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

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 The human circulatory system transports blood around the body.

0 1 . 1 The human circulatory system is made of different structures.

Give the structures in order of size from the largest to the smallest.

Choose answers from the box.

The first one has been completed for you.

[1 mark]

heart	**muscle cell**	**nucleus**

Largest circulatory system

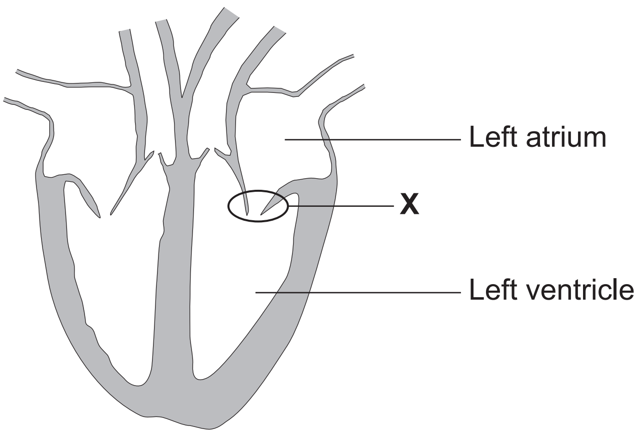
____

____

Smallest ____________________

Figure 1 shows a heart.

Figure 1



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0 1 . 2 The heart pumps blood from the body to the lungs.

Which route does blood travel through the heart?

[1 mark]

Tick (✓) **one** box.

aorta → left atrium → left ventricle → pulmonary artery ☐

aorta → right atrium → right ventricle → pulmonary artery ☐

vena cava → left atrium → left ventricle → pulmonary artery ☐

vena cava → right atrium → right ventricle → pulmonary artery ☐

0 1 . 3 Explain why the wall of the left ventricle is thicker than the wall of the right ventricle.

[2 marks]

____

____

____

____

0 1 . 4 What is the function of structure **X** shown in **Figure 1**?

[1 mark]

____

____

Question 1 continues on the next page

0 1 . 5 The heart contains a group of cells called the pacemaker.

Which part of the heart contains the pacemaker?

[1 mark]

Tick (✓) **one** box.

Left atrium ☐

Left ventricle ☐

Right atrium ☐

Right ventricle ☐

0 1 . 6 What is the function of the pacemaker?

[1 mark]

____

____

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0 1 . 7 A person started an exercise training programme to improve their health.

Table 1 shows information about the person's heart.

- Stroke volume is the volume of blood pumped out of the heart each beat.
- Cardiac output is the total volume of blood pumped out of the heart each minute.

Table 1

Stage of training programme	Heart rate in beats per minute	Stroke volume in cm^3	Cardiac output in cm^3 per minute
Before	71	65	4615
After	57	81	4617

After the training programme the person's heart rate had decreased.

Explain the effect the training programme had on the person's **cardiac output**.

Use **Table 1**.

[2 marks]

____

____

____

____

Question 1 continues on the next page

Do not write outside the box

0 1 . 8 Explain how diet and lifestyle can **increase the risk** of poor health and non-communicable diseases.

[6 marks]

15

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 2 Some plants have leaves with white areas and green areas.

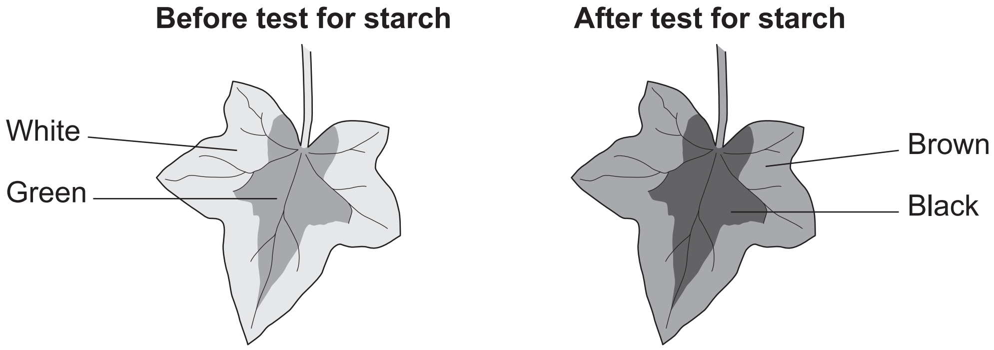
A student tested a leaf with white areas and green areas for starch.

This is the method used.

1. Boil the leaf in ethanol.
2. Rinse the leaf in water.
3. Add iodine solution to the leaf.
4. Record the colour of each area of the leaf.

Figure 2 shows the results.

Figure 2



0 2 . 1 The student boiled the leaf in ethanol to remove the green colour from the leaf.

