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

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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
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.

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0 1 Nuclear radiation is dangerous to humans.

0 1 . 1 Nuclear radiation can change atoms into ions.

Which type of particle is lost when an atom changes into an ion?

[1 mark]

Tick (✓) **one** box.

Electron ☐

Neutron ☐

Proton ☐

0 1 . 2 A nucleus of uranium-238 $\left({}^{238}_{92}\mathrm{U}\right)$ emits an alpha particle $\left({}^{4}_{2}\mathrm{He}\right)$ and decays into thorium $\left({}^{234}_{90}\mathrm{Th}\right)$.

Which nuclear equation shows this decay?

[1 mark]

Tick (✓) **one** box.

$${}^{234}_{90}\mathrm{Th} + {}^{238}_{92}\mathrm{U} \rightarrow {}^{4}_{2}\mathrm{He}$$ ☐

$${}^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He}$$ ☐

$${}^{238}_{92}\mathrm{U} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{234}_{90}\mathrm{Th}$$ ☐

Do not write outside the box

0 1 . 3 How does the penetrating power of alpha particles compare with the penetrating power of beta particles?

[1 mark]

Tick (✓) **one** box.

Alpha particles are less penetrating than beta particles. ☐

Alpha particles have the same penetrating power as beta particles. ☐

Alpha particles are more penetrating than beta particles. ☐

Question 1 continues on the next page

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0 1 . 4 Uranium is dug out of the ground in a process called mining.

Uranium mining is hazardous because uranium is radioactive.

The radioactive decay of uranium produces radon gas which is also radioactive.

Table 1 compares the properties of uranium and radon.

Table 1

	Uranium	**Radon**
State of matter	Solid	Gas
Type of radiation emitted	Alpha	Alpha
Colour	Grey	Colourless

People who work in uranium mines are more at risk of harm from radon gas than from uranium.

Give **two** reasons why.

Use **Table 1**.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

0 1 . 5 Scientists collected data about lung diseases in the population of one country.

The scientists used the data to predict the number of people with lung diseases who worked in uranium mines.

Table 2 shows the predicted data and the actual data for people who worked in uranium mines.

Table 2

	Predicted number of people	**Actual number of people**
Lung cancer	74	405
Other lung diseases	41	142

Give **two** conclusions that can be made from the data in **Table 2**.

[2 marks]

1 _____

_____

2 _____

_____

0 1 . 6 Suggest **one** reason why people who work in uranium mines should be told that uranium is a hazard.

[1 mark]

_____

_____

_____

8

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 2 Carbon monoxide is an atmospheric pollutant.

0 2 . 1 How is carbon monoxide formed?

[1 mark]

Tick (✓) **one** box.

Incomplete combustion of hydrocarbons ☐

Photosynthesis by plants ☐

Purification of water ☐

Carbon monoxide changes the amount of oxygen that blood can transport.

0 2 . 2 Which part of the blood transports oxygen?

[1 mark]

_____

Question 2 continues on the next page

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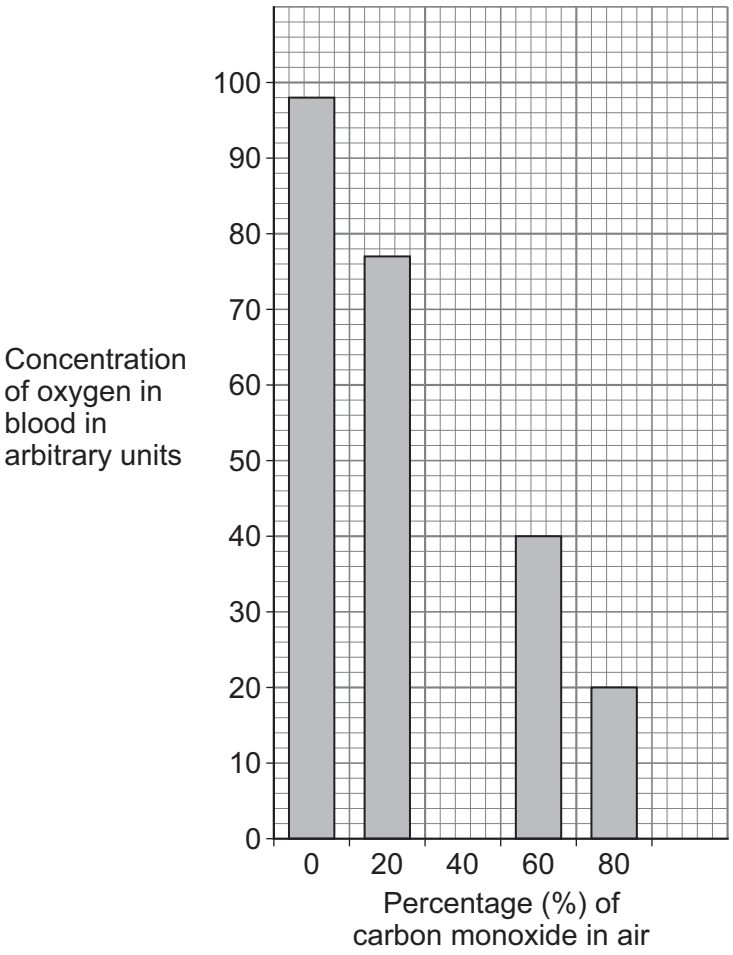
Figure 1 shows how the percentage of carbon monoxide in air affects the concentration of oxygen in blood.

