OXFORD AQA
INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____
I declare this is my own work.

INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 4 Control

Wednesday 10 January 2024 07:00 GMT Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the 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).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

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

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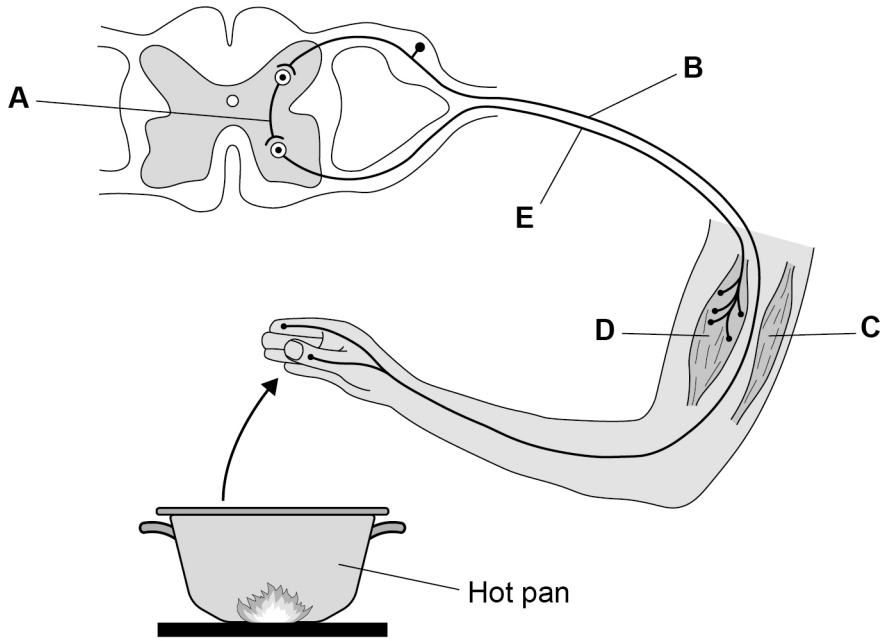
Answer **all** questions in the spaces provided.

0 1 A reflex is an automatic response to a stimulus.

Figure 1 shows the reflex arc when a person puts a hand on a hot pan.

Figure 1



0 1 . 1 Identify the structures **A**, **B** and **E**.

[2 marks]

A _____

B _____

E _____

0 1 . 2 State the importance of the reflex in **Figure 1**.

[1 mark]

_____

_____

_____

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The reflex shown in **Figure 1** causes the arm to bend at the elbow.

0 1 . 3 After bending the arm, **both** muscles in the upper arm are involved in straightening the arm again.

Explain why.

Use information from **Figure 1**.

[2 marks]

0 1 . 4 In the reflex arc shown in **Figure 1**, the effector is a muscle.

Name a different type of effector.

[1 mark]

6

Turn over for the next question

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0 2 LEMS is an autoimmune condition that affects neuromuscular junctions.

One of the symptoms of LEMS is reduced muscle contraction.

0 2 . 1 In people with LEMS, antibodies block many of the calcium ion channels on the pre-synaptic neurones at neuromuscular junctions.

Explain how the antibodies can prevent an action potential starting in muscle fibres.

[4 marks]

If patients with LEMS continue trying to move, their muscles will eventually contract.

This information has encouraged doctors to use an inhibitor of the enzyme acetylcholinesterase as a treatment for LEMS.

Acetylcholinesterase is an enzyme that breaks down acetylcholine.

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0 2 . 2 Suggest why an inhibitor of acetylcholinesterase can be used to treat LEMS.

[2 marks]

Amifampridine (AFP) is a new drug used for treating LEMS.
Doctors monitor the use of AFP with further clinical trials.

Doctors select 26 patients with LEMS who are all the same age, race and sex.

At the start of the trial, all the patients are:

- already taking AFP
- assessed by the doctors on their ability to do exercises (= doctor score)
- asked how they feel (= patient score).

The patients are then put into two groups at random:

- AFP group – continue to take the AFP tablets
- placebo group – take tablets that do **not** contain AFP.

After 4 days, the doctor score and patient score are collected again.
The patients and the doctors do not know which group the patients are in.

0 2 . 3 This type of trial is called a withdrawal trial as patients in the placebo group stop taking the AFP.

The trial only lasts for 4 days.

Suggest why.

[1 mark]

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Both the doctor score and the patient score use 7-point scales.

Table 1 shows the meanings of the highest and lowest scores.

Table 1

	Highest score (7)	**Lowest score (1)**
Doctor score	Able to complete all of the exercises	Unable to complete any of the exercises
Patient score	Feels very well	Feels very unwell

Figure 2 shows the mean doctor score.

Figure 3 shows the mean patient score.