Why does the green colour need to be removed from the leaf before the leaf is tested for starch?

[1 mark]

____

____

Do not write outside the box

0 2 . 2 Explain how the results in **Figure 2** provide evidence that the white area of the leaf did **not** contain chlorophyll.

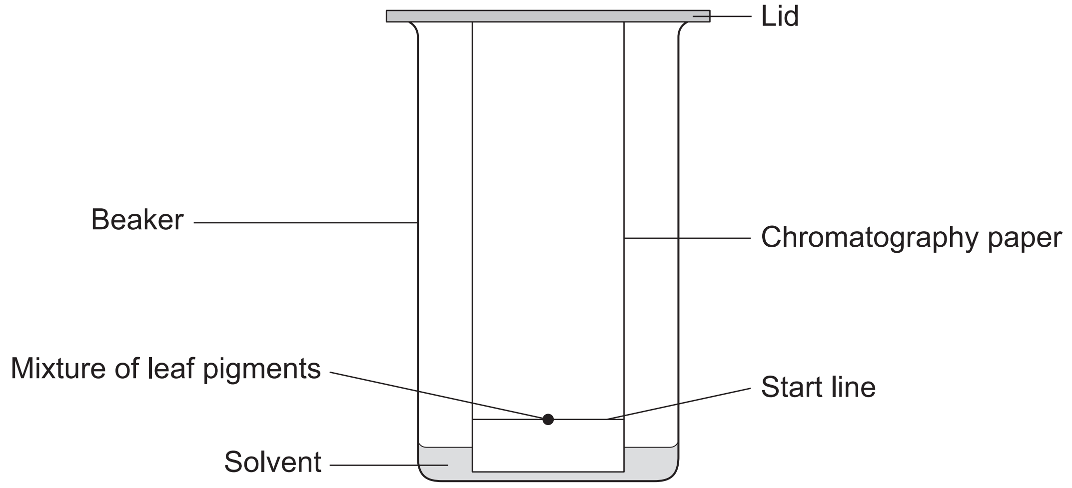
[3 marks]

Question 2 continues on the next page

The student investigated the coloured pigments in the leaf.

Figure 3 shows the apparatus.

Figure 3



0 2 . 3 Chromatography involves a mobile phase and a stationary phase.

Draw **one** line from each phase to the identity of that phase in the investigation.

[2 marks]

Phase	Identity of phase
	Beaker
Mobile phase	Chromatography paper
Stationary phase	Mixture of leaf pigments
	Solvent

0 2 . 4 The student drew the start line in pencil.

Why did the student **not** draw the start line in ink?

[1 mark]

____

____

Question 2 continues on the next page

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Table 2 shows the results.

Table 2

Colour of leaf pigment	**Distance moved by leaf pigment in mm**	**R_f value**
Orange	116	0.96
Brown	42	0.35
Green	33	0.27
Yellow	**X**	0.24

0 2 . 5 Calculate **X** in **Table 2**.

Use the equation:

$$R_f \text{ value} = \frac{\text{distance moved by leaf pigment}}{\text{distance moved by solvent}}$$

The distance moved by the solvent was 121 mm.

Give your answer to 2 significant figures.

[4 marks]

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____

X (2 significant figures) = ______________ mm

Do not write outside the box

Table 3 shows the range of R_f values for known leaf pigments.

Table 3

Leaf pigment	**Range of R_f values**
Carotene	0.89 to 0.98
Chlorophyll a	0.20 to 0.30
Phaeophytin	0.33 to 0.40
Xanthophyll	0.04 to 0.28

0 2 . 6 The student used **Table 3** to identify the leaf pigments in their investigation.

Which colour is the leaf pigment phaeophytin?

Use **Table 2** and **Table 3**.

[1 mark]

____

0 2 . 7 Another student did the investigation using the same leaf pigments.

The R_f values for the same pigments were different.

What is the reason for the difference?

[1 mark]

Tick (✓) **one** box.

A different solvent was used. ☐

A greater volume of solvent was used. ☐

The solvent moved further. ☐

13

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ANSWER IN THE SPACES PROVIDED**

0 3 Waves transfer energy.

0 3 . 1 Radio waves are transmitted from a radio station and absorbed by a radio receiver.

What is created in the radio receiver when the radio waves are absorbed?

[1 mark]

Tick (✓) **one** box.

