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

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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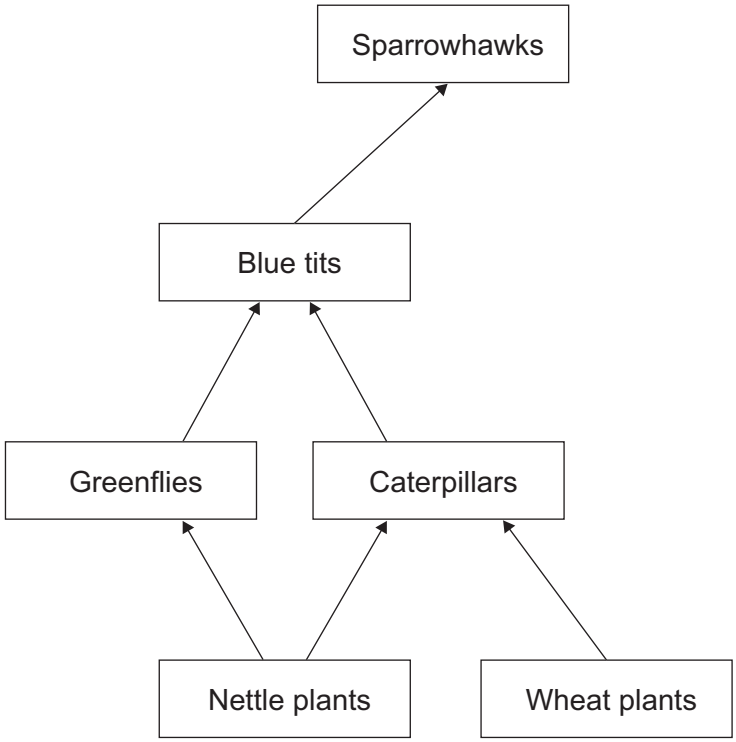
0 1 **Figure 1** shows part of a food web.

Figure 1



0 1 . 1 What is the source of energy for the nettle plants?

[1 mark]

Tick (✓) **one** box.

Caterpillars ☐

Soil ☐

Sun ☐

Do not write outside the box

0 1 . 2 Which term describes the caterpillars in the food web?

[1 mark]

Tick (✓) **one** box.

Primary consumer ☐

Secondary consumer ☐

Tertiary consumer ☐

0 1 . 3 What is the name of **one** producer in the food web?

[1 mark]

Tick (✓) **one** box.

Blue tits ☐

Greenflies ☐

Sparrowhawks ☐

Wheat plants ☐

0 1 . 4 Mice eat wheat plants **and** are eaten by sparrowhawks.

Complete the food web in **Figure 1** by adding mice to **Figure 1**.

[2 marks]

Question 1 continues on the next page

Do not write outside the box

0 1 . 5 A sparrowhawk competes with other sparrowhawks for food.

Give **one** other factor sparrowhawks will compete for.

Do **not** refer to food in your answer.

[1 mark]

_____

0 1 . 6 The nettle plants were removed.

Explain how removing the nettle plants will affect the number of caterpillars.

Use **Figure 1** on page 2.

[2 marks]

_____

_____

_____

_____

8

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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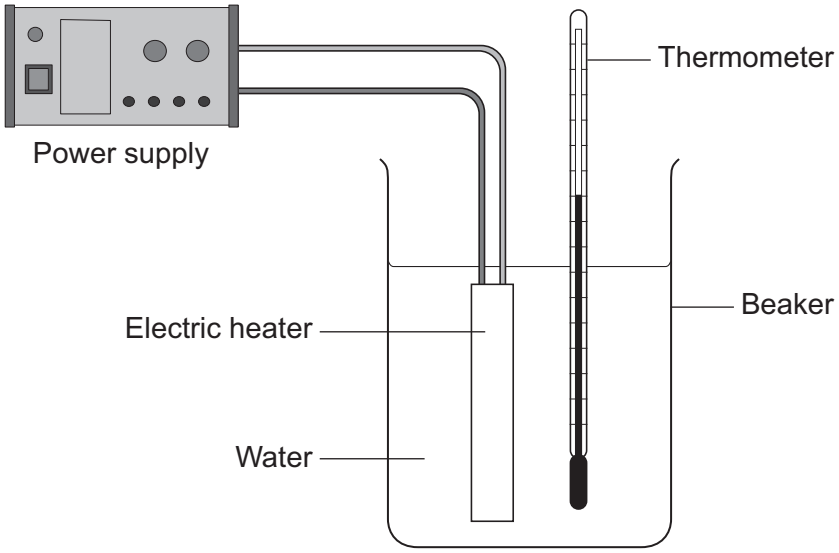
0 2 A student investigated how the temperature of water changed as it was heated.

Figure 2 shows some of the apparatus used.

Figure 2



The student switched the heater on then recorded the temperature of the water every 5 minutes.

Table 1 shows the results.

Table 1

Time in minutes	Temperature in °C			
	Test 1	Test 2	Test 3	Mean
0	25	25	25	25
5	31	32	33	32
10	42	45	45	**X**
15	56	54	64	58

Do not write outside the box

0 2 . 1 What was the resolution of the thermometer used in the investigation?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

0.1 °C ☐ 1 °C ☐ 10 °C ☐ 100 °C ☐

0 2 . 2 Calculate mean value **X** in **Table 1**.