Figure 2

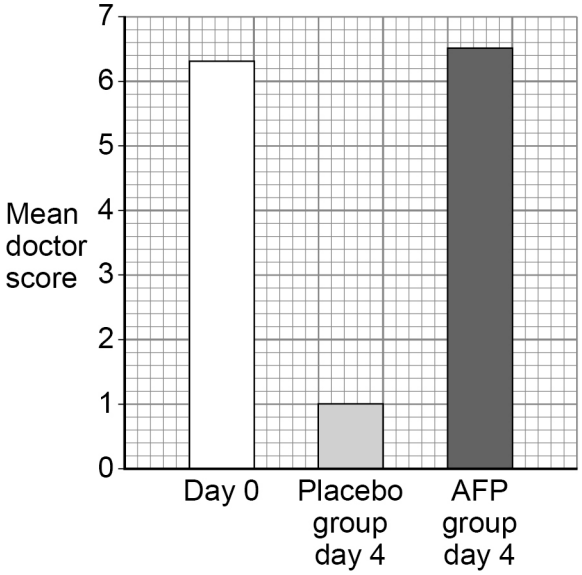
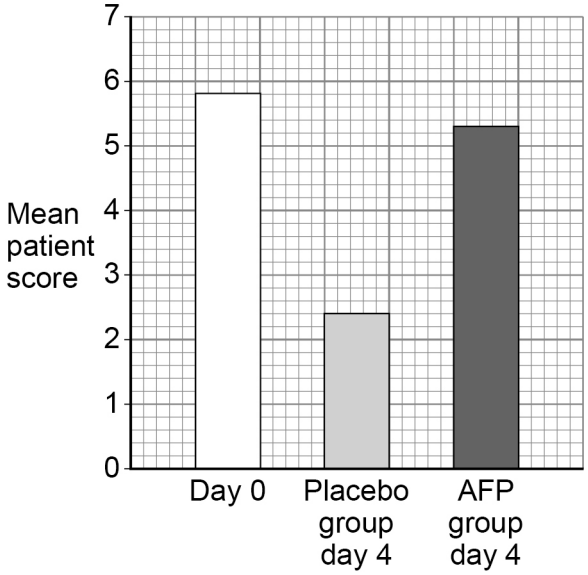


Figure 3



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0 2 . 4 As LEMS is a rare condition, the number of patients in any trial will always be small.

However, even with this limitation, the doctors conclude that this trial shows that AFP is a suitable treatment for LEMS.

Evaluate this conclusion.

Use all the information provided in Question **02** to answer this question.

[4 marks]

11

Turn over for the next question

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0 3 Tomatoes are climacteric fruit. This means that tomatoes can be picked unripe (when they are green) and they will ripen (turn red) off the plant.

A plant growth substance, **X**, ripens the tomatoes.

0 3 . 1 Name plant growth substance **X**, that ripens the tomatoes.

[1 mark]

Growers can use plant growth substance **X** to artificially ripen tomatoes.

Peppers are another fruit that change colour from green to red when fully ripe.

A student investigates if plant growth substance **X** can be used to ripen peppers.

The student has:

- green tomatoes
- green peppers
- suitable containers
- plant growth substance **X**.

0 3 . 2 Describe an investigation to test if plant growth substance **X** can ripen peppers as quickly as it ripens tomatoes.

[3 marks]

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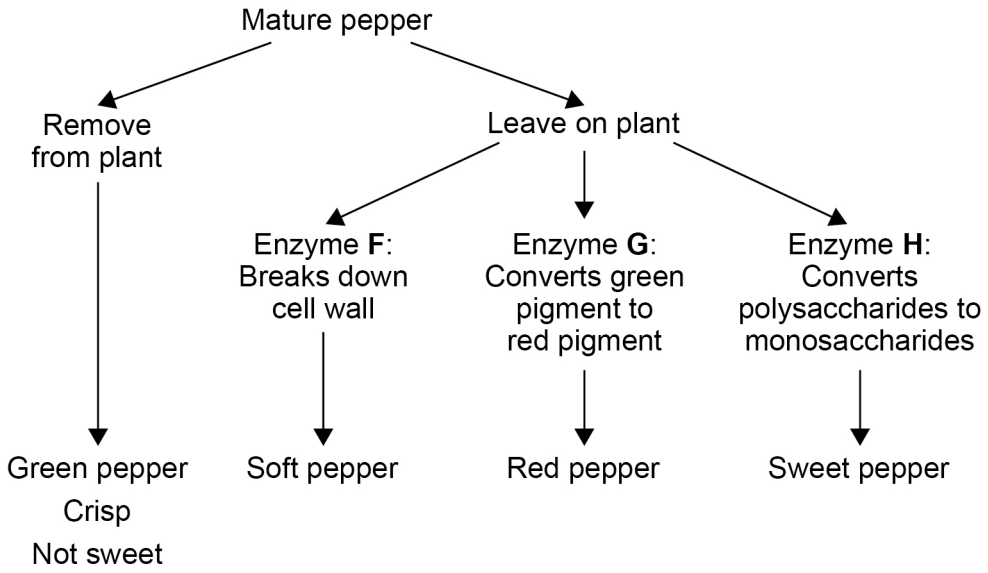
Peppers can be eaten when green or when red. Ripe red peppers are softer and sweeter than green peppers.

Figure 4 shows the different enzyme pathways involved in ripening peppers from green to red.