An alpha particle ☐

An alternating current ☐

An ultraviolet wave ☐

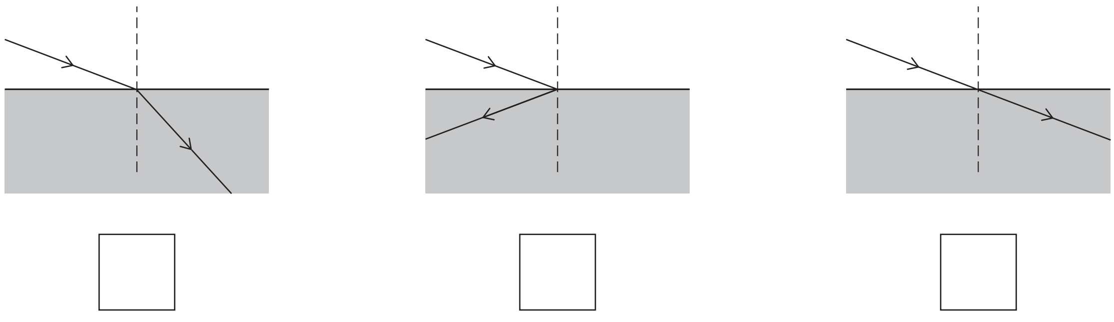
An X-ray ☐

0 3 . 2 Radio waves may be refracted when they travel from one substance into another substance.

Which diagram shows the refraction of a radio wave?

[1 mark]

Tick (✓) **one** box.



Question 3 continues on the next page

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When the radio receiver is switched on, a sound wave is produced.

0 3 . 3 Give **two** differences between radio waves and sound waves.

[2 marks]

1 ____

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2 ____

____

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0 3 . 4 **Table 4** shows the speed of sound in different substances at two different temperatures.

Table 4

Substance	Temperature of substance in °C	Speed of sound in metres per second
Air	1	332
Air	20	344
Steel	1	5002
Steel	20	5136
Water	1	1411
Water	20	1465

Give **three** conclusions about the effect of temperature and the type of substance on the speed of sound waves.

[3 marks]

1 ____

____

2 ____

____

3 ____

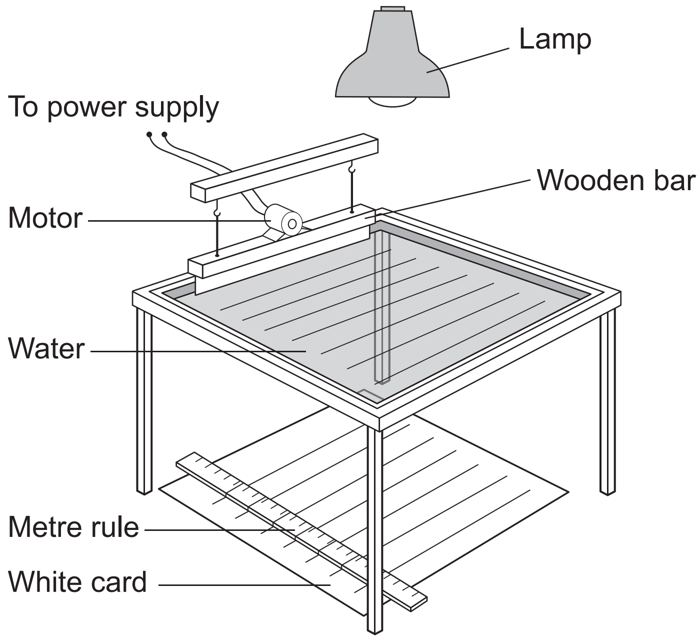
____

Question 3 continues on the next page

0 3 . 5 A teacher used a ripple tank to show how varying the frequency affected the wavelength of water waves.

Figure 4 shows the apparatus.

Figure 4



This is the method used.

1. Turn on the lamp.
2. Adjust the power supply so that the wooden bar vibrates with a frequency of 10 Hz to produce waves on the water.
3. Take a photograph of the image of the waves projected onto the white card.
4. Measure the length of 5 waves from the photograph.
5. Calculate the wavelength of 1 wave.
6. Repeat steps 2 to 5 for different frequencies.

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The method used by the teacher is better than measuring the length of only 1 wave directly from the white card.

Explain why.

[3 marks]

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10

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ANSWER IN THE SPACES PROVIDED

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0 4 A tumour is a group of abnormal cells that form a lump.

0 4 . 1 Give **one** factor that causes cells to form tumours.

[1 mark]

____

____

0 4 . 2 Tumours can be benign or malignant.

Malignant tumours are cancers.

Give **two** ways a malignant tumour is different from a benign tumour.

[2 marks]

1 ____

____

2 ____

____

Question 4 continues on the next page

Scientists tested a new drug to treat tumours in mice.

All the mice:

- had the same type of tumour
- were the same age
- were female.

This is the method used.

1. Inject the mice with a dose of 0.015 mg of the drug every day for 20 days.
2. Measure the volume of the tumour every 4 days.
3. Repeat steps 1 and 2 with new groups of mice using doses of:
   - 0.030 mg of the drug
   - 0.060 mg of the drug.