Figure 1



0 2 . 3 When the percentage of carbon monoxide in air is 40% the concentration of oxygen in blood is 64 arbitrary units.

Complete **Figure 1** to show the result for 40% carbon monoxide in air.

[1 mark]

Do not write outside the box

0 2 . 4 The percentage of carbon monoxide in air changes from 0% to 80%.

Determine the change in the concentration of oxygen in blood.

Use **Figure 1**.

[2 marks]

Change = _____ arbitrary units

0 2 . 5 Describe how increasing the percentage of carbon monoxide in air affects the concentration of oxygen in blood.

Use **Figure 1**.

[1 mark]

Question 2 continues on the next page

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0 2 . 6 Breathing in carbon monoxide can cause carbon monoxide poisoning.

Which of the following is a symptom of carbon monoxide poisoning?

[1 mark]

Tick (✓) **one** box.

Burns on the skin ☐

Faster heart rate ☐

High temperature ☐

0 2 . 7 Carbon monoxide can build up in a room.

The risk of carbon monoxide poisoning can be reduced by opening windows in the room.

Suggest how opening windows reduces the risk of carbon monoxide poisoning.

[1 mark]

_____

_____

8

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

0 3 . 1 Draw **one** line from each type of wave to a use of the wave.

[3 marks]

Type of wave	Use
	Fibre optic communications
Gamma	Radio programme transmission
Microwave	Satellite communications
Ultraviolet	Sterilising surgical instruments
	Sun tanning

Question 3 continues on the next page

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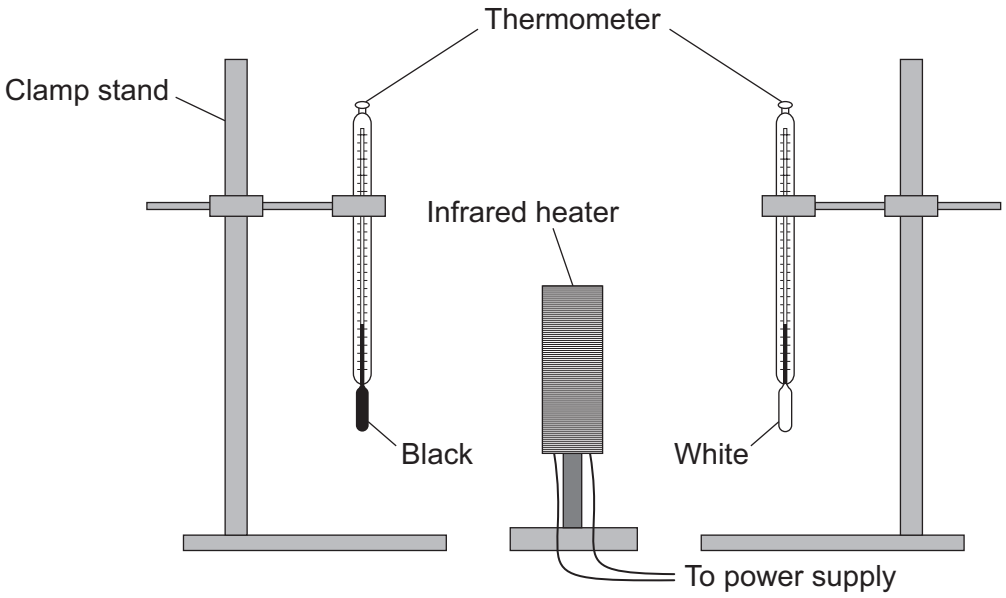
Infrared radiation is emitted by heaters.

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

Figure 2 shows some of the equipment used.