Figure 4



0 3 . 3 Epigenetic changes can produce **sweeter** red peppers.

Suggest how.

Use information from **Figure 4**.

[3 marks]

Do not write outside the box

Growers would like to produce green peppers that are as soft and sweet as red peppers.

Scientists plan to help the growers do this using RNA interference techniques.

0 3 . 4 Explain how RNA interference could produce soft, sweet, green peppers.

Use information from **Figure 4**.

[4 marks]

11

Turn over for the next question

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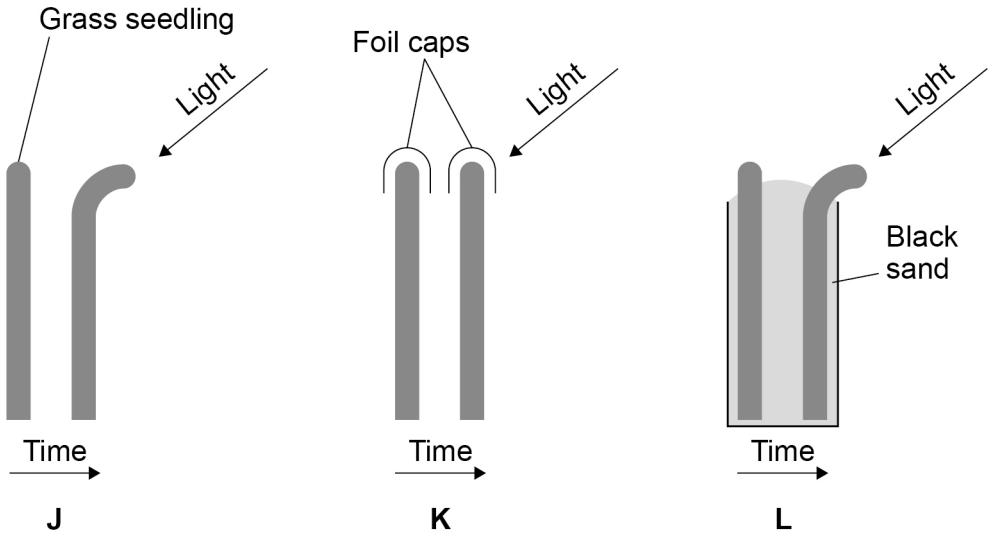
0 4 Charles Darwin investigated the effect of light on the growth of grass seedlings. The results from some of his investigations are shown in **Figure 5**.

Figure 5



0 4 . 1 Describe how the diagrams demonstrate that seedlings show positive phototropism and that the stimulus for this is detected by the tip.

[2 marks]

0 4 . 2 Explain how positive phototropism helps a plant to grow.

[2 marks]

Do not write outside the box

Experiments show that the tropism is a result of IAA causing cell elongation. However, it is not clear how the light is detected by the plant.

Some students think that a light-absorbing pigment is involved.

The students investigate three pigments found in plants. These pigments are:

- cryptochrome
- phototropin
- phytochrome.

Question 4 continues on the next page

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The students measure:

- the wavelengths of light absorbed by these pigments (**Figure 6**)
- the wavelengths of light that cause the plant to show phototropism (**Figure 7**).

Figure 6 shows the wavelengths of light absorbed by the three pigments.