0 4 . 3 Give **two** control variables the scientists should have used in the drug test.

Do **not** refer to the type of tumour, the age of the mice or the sex of the mice.

[2 marks]

1 ____

____

2 ____

____

0 4 . 4 Some mice were used as a control group.

Suggest what treatment was given to the control group.

[1 mark]

____

____

0 4 . 5 Give **one** reason why the scientists used a control group.

[1 mark]

____

____

Question 4 continues on the next page

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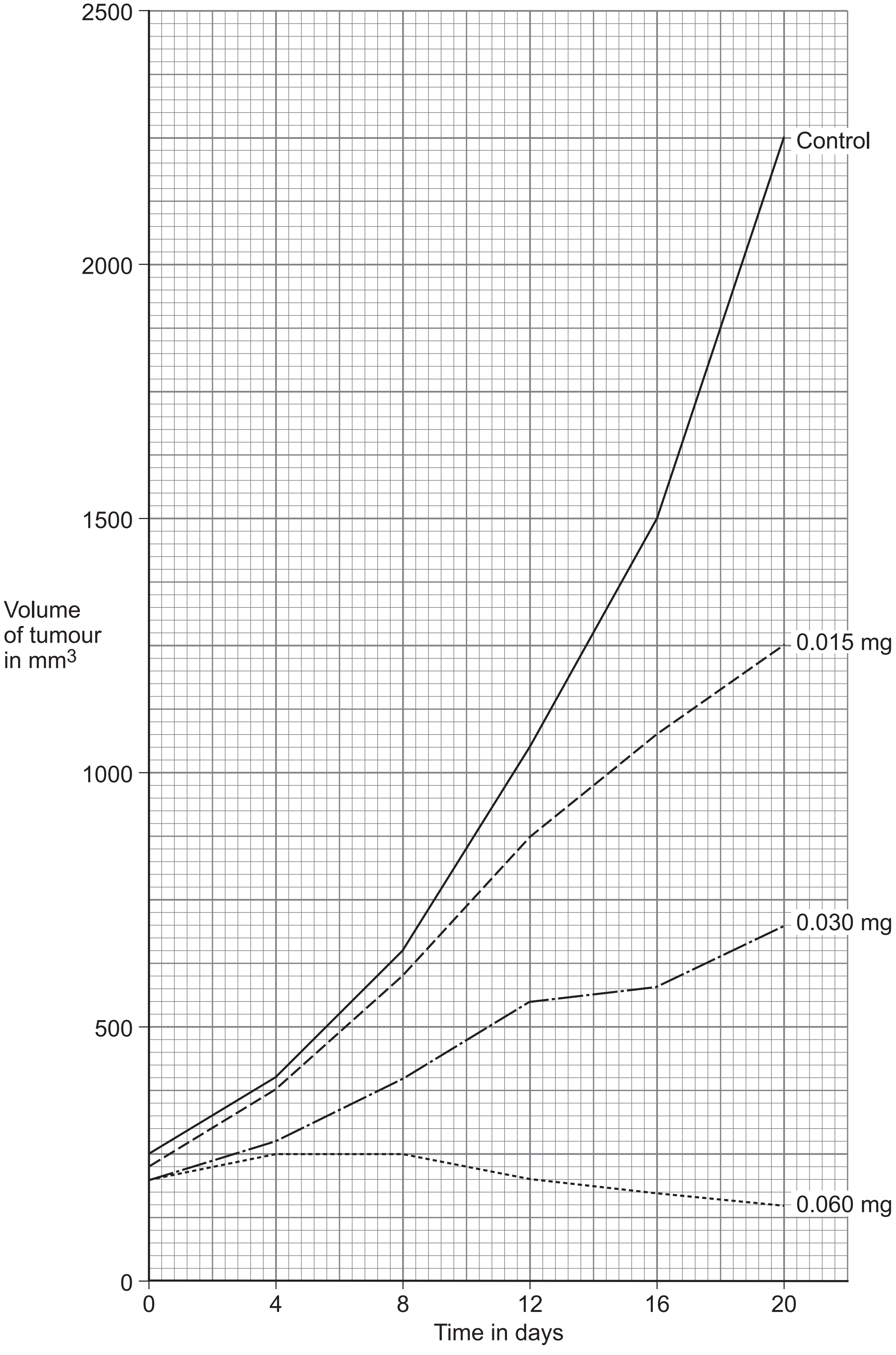
Figure 5 shows the results.

Figure 5



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0 4 . 6 Calculate the percentage increase in the volume of the tumour in the control group between 0 and 20 days.

[3 marks]

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____

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____

Percentage increase = ______________ %

0 4 . 7 Give **two** conclusions about the effectiveness of the different doses of the drug.