Figure 2



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 What equipment should the student have used to measure time?

[1 mark]

_____

0 3 . 3 The distance between the infrared heater and each thermometer was kept the same throughout the investigation.

What type of variable was the distance?

[1 mark]

Tick (✓) **one** box.

A control variable ☐

A dependent variable ☐

An independent variable ☐

0 3 . 4 What was a risk to the student in the investigation?

[1 mark]

Tick (✓) **one** box.

Burns from the infrared heater ☐

Misreading the thermometers ☐

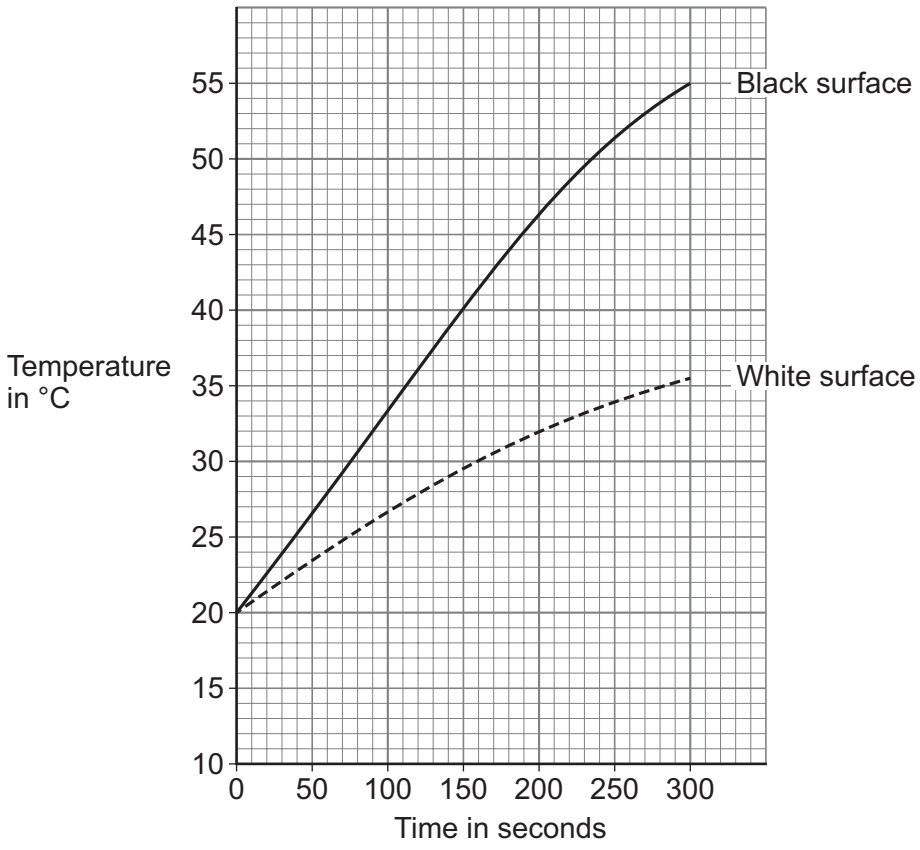
Wearing safety glasses ☐

Question 3 continues on the next page

Do not write outside the box

Figure 3 shows the results.

Figure 3



0 3 . 5 What was the temperature of the room where the investigation took place?

Use **Figure 3**.

[1 mark]

Temperature = _____ °C

Do not write outside the box

0 3 . 6 What **two** conclusions can be made from **Figure 3**?

[2 marks]

Tick (✓) **two** boxes.

The black surface absorbed all the infrared radiation. ☐

The black surface had a greater temperature increase per second. ☐

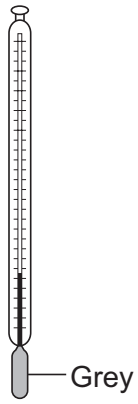
The black surface reflected all the infrared radiation. ☐

The black surface was a better absorber of infrared radiation. ☐

The black surface was a better reflector of infrared radiation. ☐

0 3 . 7 **Figure 4** shows a thermometer with a grey surface.

Figure 4



The investigation was repeated using this thermometer.

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

The room temperature was the same as the first investigation.

Draw a line on **Figure 3** to predict the results for the thermometer shown in **Figure 4**.

[2 marks]

11

Turn over ▶

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0 4 **Figure 5** shows a green pepper growing on a pepper plant.

Figure 5

0 4 . 1 Water is lost from the leaves.

Complete the sentences.

Choose answers from the box.