Figure 6

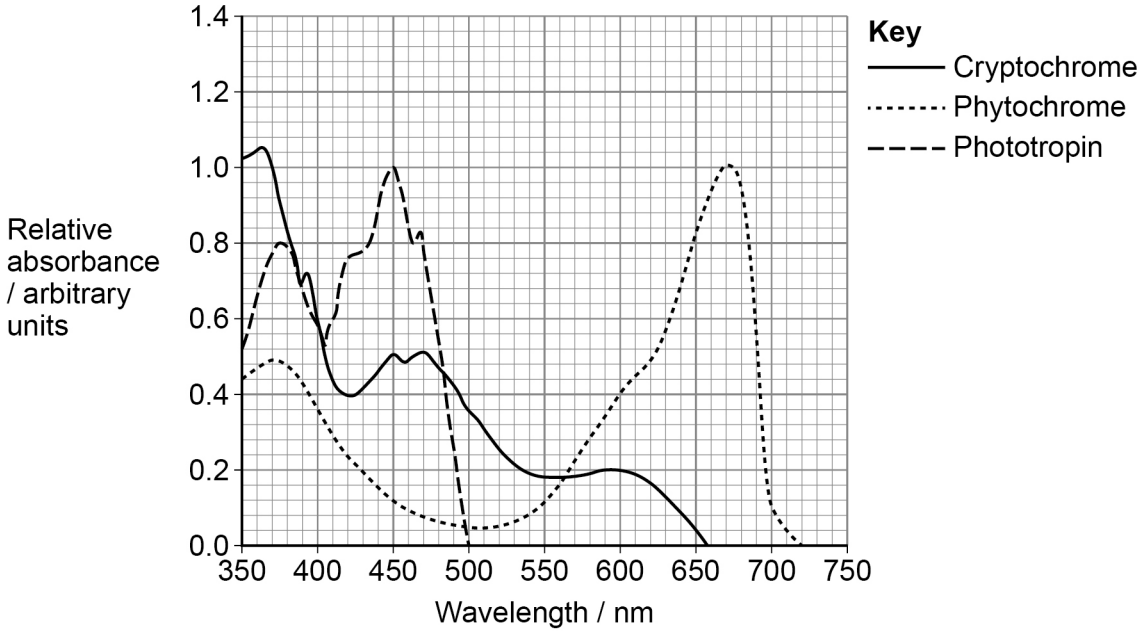
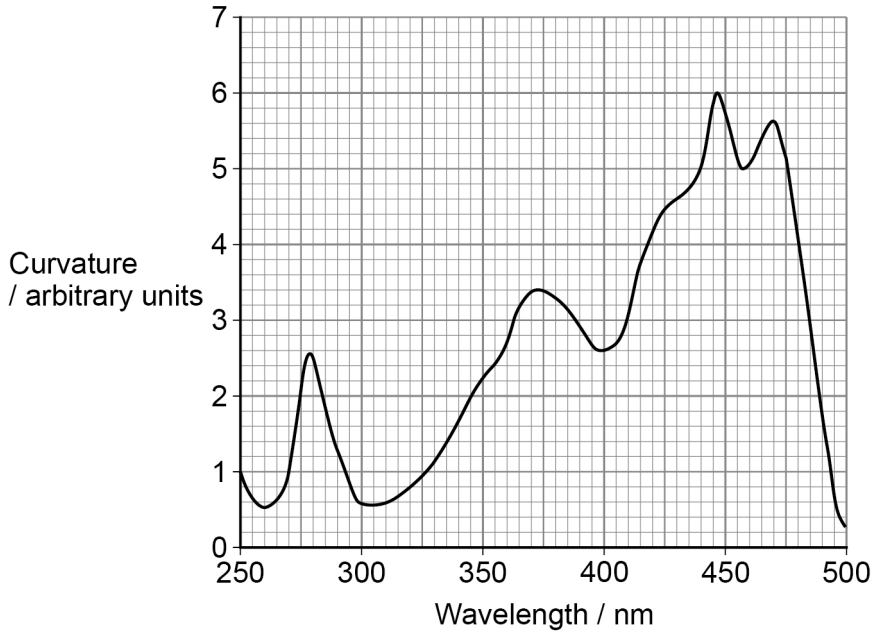


Figure 7 shows the wavelengths of light that cause the plant to show phototropism by curving towards the light.

Figure 7



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0 4 . 3 The students use the information from **Figure 6** and **Figure 7** to identify the pigment most likely to detect light.

Describe how they use the information to identify the pigment.

[2 marks]

0 4 . 4 Using only **Figure 6** and **Figure 7**, the students identify the pigment most likely to detect light.

Give the pigment the students identify.

[1 mark]

0 4 . 5 The students' teacher is **not** confident with the identification of the pigment.

Give **one** reason why.

[1 mark]

8

Turn over for the next question

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0 5 Mammals maintain their core body temperature within a set range.

0 5 . 1 Describe why it is important to maintain a stable core body temperature.

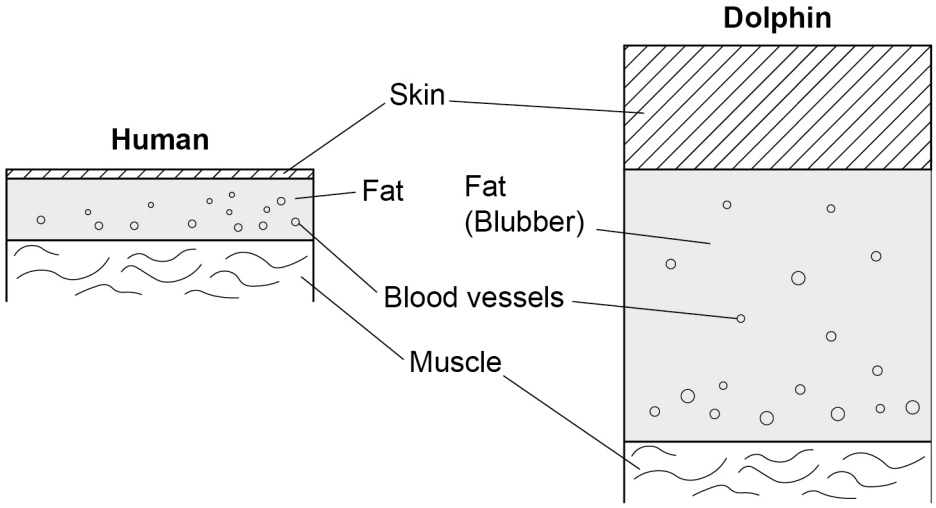
[1 mark]

Dolphins are marine mammals with a core body temperature of 37 °C

Dolphins are often found in seas with water temperatures as low as 10 °C

Figure 8 shows the relative thickness of the different layers covering a human and a dolphin.

Figure 8



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0 5 . 2 Suggest why dolphins can stay in cold water for longer than humans.

Use information from **Figure 8**.