[2 marks]

_____

_____

_____

X = _____ °C

0 2 . 3 Draw a ring around the anomalous result in **Table 1**.

[1 mark]

0 2 . 4 What should the student have done with the anomalous result?

[1 mark]

_____

_____

Question 2 continues on the next page

Do not write outside the box

0 2 . 5 Give **two** ways to reduce energy transfer from the apparatus to the surroundings.

[2 marks]

1 _____

_____

2 _____

_____

0 2 . 6 The water in the beaker had a mass of 0.20 kg.

The temperature increase of the water was 33 °C.

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

Calculate the change in thermal energy of the water.

Use the equation:

change in thermal energy = mass × specific heat capacity × temperature change

Choose the unit from the box.

[3 marks]

°C	**cm^3**	**J**	**kg**

_____

_____

_____

_____

_____

Change in thermal energy = _____

Unit _____

Do not write outside the box

0 2 . 7 Explain what happens to the mass of water in the beaker during a test.

[2 marks]

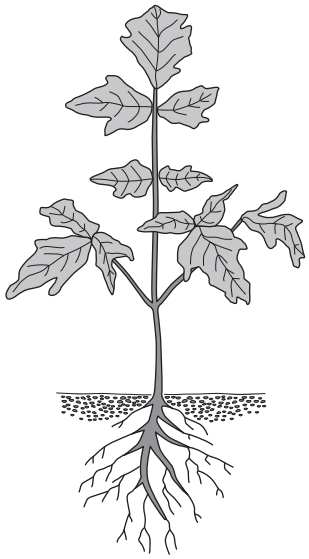
12

Turn over for the next question

Do not write outside the box

0 3 **Figure 3** shows a tomato plant.

Figure 3



0 3 . 1 A leaf is a plant organ.

Name **one** other plant organ shown in **Figure 3**.

[1 mark]

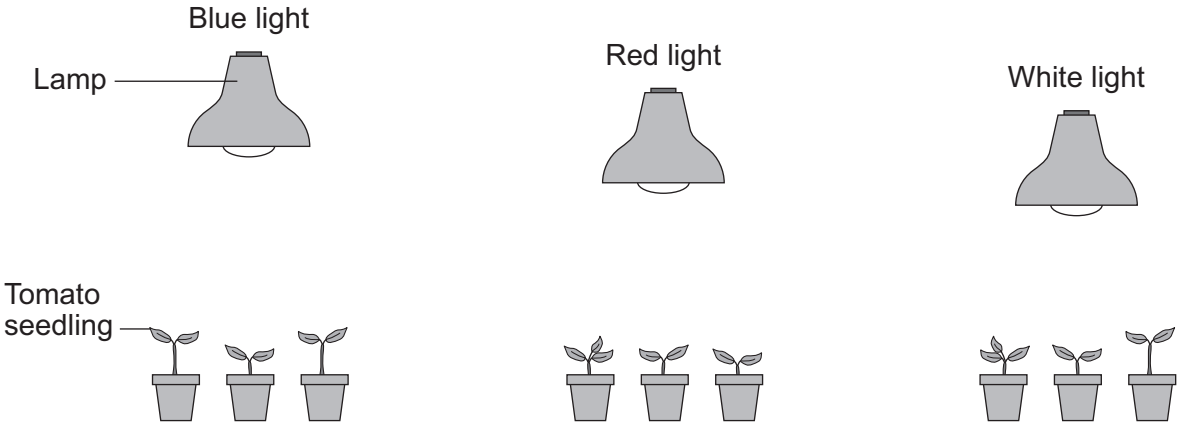
_____

Do not write outside the box

A student investigated the effect of different colours of light on the growth of tomato plant seedlings.

Figure 4 shows the apparatus used.

Figure 4



This is the method used.

1. Place three tomato plant seedlings under each colour of light.

2. Water each seedling every day.

3. Measure the height of each seedling after 30 days.

0 3 . 2 Give **two** control variables the student should have used in their investigation.

[2 marks]

1 _____

2 _____

Question 3 continues on the next page

Do not write outside the box

0 3 . 3 The student repeated the investigation using a valid method.

Table 2 shows the results.

Table 2

Colour of light	**Mean height of seedlings in cm**
Blue	14.5
Red	12.0
White	11.8

Give **two** conclusions from the results in **Table 2**.

[2 marks]

1 _____

_____

2 _____

_____

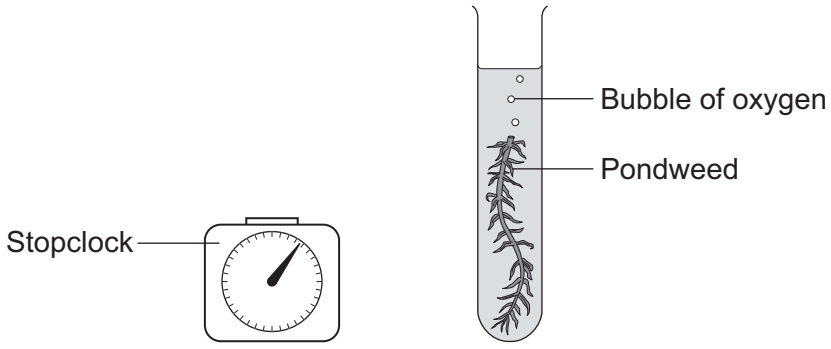
Do not write outside the box

Another student investigated the effect of light intensity on the rate of photosynthesis.