[2 marks]

guard cells	**starch**	
stomata		**xylem**

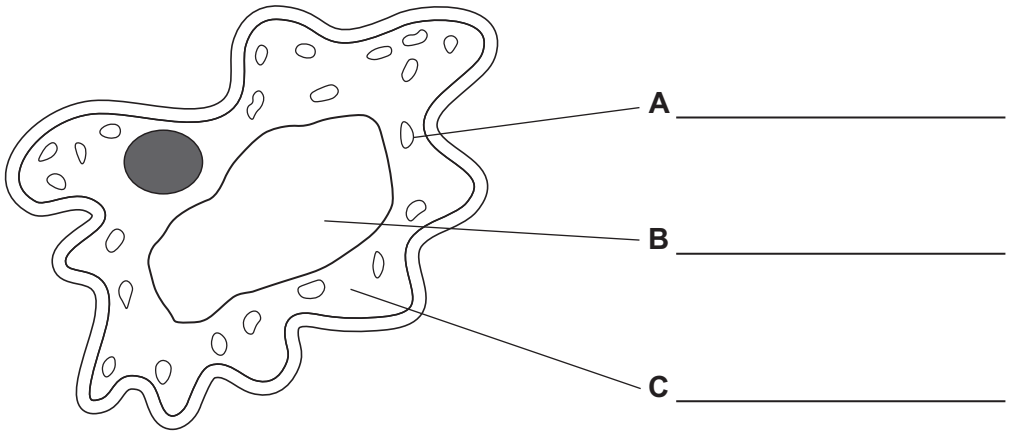
Water is lost through tiny holes in the leaves called _____.

The size of each hole is controlled by _____.

Do not write outside the box

Figure 6 shows a drawing of a cell from a pepper.

Figure 6



0 4 . 2 Cell part **A** contains a green pigment.

Label parts **A**, **B** and **C** on **Figure 6**.

Choose answers from the box.

[3 marks]

cell membrane	**chloroplast**	**cytoplasm**
nucleus	**vacuole**	

Question 4 continues on the next page

Do not write outside the box

0 4 . 3 An image of one cell from a pepper has a width of 32 mm.

The real cell has a width of 0.08 mm.

Calculate the magnification of the image of the cell.

Use the equation:

$$\text{magnification} = \frac{\text{size of image}}{\text{size of real cell}}$$

[2 marks]

Magnification = × _____

Do not write outside the box

Water can move into cells and out of cells.

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.

0 4 . 4 Before the investigation, the pepper was wrapped in plastic and kept at 5 °C.

Which are **two** reasons for keeping the pepper wrapped in plastic at 5 °C?

[2 marks]

Tick (✓) **two** boxes.