[3 marks]

Although dolphins are commonly found in colder waters, they have also been observed in tropical waters with temperatures up to 38 °C

At 38 °C, humans sweat to cool their bodies.

0 5 . 3 Describe how sweating helps to cool a human.

[2 marks]

Question 5 continues on the next page

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Dolphins are not able to sweat to cool their body temperature.

Scientists investigate if dolphins can cool themselves.

The scientists:

- use a captive bottlenose dolphin
- put the dolphin in a tank of water at 15 °C
- slowly heat the water to 38 °C
- leave the dolphin in the tank of warmed water for 20 minutes
- measure the dolphin's core body temperature throughout
- return the dolphin to its pool.

0 5 . 4 Give **three** disadvantages to the method.

[3 marks]

1 _____

_____

_____

2 _____

_____

_____

3 _____

_____

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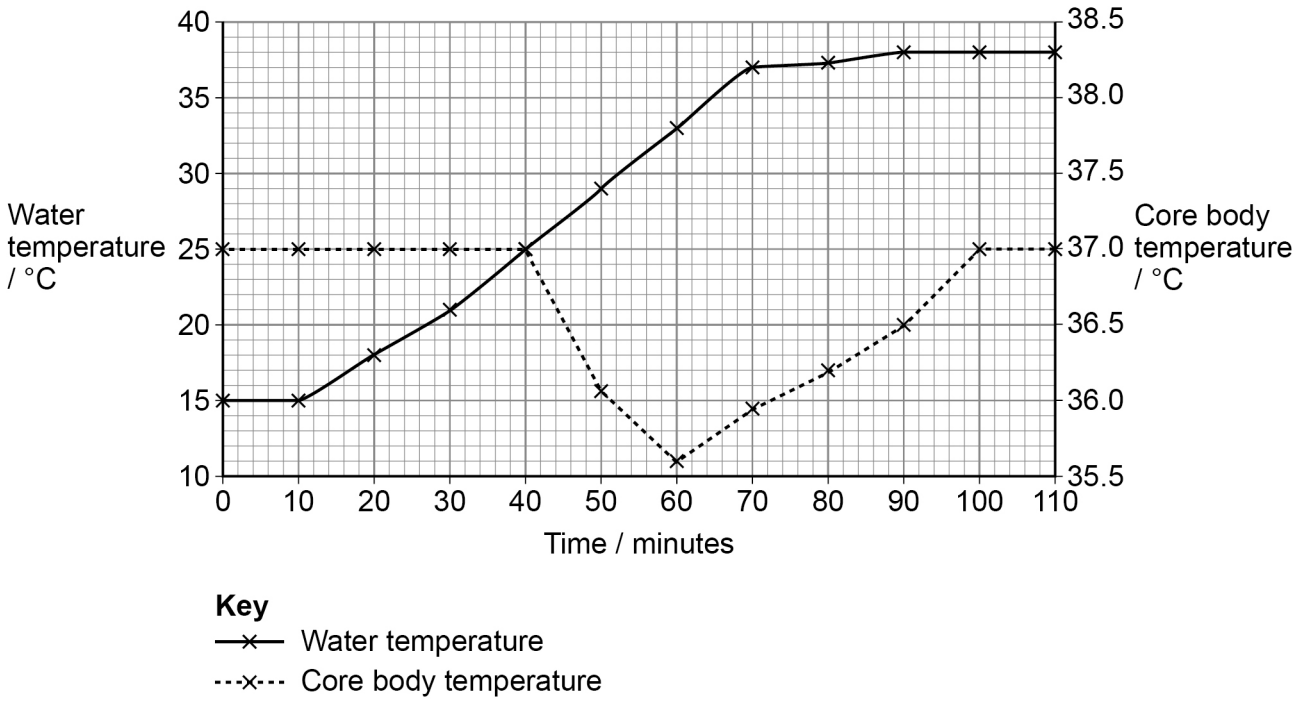
Figure 9 shows the change in core body temperature for the dolphin over time.

Figure 9



While the dolphin is in the tank of water, the scientists predict that its core body temperature will rise if the dolphin cannot cool itself.

This rise in temperature is due to metabolic activity and would start when the water temperature exceeds 25 °C

Metabolic activity would raise core body temperature by 0.03 °C min^{-1}

0 5 . 5 Calculate the dolphin's predicted core body temperature at the end of the investigation if no cooling happens.

Give your answer to 2 significant figures.

[3 marks]

Temperature at end = _____ °C

Question 5 continues on the next page

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0 5 . 6 The scientists were surprised by the decrease in core body temperature between 40 and 60 minutes.

The scientists think that the dolphins are using the fat (blubber) layer to keep themselves cool.

Suggest how. Use information from **Figure 8** (on page 16).

[1 mark]

_____

_____

_____

13

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0 6 Regular exercise helps to keep the heart healthy. During exercise, the heart rate increases.

Scientists have calculated the safe maximum heart rate and target heart rate ranges for moderate and intense exercise. These values vary for people of different ages.

Table 2 shows the safe maximum heart rate and the target heart rates for moderate and intense exercise.