The student counted the number of bubbles of oxygen produced by pondweed at different light intensities.

Figure 5 shows some of the apparatus used.

Figure 5



0 3 . 4 Describe how the student could change the light intensity.

[2 marks]

Question 3 continues on the next page

Do not write outside the box

0 3 . 5 The pondweed did **not** produce many bubbles.

How could the student change the investigation to increase the number of bubbles produced?

[1 mark]

Tick (✓) **one** box.

Add more water to the test tube. ☐

Use a smaller piece of pondweed. ☐

Use water at a higher temperature. ☐

0 3 . 6 The student calculated the **rate** of photosynthesis.

Which equation is used to calculate the rate of photosynthesis?

[1 mark]

Tick (✓) **one** box.

rate of photosynthesis = $\frac{\text{number of bubbles}}{\text{time}}$ ☐

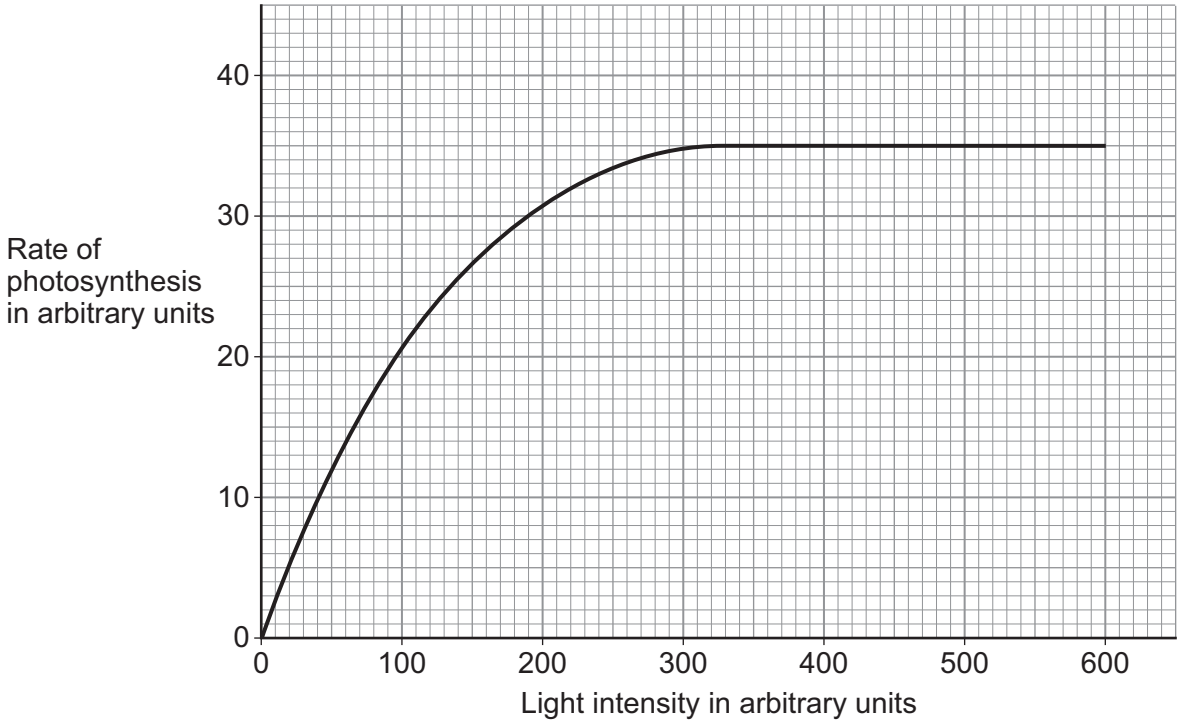
rate of photosynthesis = number of bubbles × time ☐

rate of photosynthesis = $\frac{\text{time}}{\text{number of bubbles}}$ ☐

Do not write outside the box

0 3 . 7 **Figure 6** shows the rate of photosynthesis at different light intensities.

Figure 6



Describe the pattern in **Figure 6**.

Use data from **Figure 6**.

[2 marks]

11

Turn over ▶

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ANSWER IN THE SPACES PROVIDED

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0 4 Two students investigated the effect of exercise on breathing rate.

Breathing rate was measured by counting the number of times a student breathed in during 1 minute.

This is the method used.

1. Measure the breathing rate at rest before exercise.

2. Run on the spot for 5 minutes.

3. Measure the breathing rate every minute during exercise.

4. Measure the breathing rate every minute after exercise for 10 minutes.

0 4 . 1 The students had different breathing rates at rest.

Suggest **two** factors that could cause the students' breathing rates at rest to be different.

[2 marks]

1 _____

_____

2 _____

_____

0 4 . 2 Suggest **one** reason why the measurements for breathing rate may **not** be accurate.