To change the colour of the pepper ☐

To decrease the size of the pepper ☐

To increase growth of the pepper ☐

To reduce water loss from the pepper ☐

To slow down decay of the pepper ☐

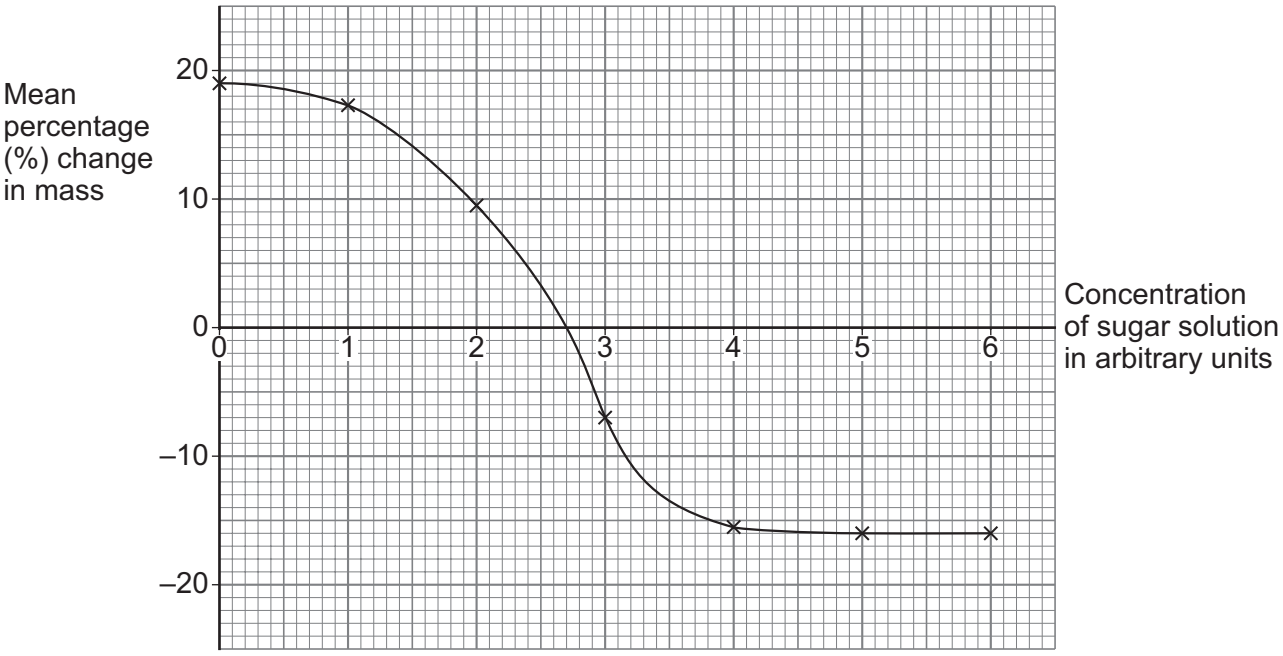
Question 4 continues on the next page

Do not write outside the box

The student calculated the mean percentage change in mass at each concentration of sugar solution.

Figure 7 shows the results.

Figure 7



0 4 . 5 In some concentrations of sugar solution, the mass of the pieces of pepper increased.

The mass increased because water moved into the cells.

What process moved water into the cells?

[1 mark]

_____

0 4 . 6 What concentration of sugar solution would cause a mean percentage change in mass of 0%?

Use **Figure 7**.

[1 mark]

Concentration of sugar solution = _____ arbitrary units

Do not write outside the box

0 4 . 7 The cells of the pepper have wrinkled cell walls.

What is the advantage of wrinkled cell walls to the pepper plant?

[1 mark]

Tick (✓) **one** box.

The cells can expand ☐

The cells contain less cellulose ☐

The surface area is smaller ☐

0 4 . 8 Tobacco mosaic virus (TMV) can infect pepper plants.

Infected plants have yellow patches on the leaves.

Explain why plants with TMV grow slower than plants that do **not** have TMV.

[3 marks]

_____

_____

_____

_____

_____

_____

15

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0 5 This question is about genetics.

0 5 . 1 Draw **one** line from each term to the meaning of the term.

[3 marks]

Term	Meaning
Chromosome	A change in the DNA
Genome	A structure made of DNA and found in the nucleus
Mutation	All the genes in an organism
	An inherited disorder

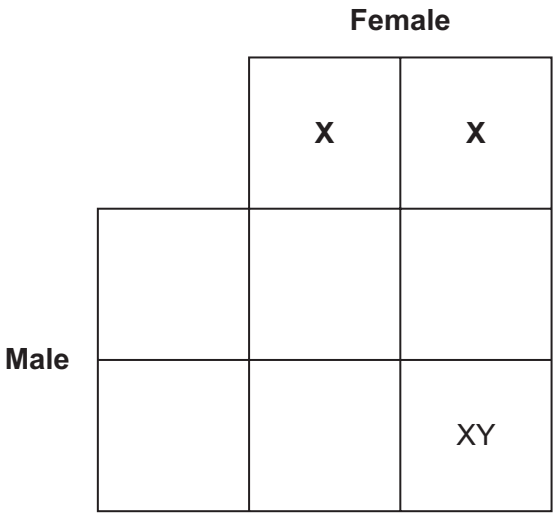
Do not write outside the box

0 5 . 2 The inheritance of sex in humans is controlled by two chromosomes, **X** and **Y**.

Complete **Figure 8** to show how sex is inherited.

[3 marks]

Figure 8



Question 5 continues on the next page

Do not write outside the box

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

0 5 . 3 Why is genetic modification of human embryos illegal in most countries?

[1 mark]

Tick (✓) **one** box.

Genetic modification technology is too expensive. ☐

Specialist equipment is needed for genetic modification. ☐

The side effects of genetic modification are not known. ☐

0 5 . 4 The scientist claimed the genetic modification was made to embryos immediately after fertilisation.

Why is genetic modification of embryos more of a concern than genetic modification of body tissues in an adult?

[1 mark]

Tick (✓) **one** box.

Genetically modified body tissues are much larger than an embryo. ☐

The genetic modification of an embryo would not affect all the body tissues. ☐

The modified gene in an embryo could be passed on to future offspring. ☐

Do not write outside the box

0 5 . 5 The scientist claimed that the embryos were genetically modified to be resistant to HIV infection.

Why do some scientists think this use of genetic modification is **not** necessary?