Use **Figure 5**.

[2 marks]

1 ____

____

2 ____

____

Question 4 continues on the next page

Do not write outside the box

0 4 . 8 Suggest why the scientists measured the volume of the tumour instead of measuring the width of the tumour.

[1 mark]

____

____

0 4 . 9 The scientists tested the drug in two stages:

- stage 1: drug tested on pieces of tumour tissue
- stage 2: drug tested on mice with tumours.

What extra information will the scientists gain by testing the drug on mice at stage 2?

[1 mark]

____

____

14

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ANSWER IN THE SPACES PROVIDED

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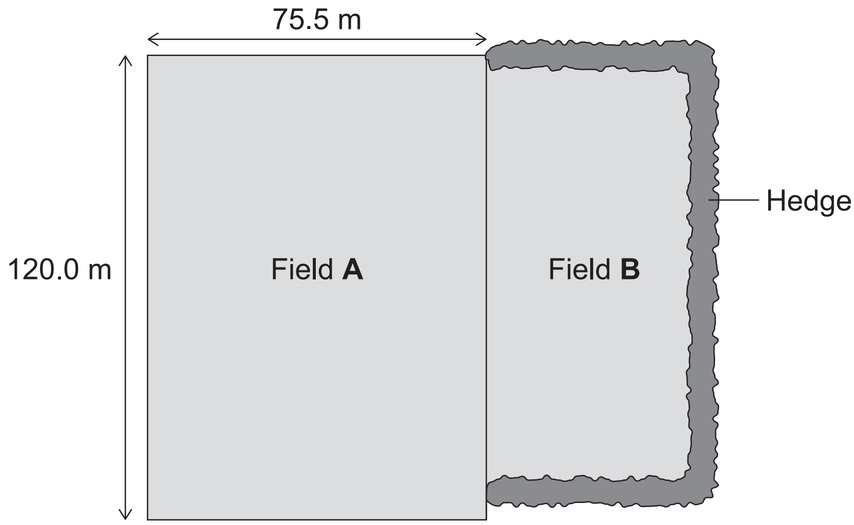
0 5 A student investigated the number of plants in two different fields.

This is the method used.

1. Place a quadrat randomly in field **A**.
2. Count the number of plants of each species in the quadrat.
   Do **not** count grasses.
3. Repeat steps 1 and 2 another 19 times.
4. Repeat steps 1 to 3 for field **B**.

Figure 6 shows the two fields.

Figure 6



0 5 . 1 Why should a random sampling method be used to sample the plants?

[1 mark]

____

____

0 5 . 2 The student counted dandelion plants.

The student used a 0.5 m × 0.5 m quadrat.

The mean number of dandelion plants in field **A** in **Figure 6** was 2.8 per quadrat.

Determine the total number of dandelion plants in field **A**.

[4 marks]

Total number = ____________________

Question 5 continues on the next page

Do not write outside the box

The student placed insect traps in the ground in field **A** and in field **B**.

The insect traps were used to estimate the total number of insects in each field.

Figure 7 shows the position of the insect traps in each field.

Figure 7

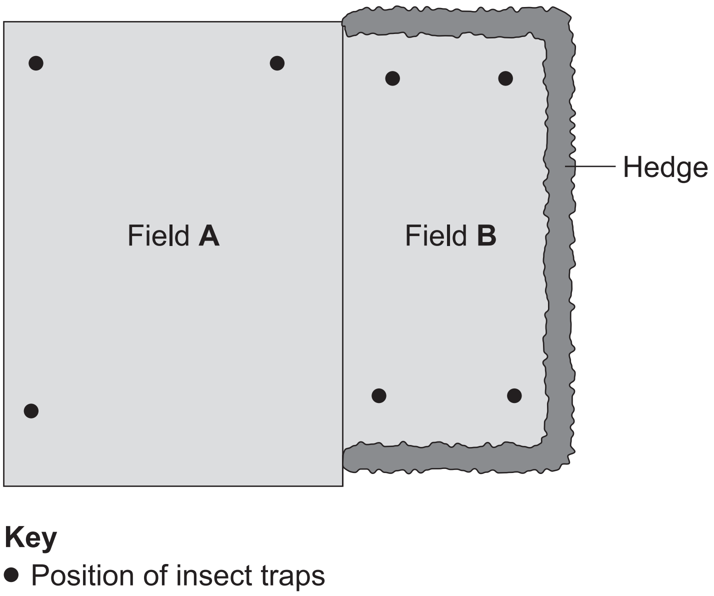
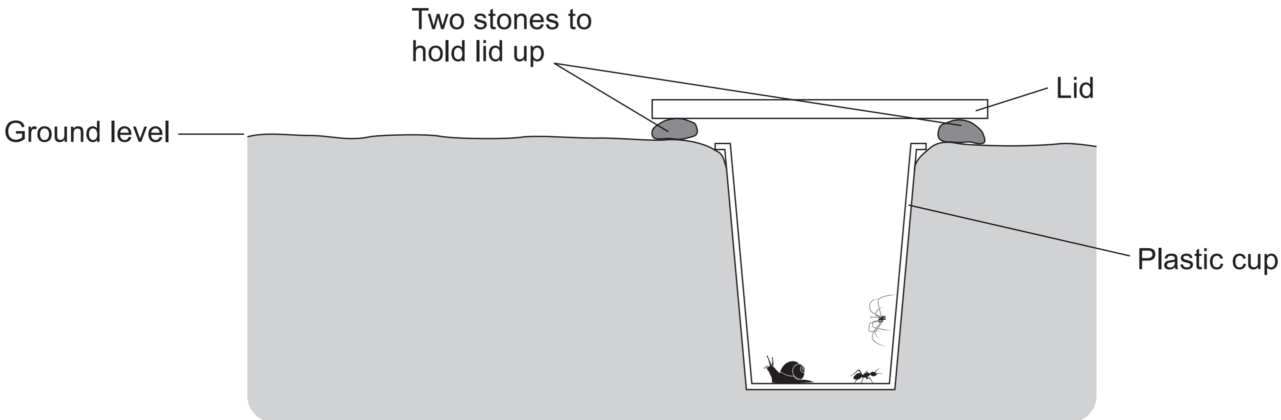