[1 mark]

_____

_____

Question 4 continues on the next page

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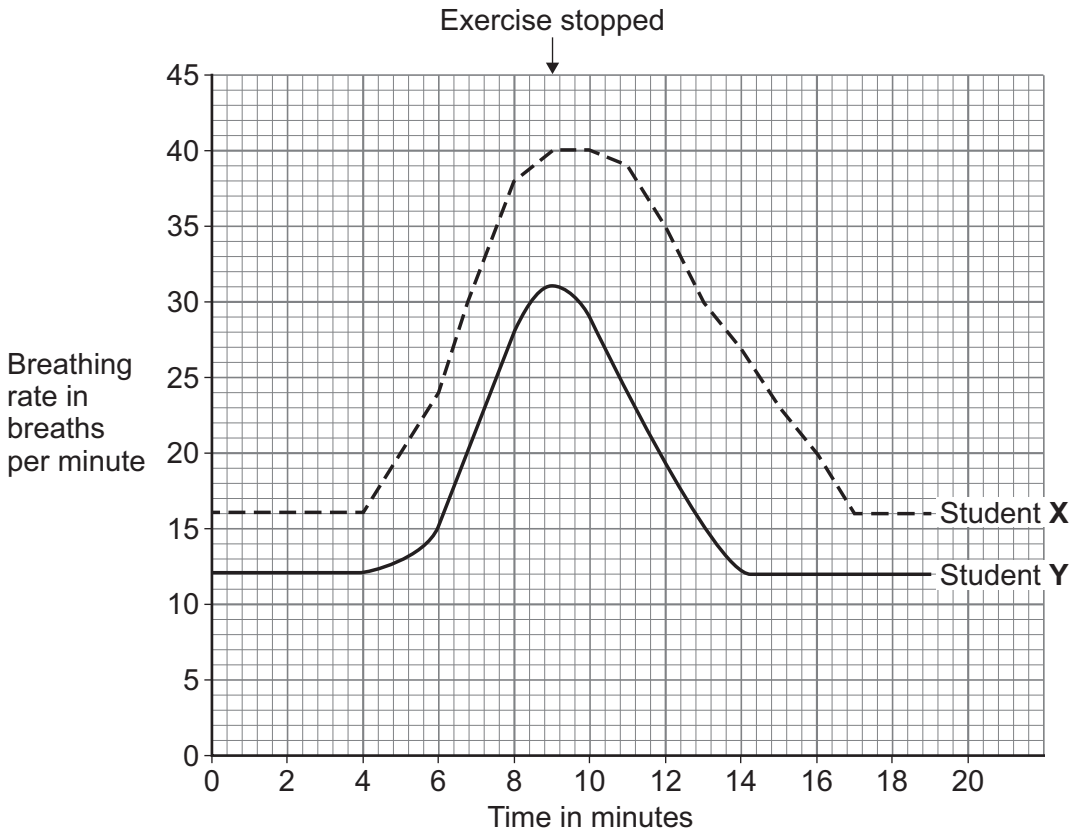
Figure 7 shows the results.

Figure 7



0 4 . 3 What time did the students start exercising?

Use **Figure 7**.

[1 mark]

Time exercise started = _____ minutes

0 4 . 4 Describe **two** differences between the results of student **X** and of student **Y**.

Use **Figure 7**.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

0 4 . 5 Why does breathing rate change during exercise?

[1 mark]

Tick (✓) **one** box.

To increase the uptake of carbon dioxide **and** oxygen from the air ☐

To increase the uptake of carbon dioxide from the air ☐

To increase the uptake of oxygen from the air ☐

0 4 . 6 The breathing rate of the students stayed high after the exercise stopped.

Why does breathing rate stay high after exercise has stopped?

[1 mark]

Tick (✓) **one** box.

To break down amino acids ☐

To break down fatty acids ☐

To break down lactic acid ☐

0 4 . 7 Give **one** other change that happens in the body during exercise.

Do **not** refer to breathing rate.

[1 mark]

_____

_____

9

Turn over ▶

Do not write outside the box

0 5 Proteins are an important part of the human diet.

0 5 . 1 Proteins are large food molecules that must be broken down in the digestive system.

Which enzyme breaks down proteins?

[1 mark]

Tick (✓) **one** box.

Carbohydrase ☐

Lipase ☐

Protease ☐

Proteins are digested into amino acids.

The body breaks down unwanted amino acids.

0 5 . 2 Which organ breaks down unwanted amino acids?

[1 mark]

Tick (✓) **one** box.

Brain ☐ Liver ☐ Lung ☐

0 5 . 3 What is produced by the breakdown of unwanted amino acids?

[1 mark]

Tick (✓) **one** box.

Fat ☐ Starch ☐ Urea ☐

Do not write outside the box

Mycoprotein is a protein made from a fungus.

Table 3 shows information about mycoprotein sausages and meat sausages.

Table 3

Nutrient	Mass of nutrient in grams per 100 grams	
	Mycoprotein sausages	**Meat sausages**
Protein	14.3	18.3
Carbohydrate	4.5	0.0
Fat	2.0	19.8
Salt	0.9	1.1

0 5 . 4 Give **three** differences between the nutrient content of mycoprotein sausages and meat sausages.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

Question 5 continues on the next page

Do not write outside the box

A student tested the mycoprotein sausage and the meat sausage for protein.

0 5 . 5 What is used to test for protein?

