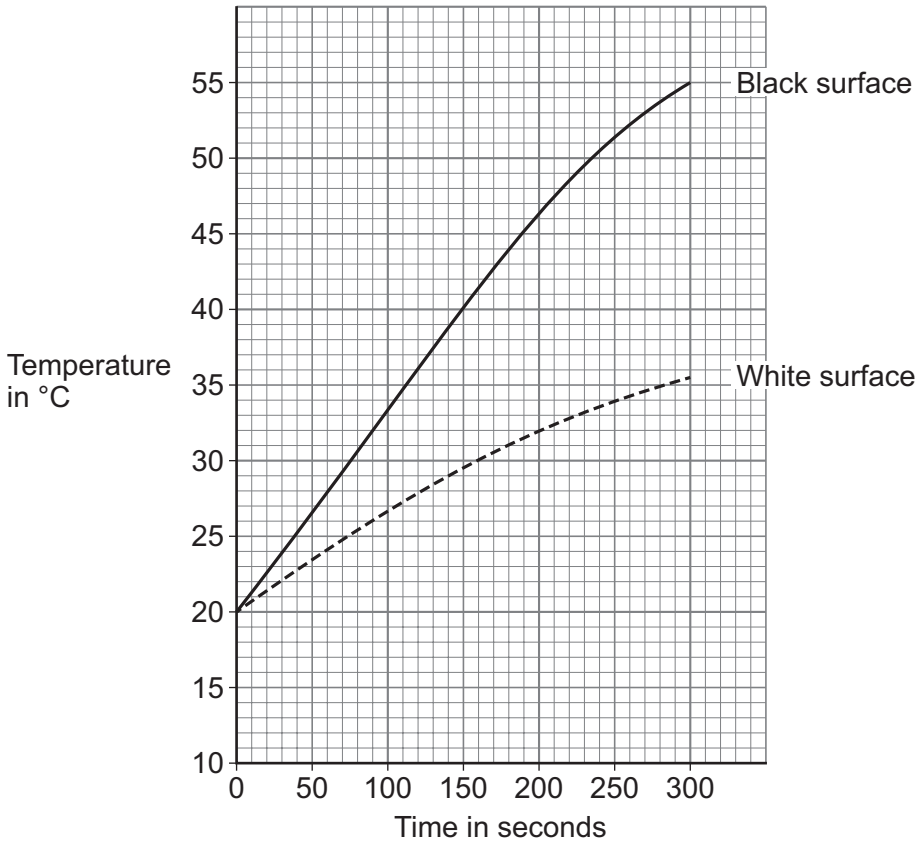
_____

Question 3 continues on the next page

Do not write outside the box

Figure 4 shows the results.

Figure 4



0 3 . 4 Explain the conclusion that can be made from the results in **Figure 4**.

[2 marks]

Do not write outside the box

0 3 . 5 The paint used for the thermometer bulb painted white was a matt white paint.

The investigation was repeated using a thermometer bulb painted with shiny silver paint.

The distance between the thermometer and the heater was the same as in the first investigation.

The room temperature was the same as in the first investigation.

Draw a line on **Figure 4** to predict the results for a thermometer painted with shiny silver paint.

[2 marks]

11

Turn over for the next question

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 4 Carbon monoxide is an atmospheric pollutant.

Carbon monoxide can have dangerous effects on the human body.

0 4 . 1 Describe how carbon monoxide is formed from hydrocarbon fuels.

[2 marks]

_____

_____

_____

_____

Red blood cells contain haemoglobin.

0 4 . 2 Describe **how** the shape and internal cell structure of a red blood cell are adaptations to its function.

[2 marks]

Shape _____

_____

Internal cell structure _____

_____

Question 4 continues on the next page

Do not write outside the box

Scientists investigated the effect of breathing in air containing different concentrations of carbon monoxide.