Table 2

Age	Safe maximum heart rate	Target heart rate range during moderate exercise	Target heart rate range during intense exercise
20			
30	187	120–142	144–174
40	180	115–137	139–167
50	173	111–132	133–161

The safe maximum heart rate can be calculated using the formula:

Safe maximum heart rate = 206.9 – (0.67 × age)

Moderate exercise should raise the heart rate to 64–76% of the maximum.

Intense exercise should raise the heart rate to 77–93% of the maximum.

0 6 . 1 Complete **Table 2** for a person who is 20 years old.

[2 marks]

Question 6 continues on the next page

Do not write outside the box

0 6 . 2 Heart rate increases during exercise but starts to decrease when the exercise stops.

Complete **Figure 10** with the most appropriate word or words to explain how this decrease is controlled.

[4 marks]

Figure 10

Exercise stops

↓

CO_2 concentration in blood decreases

↓

Detected by chemoreceptors in the _____

↓

Impulses to inhibitory centre in the _____ of the brain

↓

Impulses sent via _____ nerves

to the _____ in the heart

↓

Heart rate decreases

Do not write outside the box

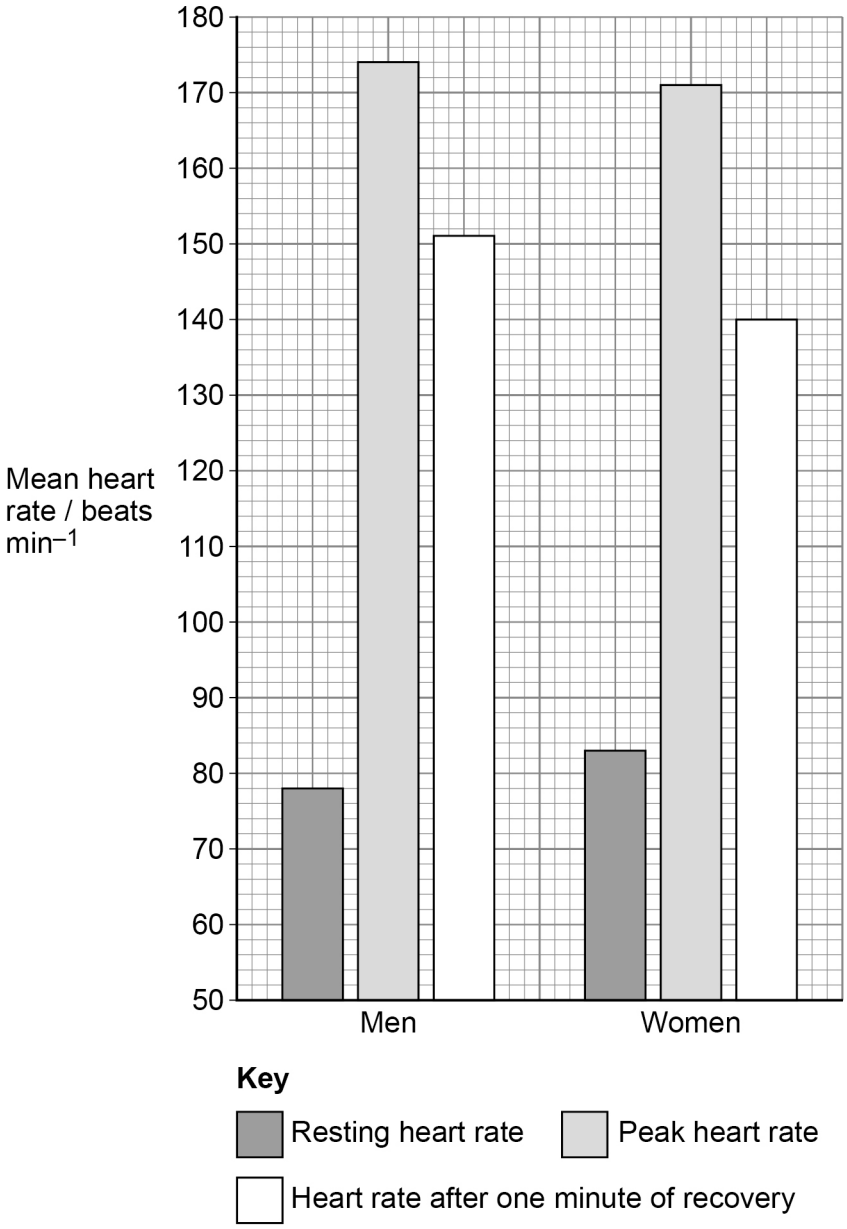
Some students investigate heart rate before, during and after exercise.

They measure the heart rates of 10 men and 10 women:

- before exercise
- during exercise
- after 1 minute of recovery from the exercise.

Figure 11 shows the mean heart rates.

Figure 11



Question 6 continues on the next page

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0 6 . 3 Compare the resting heart rate of the men with the resting heart rate of the women.

Use data from **Figure 11** (on page 23).

[1 mark]

One student claims that the resting heart rates prove that the men must be fitter than the women.

Another student suggests that they should consider heart rate recovery (HRR).