[1 mark]

Tick (✓) **one** box.

HIV infection can be treated with antiretroviral drugs. ☐

Only adults are at risk of HIV infection. ☐

Oral contraceptives reduce the risk of HIV infection. ☐

9

Turn over for the next question

Do not write outside the box

0 6 This question is about respiration.

0 6 . 1 Complete the sentence.

Choose the answer from the box.

[1 mark]

balanced	**exothermic**	**photosynthetic**

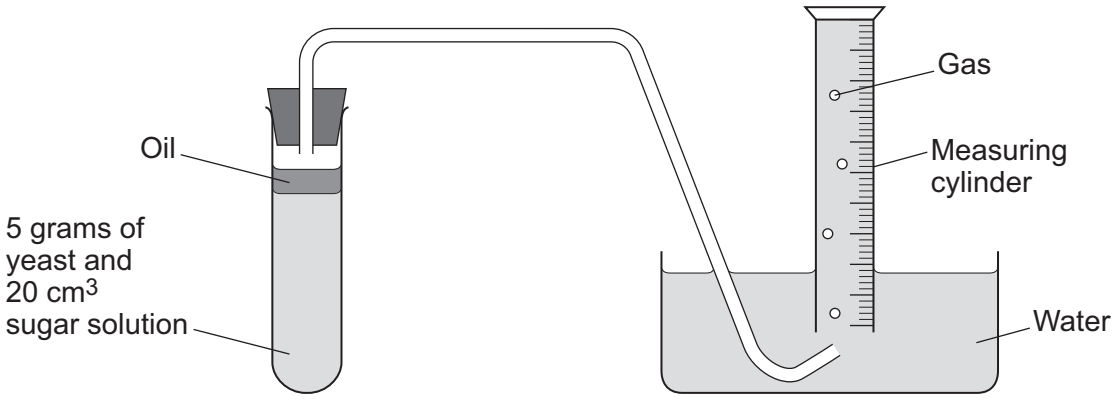
Respiration releases energy, therefore respiration is _____.

Yeast is a type of fungus.

A student investigated how temperature affects respiration in yeast.

Figure 9 shows some of the apparatus used.

Figure 9



The yeast produces a gas. The gas passes through the layer of oil and is collected in the measuring cylinder.

Do not write outside the box

0 6 . 2 The oil above the yeast and sugar solution prevents oxygen from entering the solution.

What type of respiration occurs in the yeast when **no** oxygen is present?

[1 mark]

_____

This is the method used.

1. Place yeast and sugar solution in a test tube.
2. Add a thin layer of oil.
3. Place the test tube in a water bath at 5 °C
4. After 10 minutes set up the apparatus as shown in **Figure 9**.
5. Record the volume of gas collected in 1 hour.
6. Repeat steps 1 to 5 at different temperatures.

0 6 . 3 Give **two** control variables the student used in the investigation.

[2 marks]

1 _____

_____

2 _____

_____

Question 6 continues on the next page

Do not write outside the box

Table 3 shows the results.

Table 3

Temperature in °C	Volume of gas produced in cm^3
5	0.8
10	1.6
15	2.4
20	3.2
25	4.0

0 6 . 4 Complete the sentence.

Choose the answer from the box.

[1 mark]

decreased	**stayed the same**	**increased**

As the temperature increased, the volume of

gas produced _____.

0 6 . 5 Why should the data from **Table 3** be presented as a line graph and **not** as a bar chart?

[1 mark]

Tick (✓) **one** box.