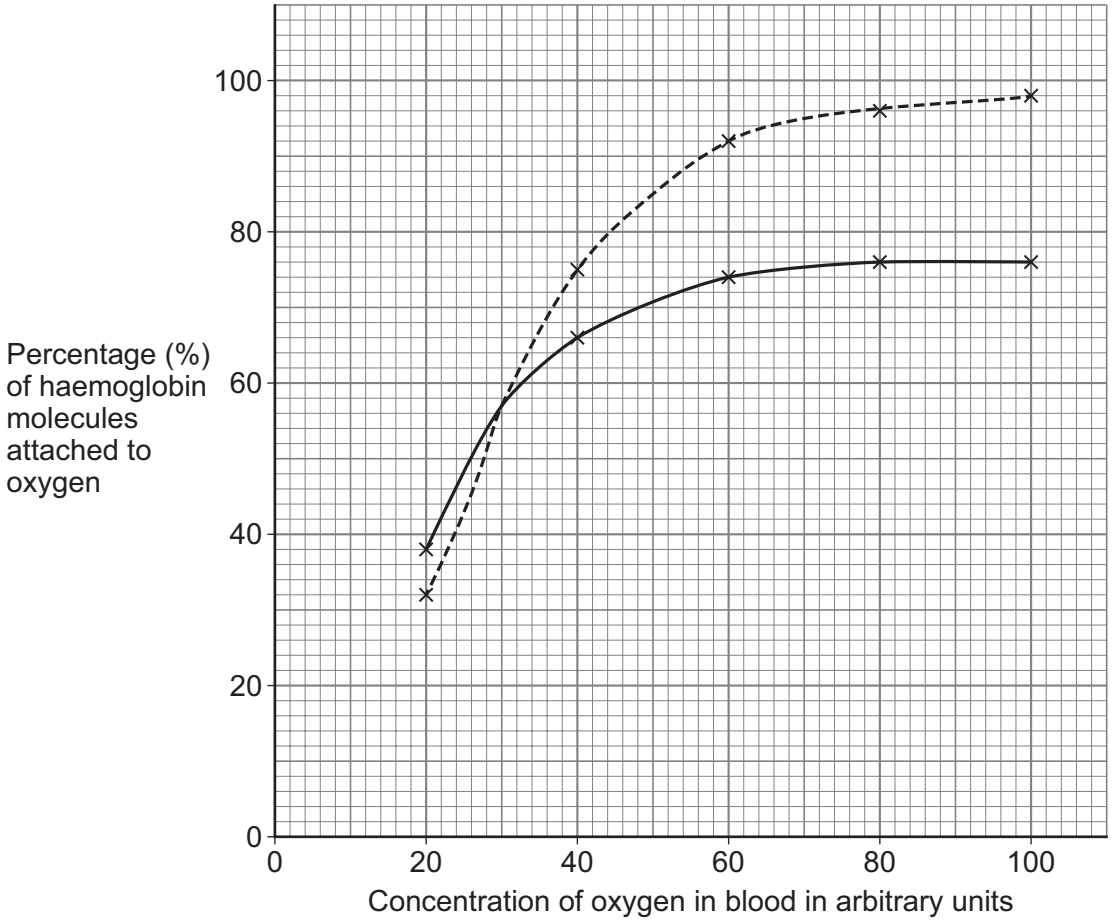
The scientists measured the percentage of haemoglobin molecules attached to oxygen at different concentrations of oxygen in the blood.

The air breathed contained:

- no carbon monoxide
- a low concentration of carbon monoxide.

Figure 5 shows the results.

Figure 5



Key

----- Air containing no carbon monoxide

——— Air containing a low concentration of carbon monoxide

Do not write outside the box

0 4 . 3 A person:

- breathes in air containing no carbon monoxide
- has a concentration of oxygen in the blood of 90 arbitrary units.

What percentage of haemoglobin molecules are attached to oxygen?

Use **Figure 5**.

[1 mark]

Percentage = _____%

0 4 . 4 The scientists repeated the investigation with air containing a **higher** concentration of carbon monoxide.

Table 3 shows the results.

Table 3

Concentration of oxygen in blood in arbitrary units	Percentage (%) of haemoglobin molecules attached to oxygen
20	27
40	36
60	38
80	39
100	39

Complete **Figure 5**.

You should:

- plot the data from **Table 3**
- draw a line of best fit.

[3 marks]

Question 4 continues on the next page

Do not write outside the box

0 4 . 5 A person breathes in air containing a **low** concentration of carbon monoxide.

Suggest **two** symptoms the person might show.

[2 marks]

1 _____

_____

2 _____

_____

0 4 . 6 Explain why a **high** concentration of carbon monoxide in the air causes a person to become seriously ill.

[3 marks]

_____

_____

_____

_____

_____

_____

_____

13

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 5 Ionising radiation is dangerous to humans because it causes mutations which can cause cancer.

0 5 . 1 Which of the following can be mutated by ionising radiation?

[1 mark]

Tick (✓) **one** box.

Atoms ☐

Genes ☐

Red blood cells ☐

0 5 . 2 A nucleus of uranium-238 (U) emits an alpha particle (He) and decays into thorium-234 (Th).

Complete the nuclear equation to show the decay of a uranium-238 nucleus by emitting an alpha particle.

[2 marks]

$$^{238}_{92}U \rightarrow \underline{\quad}^{234}Th + \underline{\quad}^{\quad}_{2}He$$

Do not write outside the box

0 5 . 3 Rocks from a uranium mine contain uranium and several other radioactive isotopes.

Table 4 shows information about two isotopes in a sample of rock from a uranium mine.