HRR measures how quickly the heart rate decreases per second in the first minute after exercise stops. HRR is used to classify fitness level.

Table 3 shows the mean HRR for people with poor, good and excellent fitness levels.

Table 3

	Fitness level		
	Poor	Good	Excellent
Mean HRR / beats s^{-1}	0.2	0.3	0.5

Do not write outside the box

0 6 . 4 Compare the fitness level of the men with the fitness level of the women using HRR.

Use **Figure 11** (on page 23) and **Table 3**.

[3 marks]

0 6 . 5 HRR may also indicate heart health. The fitness level, age and sex of a person can affect HRR.

Suggest **one** other factor that could affect HRR.

[1 mark]

11

Turn over for the next question

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0 7 Type 2 diabetes is becoming more common.

One way to control Type 2 diabetes is by making changes to a person's diet.

Some common foods have medicinal properties.

Scientists investigate if including onions in the diet could help to control Type 2 diabetes.

Investigation 1

The scientists:

- put 21 people with Type 2 diabetes into 3 groups of 7
- measure blood glucose concentration of each person at the start
- give water to the first group
- give glibenclamide (a common drug treatment for Type 2 diabetes) to the second group
- give onion (100 g raw) to the third group
- measure blood glucose concentrations again after 2 hours and 4 hours.

Table 4 shows the scientists' results.

Values are means ± standard deviations (SD).

Table 4

	Mean blood glucose concentration / mg 100 cm^{-3}		
Group	At start	After 2 hours	After 4 hours
Water	164 ± 18.5	162 ± 19.1	149 ± 8.7
Glibenclamide	171 ± 11.7	131 ± 7.5	100 ± 6.4
Onion	160 ± 25.3	150 ± 17.7	115 ± 15.5

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0 7 . 1 **Table 4** shows standard deviations.

Describe how standard deviations can be used when comparing mean values.

[1 mark]

0 7 . 2 Doctors aim to keep blood glucose concentration within the range 80–120 mg 100 cm^{-3} for all patients.

After **Investigation 1**, the scientists suggest that glibenclamide is a more appropriate treatment for Type 2 diabetes than water or onion.

Explain why.

[3 marks]

Question 7 continues on the next page

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Drug treatments can be expensive. The use of onions could be more cost-effective but not everyone likes eating raw onions.

The scientists investigate if quercetin is the active compound in onion that affects blood glucose concentration. Quercetin is also found in other vegetables.

The scientists plan to repeat **Investigation 1** with different vegetables. To make it comparable, they must use the same amount of quercetin as in the 100 g of raw onion.

The scientists:

- measure the concentration of quercetin in some other vegetables
- calculate the mass of the vegetable needed to provide the same dose of quercetin as 100 g of raw onion.

The results are shown in **Table 5**.

Table 5

Vegetable	**Concentration of quercetin / mg g^{-1}**	**Mass of vegetable to be eaten / g**
Onion	0.226	100
Broccoli	0.028	807
Celery	0.035	646
Kale	0.051	**Y**

0 7 . 3 Calculate the value of **Y** in **Table 5**.

[2 marks]

Y = _____ g

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Based on **Table 5**, the scientists decide it is not realistic to rely on only one type of vegetable to get the required amount of quercetin each day.

However, drying onions would allow the amount of quercetin to be concentrated in powder form.

The scientists investigate if the method used for drying the onion changes its effectiveness.

Investigation 2

The scientists investigate two different methods of drying the onions:

1. Dried by freezing.
2. Dried by heating.

The scientists put adult rats into 4 groups.

The rats:

- in group **P** are controls and do not have diabetes
- in groups **Q**, **R** and **S** have diabetes
- in all the groups are kept in the same standard conditions for 8 weeks
- are fed standard rat food with or without added onion.

Table 6 shows the food each group is given.

Table 6

Group	Standard rat food	Freeze-dried onion added	Heat-dried onion added
P (control)	✓	x	x
Q	✓	x	x
R	✓	✓	x
S	✓	x	✓