Figure 8 shows the insect trap the student used.

Figure 8



This is the method used.

1. Place the insect traps in the fields as shown in **Figure 7** and **Figure 8**.
2. Leave for 12 hours.
3. Count the number of insects of each species in each trap.
4. Repeat every 2 days for 6 days.

0 5 . 3 The method for estimating the total number of insects in field **A** and field **B** may **not** give valid results.

Suggest **two** reasons why.

[2 marks]

1 ____

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2 ____

____

Question 5 continues on the next page

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0 5 . 4 **Table 5** shows the results for all the plants and insects sampled.

Table 5

	Mean number of plants per quadrat	**Number of different species of plant**	**Total number of insects**	**Number of different species of insect**
Field A	10.7	3	75	3
Field B	10.6	16	130	2

A student concluded:

'There is greater biodiversity in field **B** than in field **A**.'

Give the reason why.

[1 mark]

____

____

0 5 . 5 There has been a decrease in the total number of birds in the UK since 1970.

Explain how planting more hedges would affect the number of birds.

[2 marks]

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10

Turn over for the next question

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0 6 Some mosquitos can transmit malaria.

0 6 . 1 Describe how a mosquito transmits malaria.

[2 marks]

Scientists discovered a population of mosquitos living in the tunnels of the London Underground train system.

The mosquito '*C. pipiens*' entered the tunnels when the London Underground was being built in the 1800s.

Some mosquitos were trapped in the tunnels.

Table 6 gives information about *C. pipiens* mosquitos.

Table 6

***C. pipiens* that live above ground**	***C. pipiens* that live in the tunnels**
Feed on the blood of birds during the spring and summer	Feed on the blood of rats throughout the year
Need to feed on blood before laying eggs	Do **not** need to feed on blood before laying eggs
Are **not** active in the autumn and winter	Stay active all year round

0 6 . 2 Suggest **one** reason why the mosquitos living in the tunnels stay active all year round.

[1 mark]

Do not write outside the box

Some scientists believe that the mosquitos living in the tunnels have evolved into a new species.

0 6 . 3 Name the process that causes evolution.

[1 mark]

____

0 6 . 4 Explain how the mosquitos living in the tunnels could have evolved into a different species from those living above ground.

[6 marks]

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Question 6 continues on the next page