Table 4

	Bismuth-210	**Lead-214**
Half-life	5.0 days	30 minutes

The initial number of nuclei of each isotope in the sample was the same.

Explain the difference in the number of nuclei of each isotope in the sample after 5.0 days.

Your answer should include calculations.

[5 marks]

Question 5 continues on the next page

Do not write outside the box

Scientists collected data about lung cancer in the population of one country.

They used the data to predict the number of cases of lung cancer in people who work in uranium mines.

Table 5 shows the predicted number and the actual number of cases.

Table 5

	Predicted number	**Actual number**
Lung cancer	75	405

0 5 . 4 What was the percentage increase in the actual number of cases compared with the predicted number of cases?

[1 mark]

Tick (✓) **one** box.

185% ☐

440% ☐

540% ☐

Do not write outside the box

0 5 . 5 Radon is an odourless, colourless gas that builds up in uranium mines.

Radon nuclei emit alpha radiation.

Explain why the actual number of cases of lung cancer in **Table 5** is greater than the predicted number.

[3 marks]

_____

_____

_____

_____

_____

_____

_____

_____

12

Turn over for the next question

Do not write outside the box

0 6 **Figure 6** shows a green pepper growing on a pepper plant.

Figure 6

0 6 . 1 The cells of the green pepper contain water.

Water **cannot** enter the cells through the waxy waterproof coating on the outside of the pepper fruit.

Describe how water reaches the green pepper cells.

[3 marks]

Do not write outside the box

0 6 . 2 A pepper cell was viewed using a microscope.

The image of a pepper cell had a width of 32 mm.

The magnification of the image was ×400

Calculate the real width of the cell in micrometres.

[5 marks]

Real width = _____ micrometres

Question 6 continues on the next page

Do not write outside the box

A student investigated how different concentrations of sugar solution affect the mass of pepper tissue.

This is the method used.

1. Cut three pieces of pepper 1 cm wide and 1 cm long.
2. Dry each piece.
3. Record the mass of each piece.
4. Leave each piece in sugar solution for 1 hour.
5. Remove the pieces from the sugar solution and dry each piece.
6. Record the mass of each piece.
7. Repeat steps 1 to 6 using different concentrations of sugar solution.
8. Calculate the mean percentage change in mass at each concentration of sugar solution.

0 6 . 3 Before the investigation, the pepper was kept at 5 °C.

Suggest why.

[1 mark]

_____

_____

0 6 . 4 Describe why calculating the **percentage** change in mass is more valid than only calculating the change in mass.

[1 mark]

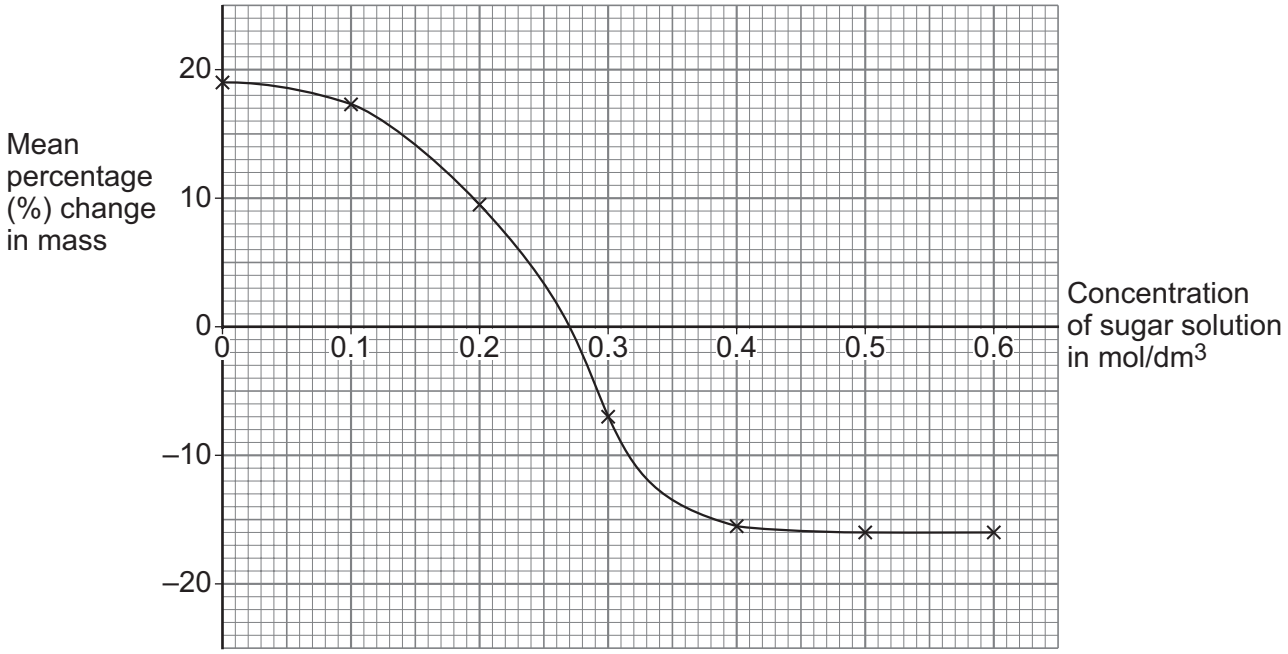
_____

_____

Do not write outside the box

Figure 7 shows the results.