Bar charts are too simple ☐

Temperature is a continuous variable ☐

Volume of gas is a categoric variable ☐

Do not write outside the box

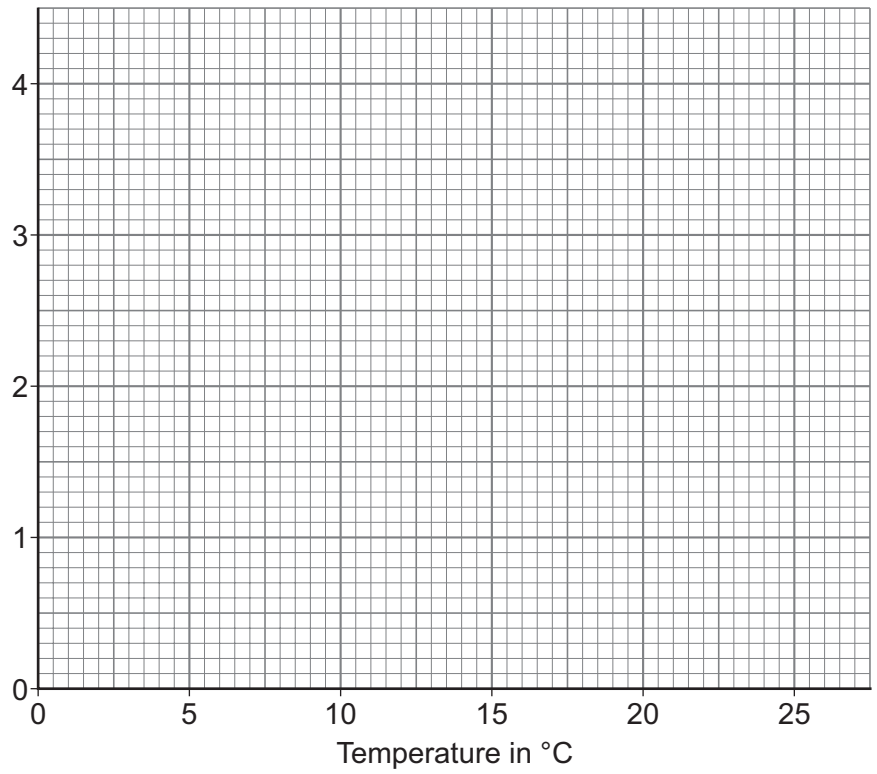
0 6 . 6 Complete **Figure 10**.

You should:

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

[4 marks]

Figure 10



0 6 . 7 Predict the volume of gas that would be produced at 7 °C.

Use **Figure 10**.

[1 mark]

Volume = _____ cm^3

Question 6 continues on the next page

Do not write outside the box

0 6 . 8 The student repeated the investigation at 60 °C.

Suggest why gas was **not** produced by the yeast at 60 °C.

[1 mark]

_____

_____

12

Do not write outside the box

0 7 Funnel-web spiders produce poison to kill prey.

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

The poison contains a protein.

0 7 . 1 What is a protein?

[1 mark]

Tick (✓) **one** box.

A chain of glucose molecules ☐

A long chain of amino acids ☐

A small insoluble molecule ☐

0 7 . 2 What reagent is used to test for protein?

[1 mark]

_____

Question 7 continues on the next page

Do not write outside the box

The protein from the spider could be used in a new drug to treat patients having a heart attack.

When a person has a heart attack:

- cells in the heart muscle do **not** receive enough oxygen
- cells in the heart muscle stop working.

0 7 . 3 Why are heart attacks non-communicable?

[1 mark]

_____

_____

0 7 . 4 The protein from the spider allows heart muscle tissues to function in low concentrations of oxygen.

Complete **Table 4** to show the risks and benefits of the new drug.

[2 marks]

Tick (✓) **one** box in **each** row.

Table 4

Statement	**Risk**	**Benefit**
The drug could be toxic		
The drug could keep hearts for transplantation functioning for more time		
The drug could treat coronary heart disease		
The drug could stop other drugs working		

Do not write outside the box

The drug made from the protein would be tested in a drug trial.

0 7 . 5 Part of the drug trial would involve a placebo.

Explain why a placebo is used in a drug trial.

[2 marks]

0 7 . 6 The results of drug trials are peer reviewed.

Which are **two** advantages of peer review?

[2 marks]

Tick (✓) **two** boxes.

People who are not experts simplify the results during peer review. ☐

Scientists not involved in the drug trial assess whether the results are valid. ☐

Scientists who planned the drug trial decide whether the results are published. ☐

The peer reviewers decide the dose for testing the drug on animals. ☐

The process of peer review reduces the chance of bias. ☐

9

Turn over for the next question

Do not write outside the box

0 8 Two students analysed water from four rivers.

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

Table 5 shows the results.

Table 5

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 8 . 1 Suggest what was used to measure the pH in each method.

[2 marks]

Method **A** _____

Method **B** _____

0 8 . 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 8 . 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 8 . 4 Which river is most likely to be in an area with a high concentration of sulfur dioxide in the air?

Use **Table 5**.

[1 mark]

Tick (✓) **one** box.

W ☐ **X** ☐ **Y** ☐ **Z** ☐

0 8 . 5 Explain your answer to Question **08.4**.

[3 marks]

_____

_____

_____

_____

_____

_____

_____

Question 8 continues on the next page

Do not write outside the box

0 8 . 6 Describe a method to determine the mass of dissolved solids in 50 cm^3 of river water.

[4 marks]

12

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Turn over for the next question

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0 9 Biodiversity is the variety of species within an ecosystem.