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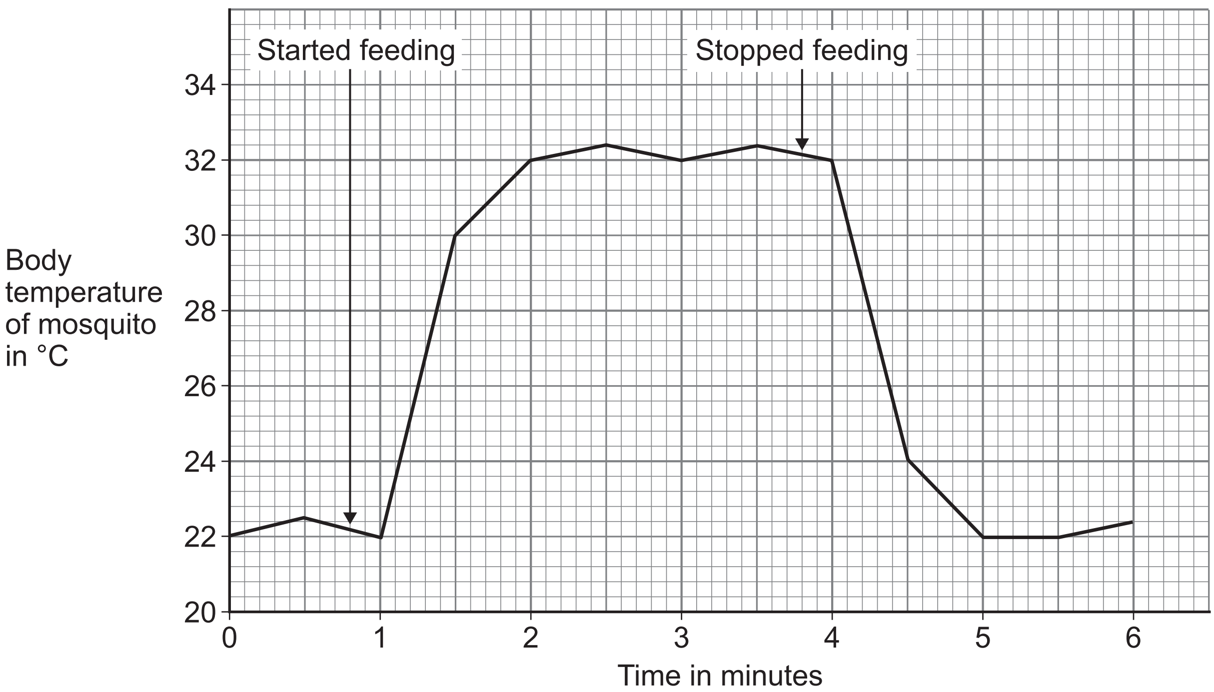
0 6 . 5 Most female mosquitos feed on the blood of animals before laying their eggs.

Figure 9 shows the change in the body temperature of a female mosquito while feeding on blood.

Figure 9



Mosquitos control their internal body temperature by homeostasis.

The optimum internal body temperature of mosquitos is 22 °C.

Explain why mosquitos can only feed on blood for a short time.

[3 marks]

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13

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

0 7 Matter can exist in different states.

Table 7 shows the melting points and boiling points of four substances.

Table 7

Substance	**Melting point in °C**	**Boiling point in °C**
Carbon dioxide	−78	−78
Methane	−183	−162
Nitrogen	−210	−196
Water	0	100

0 7 . 1 Give the temperature at which nitrogen condenses.

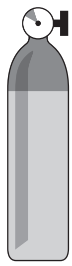
[1 mark]

______________________ °C

0 7 . 2 Nitrogen gas is transported in cylinders at high pressure.

Figure 10 shows a cylinder containing nitrogen gas.

Figure 10



What causes the pressure on the inside walls of the gas cylinder?

[1 mark]

____

____

0 7 . 3 Carbon dioxide sublimates.

What happens when carbon dioxide sublimates?

Use **Table 7**.

[1 mark]

____

____

0 7 . 4 Solid carbon dioxide is used during the transport of frozen food.

Using solid carbon dioxide keeps the food cold for longer than using frozen water.

Suggest **one** other advantage of using solid carbon dioxide instead of using frozen water during the transport of frozen food.

[1 mark]

____

____

0 7 . 5 The planet Saturn has a moon called Titan.

The surface temperature of Titan is −179.6 °C.

Features similar to rivers have been seen on Titan.

Which substance in **Table 7** could be the liquid in the rivers on Titan?

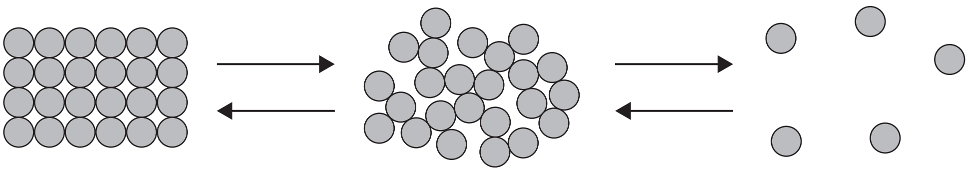
[1 mark]

____

Question 7 continues on the next page

0 7 . 6 **Figure 11** shows a simple model which can be used to describe changes of state.

Figure 11



Give **two** limitations of using this model to describe changes of state.

[2 marks]

1 ____

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2 ____

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0 7 . 7 Some water at 15 °C is heated until it all turns to steam at 100 °C.