[1 mark]

Tick (✓) **one** box.

Biuret reagent ☐

Iodine solution ☐

pH indicator solution ☐

0 5 . 6 What colour is the positive result for the test for protein?

[1 mark]

Tick (✓) **one** box.

Black ☐

Lilac ☐

Red ☐

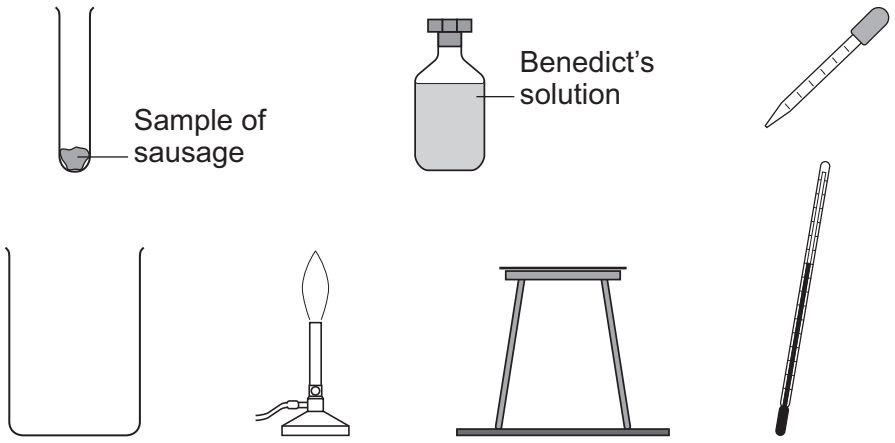
White ☐

Do not write outside the box

0 5 . 7 The student investigated the sugar content of the mycoprotein sausage and the meat sausage.

Figure 8 shows some of the apparatus used.

Figure 8



Describe a method to compare the amount of sugar in the two types of sausage.

Use the apparatus in **Figure 8** in your answer.

[6 marks]

14

Turn over ▶

Do not write outside the box

0 6 This question is about the evolution of cats.

Felis lunensis is an extinct cat that lived approximately 2.5 million years ago.

0 6 . 1 What is the genus name of the cat *Felis lunensis*?

[1 mark]

Tick (✓) **one** box.

Cat ☐

Felis ☐

Lunensis ☐

0 6 . 2 Scientists believe that modern-day cats have evolved from *Felis lunensis*.

How did modern-day cats evolve?

[1 mark]

Tick (✓) **one** box.

By cloning ☐

By genetic modification ☐

By natural selection ☐

Do not write outside the box

0 6 . 3 Give **one** type of evidence scientists can use to show that modern-day cats have evolved from *Felis lunensis*.

[1 mark]

_____

_____

Question 6 continues on the next page

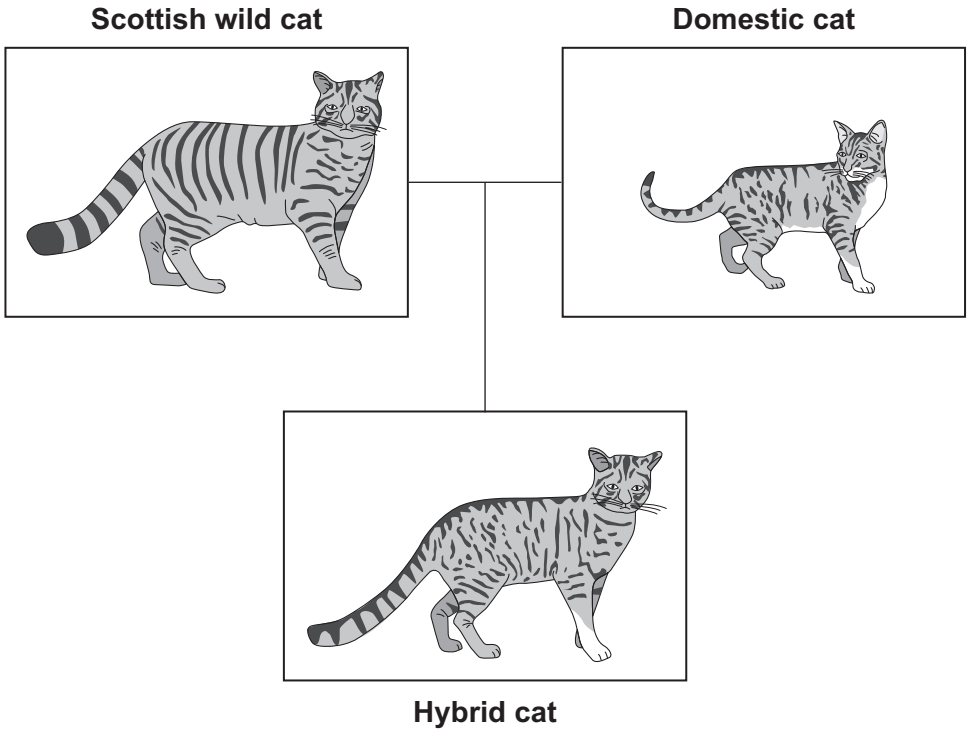
Do not write outside the box

Scottish wild cats can breed with domestic cats to produce offspring.

The offspring is called a hybrid cat.

Figure 9 shows a Scottish wild cat, a domestic cat and a hybrid cat.