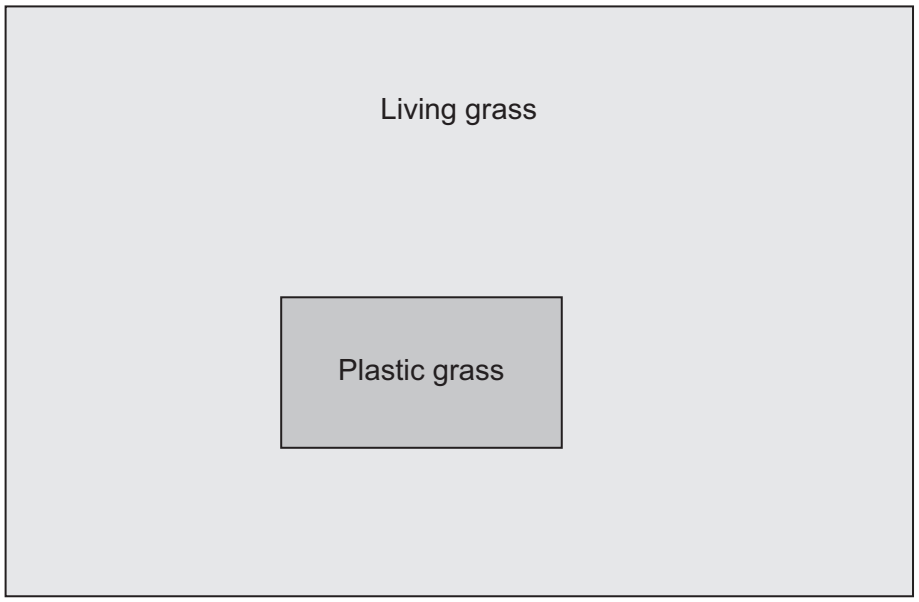
0 9 . 1 A student investigated the biodiversity in a field.

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 11 shows the field.

Figure 11



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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 9 . 2 How would a greater number of different plant species affect the biodiversity of animals in the area?

[1 mark]

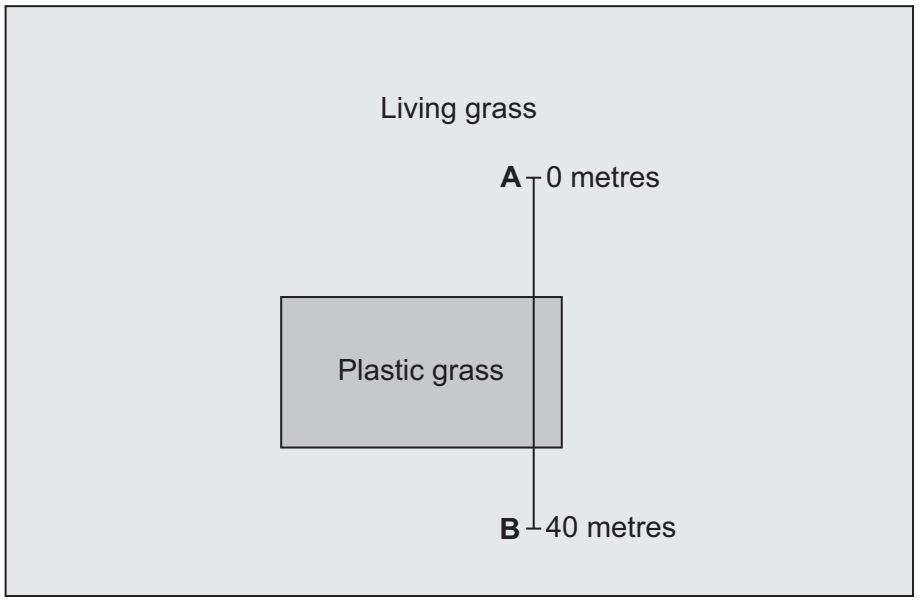
Question 9 continues on the next page

Do not write outside the box

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

Figure 12 shows the position of the transect.

Figure 12



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

Table 6 shows the results.

Table 6

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 9 . 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 9 . 4 Describe the relationship between the type of grass and the number of plant species.

[1 mark]

_____

_____

0 9 . 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 9 continues on the next page

Do not write outside the box

0 9 . 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 9 . 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 9 . 8 Suggest **two** ways biodiversity in and around fields can be increased.

Do **not** refer to plastic grass.

[2 marks]

1 _____

_____

2 _____

_____

16

END OF QUESTIONS

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

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