The total energy supplied to the water is 1 320 000 J.

mass of water = 500 g
specific heat capacity of water = 4200 J/kg °C

Calculate the specific latent heat of vaporisation of water.

Use the Physics Equations Sheet.

[6 marks]

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Specific latent heat of vaporisation = ________________ J/kg

13

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ANSWER IN THE SPACES PROVIDED

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0 8 Plants have different tissues that are adapted for special functions.

One plant tissue is meristem tissue.

Meristem tissue:

- is made of meristem stem cells
- is found in the growing areas of a plant
- contains the cells that divide as a plant grows.

Figure 12 shows how specialised leaf cells are produced from meristem cells.

Figure 12

Meristem cells $\xrightarrow[\text{Cell division}]{}$ New cells $\xrightarrow[\mathbf{X}]{}$ Specialised leaf cells

Meristem cells divide and then form specialised cells.

0 8 . 1 Cells become specialised during process **X**.

Name process **X**.

[1 mark]

____

0 8 . 2 Describe **two** changes that can happen in a plant because meristem cells divide.

[2 marks]

1 ____

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2 ____

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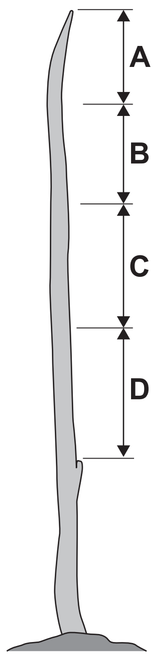
Question 8 continues on the next page

0 8 . 3 Scientists used a microscope to investigate cell division in a plant shoot.

Figure 13 shows the plant shoot.

Figure 13



The percentage of cells dividing by mitosis was estimated.

This is the method used.

1. Take a tissue sample from section **A** of the plant shoot and view 100 cells.
2. Count how many of the 100 cells are dividing by mitosis.
3. Repeat steps 1 and 2 for sections **B**, **C** and **D** of the plant shoot.

Table 8 shows the results.

Table 8

Section of plant shoot	Percentage (%) of cells dividing by mitosis
A	13
B	4
C	0
D	0

Explain the results in **Table 8**.

[2 marks]

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____

Question 8 continues on the next page

Do not write outside the box

Phloem tissue and xylem tissue are part of a plant's transport system.

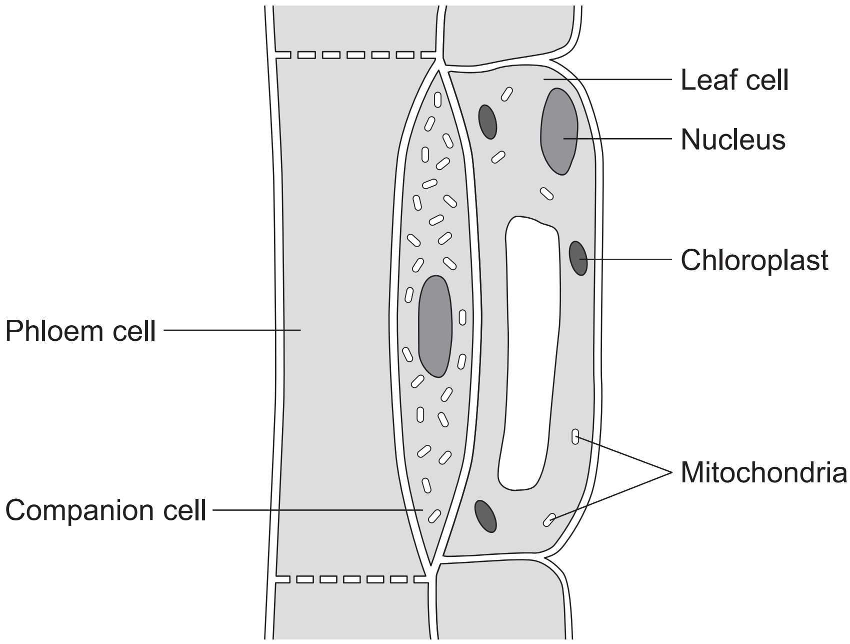
0 8 . 4 What is the name of the process that transports dissolved sugars around a plant?

[1 mark]

____

Figure 14 shows a section of phloem tissue in a leaf.

Figure 14



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0 8 . 5 Describe **two** ways the structure of phloem cells is different from the structure of xylem cells.

[2 marks]

1 ____

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2 ____

____

0 8 . 6 Dissolved sugar moves from the leaf cell into the phloem cell.

In **Figure 14**:

- the concentration of sugar in the leaf cell is 4 mg per dm^3
- the concentration of sugar in the phloem cell is 118 mg per dm^3.

The companion cell is needed to move sugar from the leaf cell into the phloem cell.

Explain why.

[4 marks]

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12

END OF QUESTIONS

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