Figure 9



The hybrid cat has inherited genes for different characteristics from both parents.

0 6 . 4 How has the hybrid cat inherited genes from both parents?

[1 mark]

Tick (✓) **one** box.

By genetic engineering ☐

By mitosis ☐

By mutation ☐

By sexual reproduction ☐

Do not write outside the box

0 6 . 5 Which chemical are genes made from?

[1 mark]

Tick (✓) **one** box.

Cellulose ☐

DNA ☐

Lipid ☐

Protein ☐

0 6 . 6 Give **one** characteristic that the hybrid cat has inherited from the Scottish wild cat.

Use **Figure 9**.

[1 mark]

_____

_____

0 6 . 7 Give **one** characteristic that the hybrid cat has inherited from the domestic cat.

Use **Figure 9**.

[1 mark]

_____

_____

Question 6 continues on the next page

Do not write outside the box

Scientists have investigated the populations of Scottish wild cats and hybrid cats.

0 6 . 8 Cats hunt for prey at night.

Suggest **one** reason why scientists find it difficult to identify the type of cat seen at night.

[1 mark]

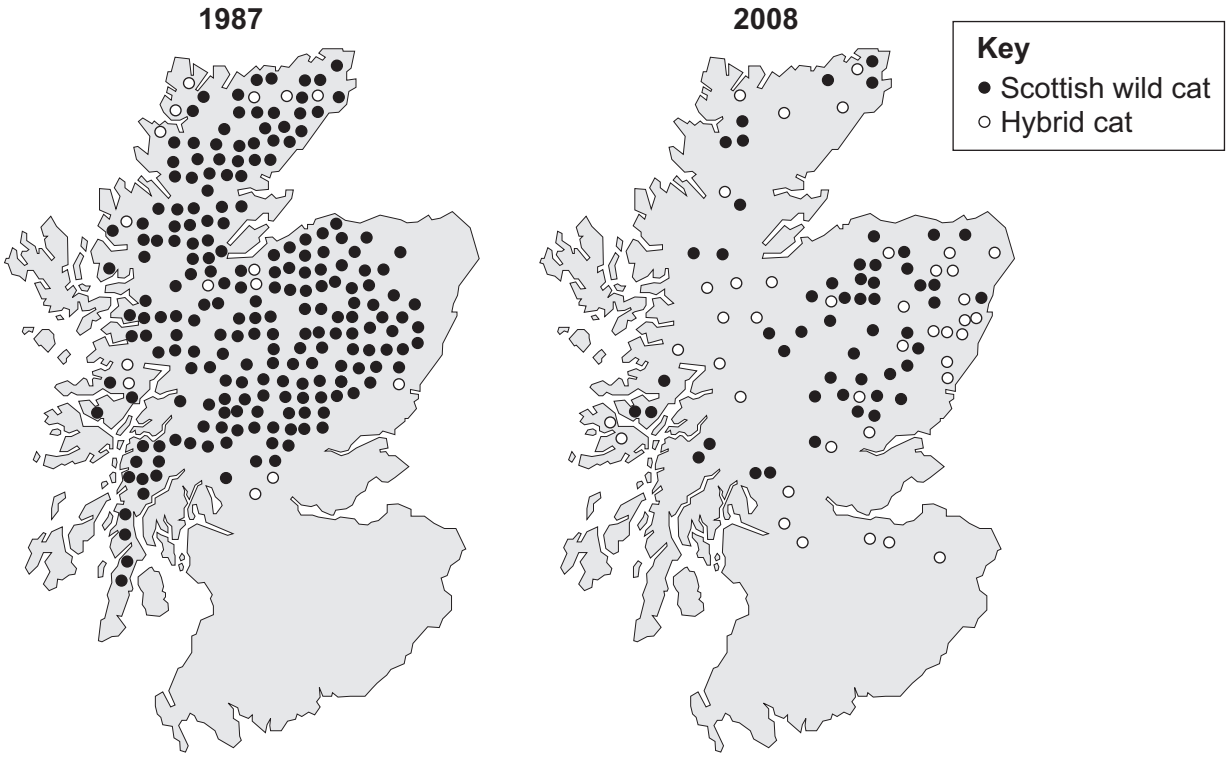
_____

_____

Do not write outside the box

0 6 . 9 **Figure 10** shows where Scottish wild cats and hybrid cats were seen in Scotland in 1987 and 2008.

Figure 10



Describe **three** differences in the populations of cats between 1987 and 2008.

Use **Figure 10**.