Question 7 continues on the next page

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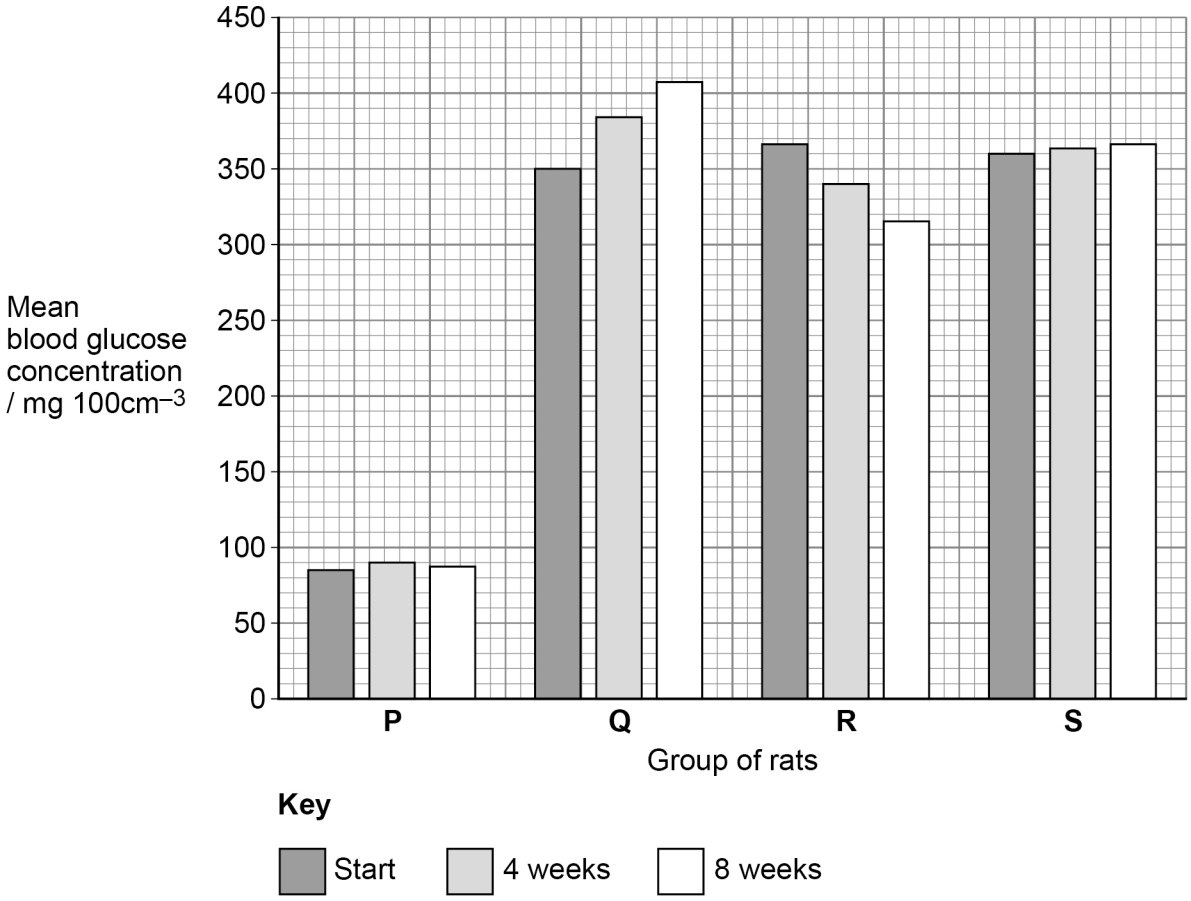
The blood glucose concentration of the rats in each group is measured at the start, after 4 weeks, and after 8 weeks.

Figure 12 shows the mean blood glucose concentration for each group of rats.

Figure 12



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0 7 . 4 Describe and compare how the mean blood glucose concentration changes over time for group **P** and group **Q**.

Use data from **Figure 12**.

[3 marks]

Group **P** _____

_____

_____

Group **Q** _____

_____

_____

Comparison _____

_____

_____

A journalist sees the data from both **Investigation 1** (**Table 4**, on page 26) and **Investigation 2** (**Figure 12**). He writes an article with the headline:

"Everyone with diabetes should add onions to their diet."

0 7 . 5 Evaluate the journalist's headline.

Use information from **Table 4** (on page 26) and **Figure 12**.

[3 marks]

_____

_____

_____

_____

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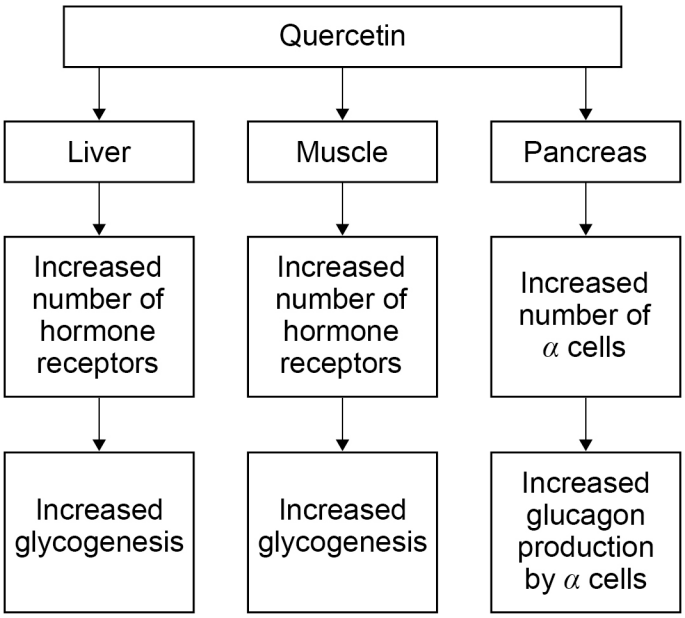
The scientists produce a diagram to show the effects quercetin has on different organs in the body.

Figure 13



0 7 . 6 Explain why quercetin is more useful in preventing high blood glucose concentration in people with **Type 2** diabetes than in people with **Type 1** diabetes.

[3 marks]

15

END OF QUESTIONS

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