Figure 7



0 6 . 5 Determine the concentration of the solution inside the pepper cells before the investigation.

[1 mark]

Concentration = _____ mol/dm^3

0 6 . 6 Explain the mean percentage change in mass of pepper when the concentration of sugar solution was 0.5 mol/dm^3.

[2 marks]

_____

_____

_____

_____

_____

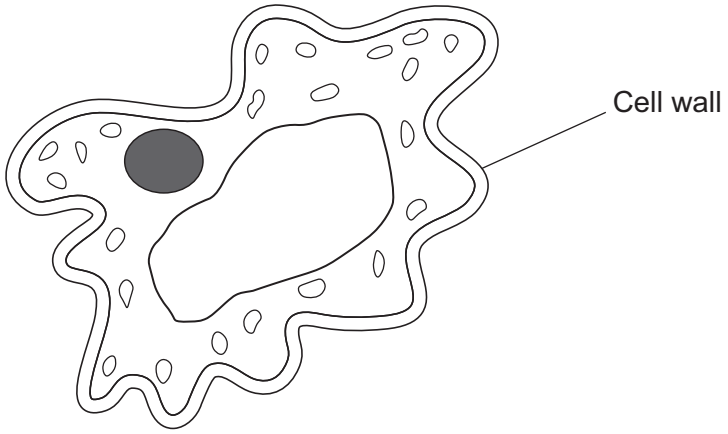
Question 6 continues on the next page

Do not write outside the box

0 6 . 7 As peppers develop, the vacuoles of the cells increase in volume.

Figure 8 shows the shape of a pepper cell before it is fully developed.

Figure 8



Suggest **two** reasons why the cell walls of pepper cells are wrinkled.

[2 marks]

1 _____

_____

2 _____

_____

15

Do not write outside the box

0 7 This question is about genetics.

0 7 . 1 Explain why different genes are made from different lengths of DNA.

[2 marks]

0 7 . 2 Describe why the human population produces approximately 50% female and 50% male babies.

[4 marks]

Question 7 continues on the next page

Do not write outside the box

In 2018, a scientist claimed to have genetically modified two human embryos.

0 7 . 3 Suggest why genetic modification of human embryos is illegal in most countries.

[1 mark]

The scientist claimed that the embryos were genetically modified to have a faulty CCR5 gene.

The CCR5 gene codes for a protein that allows HIV to enter cells.

The genetic modification may have caused the embryos to be protected against AIDS.

0 7 . 4 Suggest how the embryos were genetically modified to make the CCR5 gene faulty.

[1 mark]

0 7 . 5 Suggest what type of cell has the CCR5 protein in its cell membrane.

[1 mark]

0 7 . 6 What type of drug is used to treat HIV?

[1 mark]

10

Do not write outside the box

0 8 Funnel-web spiders produce a poison to kill prey.

The poison enters the prey when the spider bites the prey.

The poison contains a protein.

0 8 . 1 A scientist tested the spider poison for protein.

Describe the test for protein and the colour change that would be seen when the poison is tested.

[2 marks]

Description of test _____

_____

Colour change from _____ to _____

0 8 . 2 Animals produce protease enzymes.

Explain why protease enzymes do **not** protect animals that are bitten by funnel-web spiders.

[2 marks]

_____

_____

_____

_____

_____

Question 8 continues on the next page

Do not write outside the box

The protein from the poison may be used in a new drug.

The protein allows heart muscle tissue to function in low concentrations of oxygen.

0 8 . 3 Explain how coronary heart disease can decrease the concentration of oxygen in heart muscle tissue.

[2 marks]

0 8 . 4 The new drug may be useful when transporting a donor heart to a patient for a heart transplant.

Suggest why.

[1 mark]

Do not write outside the box

0 8 . 5 The species of funnel-web spider that produces the poison comes from a small, remote area.

Evaluate the use of the poison from the funnel-web spider as a drug.

[4 marks]

11

END OF QUESTIONS

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**
	Copyright information For confidentiality purposes, all acknowledgements of third-party copyright material are published in a separate booklet. This booklet is published after each live examination series and is available for free download from www.aqa.org.uk. Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team. Copyright © 2024 AQA and its licensors. All rights reserved.