[3 marks]

1 _____

_____

2 _____

_____

3 _____

_____

11

Turn over ▶

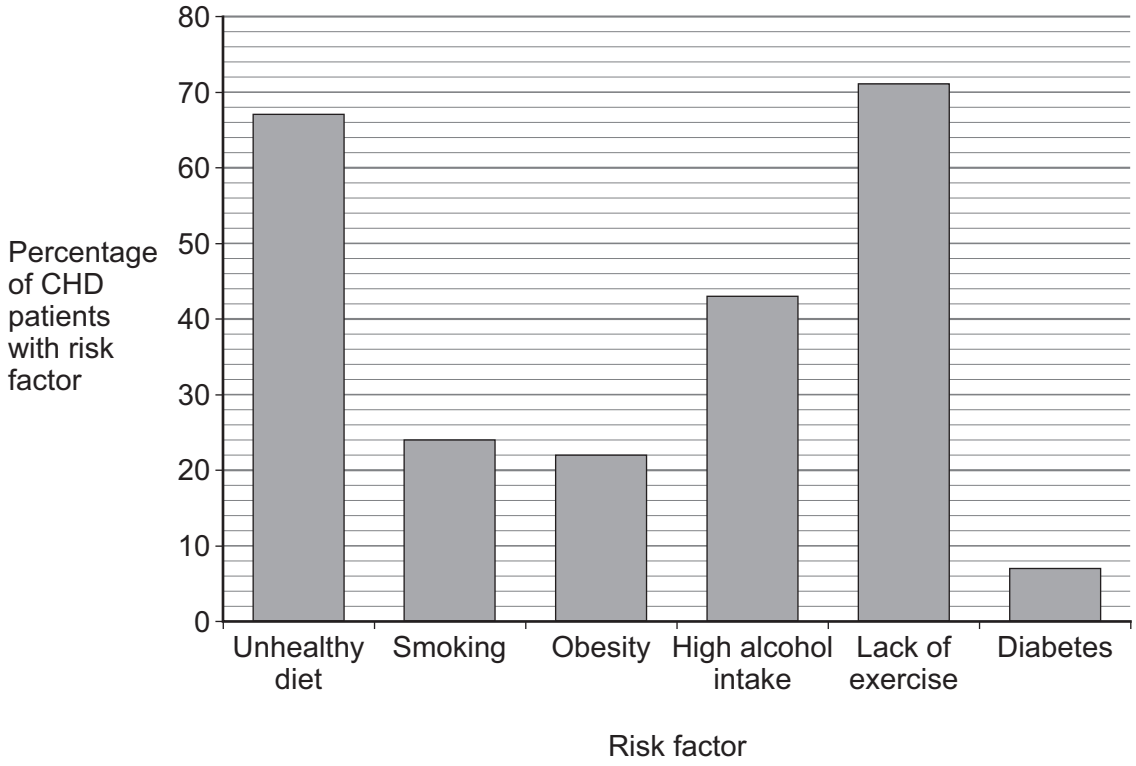
Do not write outside the box

0 7 Coronary heart disease (CHD) is caused when fatty material builds up in the coronary arteries.

Scientists investigated risk factors for CHD.

Figure 11 shows the percentage of CHD patients with each risk factor.

Figure 11



0 7 . 1 Which was the most common risk factor in CHD patients?

Use **Figure 11**.

[1 mark]

Do not write outside the box

0 7 . 2 What percentage of CHD patients had smoking as a risk factor?

Use **Figure 11**.

[1 mark]

Percentage = _____ %

0 7 . 3 Give **one** other disease that smoking is a risk factor for.

Do **not** refer to CHD.

[1 mark]

_____

0 7 . 4 Suggest **two** lifestyle changes a person can make to reduce the risk of CHD.

Do **not** refer to smoking in your answer.

[2 marks]

1 _____

_____

2 _____

_____

Question 7 continues on the next page

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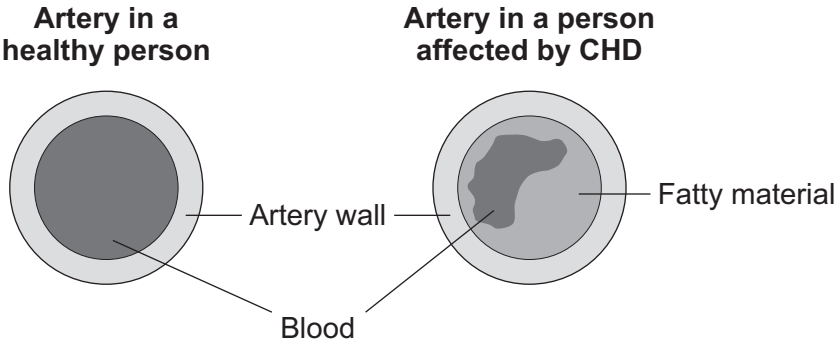
0 7 . 5 The coronary arteries supply the heart muscle with blood.

Figure 12 shows two coronary arteries.

Figure 12



A person with CHD has a risk of having a heart attack.

A heart attack will cause the heart muscle to stop contracting.

Explain how CHD can cause a heart attack.

[3 marks]

8

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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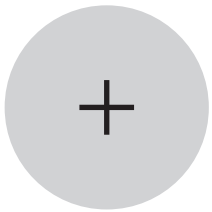
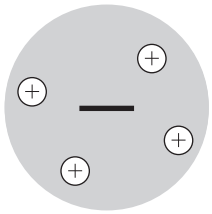
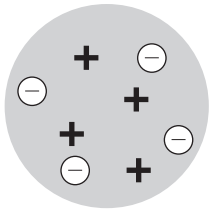
0 8 The model of the atom has changed over time.

0 8 . 1 Draw **one** line from each atomic model to the representation of that model.

[2 marks]

Atomic model	**Representation of model**
Dalton atom	
Plum pudding model	
	

Do not write outside the box

Scientists investigated the structure of the atom.

The scientists directed alpha particles at a thin sheet of gold foil.

0 8 . 2 What is an alpha particle the same as?

[1 mark]

Tick (✓) **one** box.

A fast-moving electron ☐

A helium nucleus ☐

A radioactive isotope ☐

Electromagnetic radiation ☐

Question 8 continues on the next page

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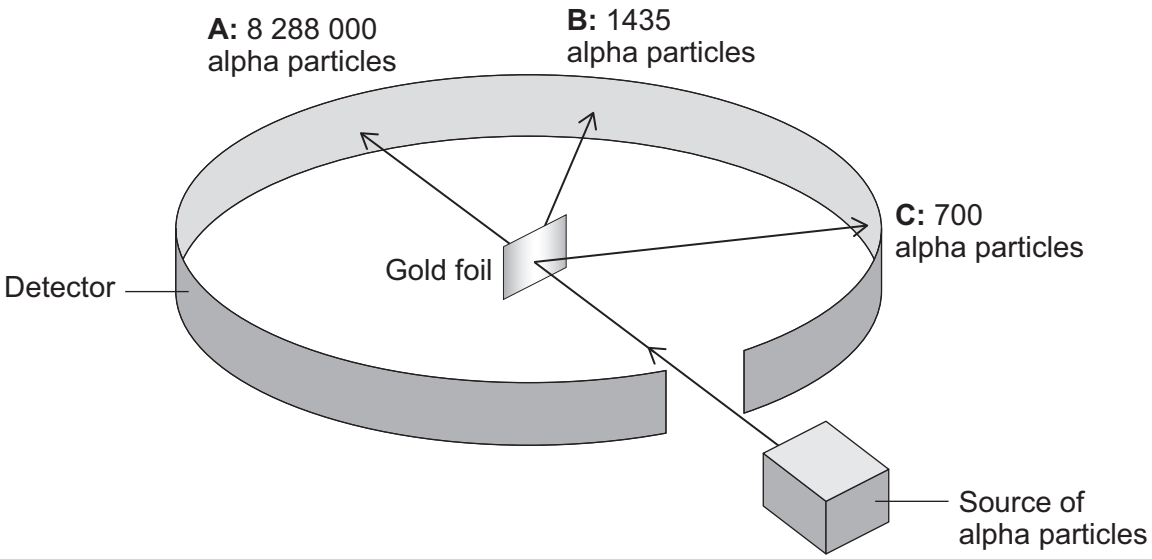
Figure 13 shows:

- three of the pathways the alpha particles take
- the number of alpha particles detected at positions **A**, **B** and **C**.

Figure 13



0 8 . 3 Determine the simplest ratio of the number of alpha particles detected at **A** to those detected at **C**.

Use **Figure 13**.

[2 marks]

Simplest ratio of **A** : **C** = _____ : 1

Do not write outside the box

The scientists concluded that a gold atom:

- is mostly empty space
- has a charged nucleus at its centre.

0 8 . 4 How do the results in **Figure 13** show that a gold atom is mostly empty space?

[1 mark]

0 8 . 5 Explain how the results in **Figure 13** show that a gold atom contains a charged nucleus.

[2 marks]

Question 8 continues on the next page

Do not write outside the box

0 8 . 6 A gold atom can be represented as:

$$^{197}_{79}Au$$

Describe the atomic structure of this gold atom.

You should include the numbers of each type of sub-atomic particle.

[5 marks]

13

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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 9 Some bacteria are pathogens.

0 9 . 1 What is meant by the term 'pathogen'?

[1 mark]

Bacterial infections can be treated using antibiotics.

Some bacteria are resistant to antibiotics.

Table 4 shows the percentage of bacteria resistant to four antibiotics.

Table 4

Antibiotic	Percentage (%) of bacteria resistant to antibiotic	
	2004	**2018**
A	10	23
B	2	11
C	3	14
D	1	2

0 9 . 2 Which antibiotic had the greatest increase in bacteria that were resistant between 2004 and 2018?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

Do not write outside the box

0 9 . 3 One of the antibiotics in **Table 4** is only used for serious infections in hospitals.

Suggest which antibiotic is only used for serious infections.

Give a reason for your answer.

[2 marks]

Antibiotic **A** ☐ **B** ☐ **C** ☐ **D** ☐

Reason _____

_____

_____

Question 9 continues on the next page

Do not write outside the box

Many strains of the bacterium *Staphylococcus aureus* (SA) are resistant to the antibiotic methicillin.

Table 5 shows information on methicillin-resistant *Staphylococcus aureus* (MRSA) infections in England.

Table 5

Year	Total population	Number of people with MRSA infection	
		Total	Per 100 000 population
2008	51 800 000	1606	3.10
2012	53 400 000	398	0.75
2015	55 000 000	297	**X**
2018	55 600 000	271	0.49

0 9 . 4 Calculate value **X** in **Table 5**.

[3 marks]

X = _____

Do not write outside the box

0 9 . 5 The number of people with MRSA infection in hospitals decreased between 2008 and 2018.

Suggest **one** reason for the decrease.

[1 mark]

0 9 . 6 Scientists are trying to develop a vaccine for MRSA.

Explain how a vaccine for MRSA would make people immune to MRSA.

[6 marks]

14

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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

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