OXFORD

INTERNATIONAL
AQA EXAMINATIONS

Please write clearly in block capitals.

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

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I declare this is my own work.

INTERNATIONAL A-LEVEL

BIOLOGY (9610)

Unit 4 Control

Monday 17 January 2022 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 IN THE SPACES PROVIDED

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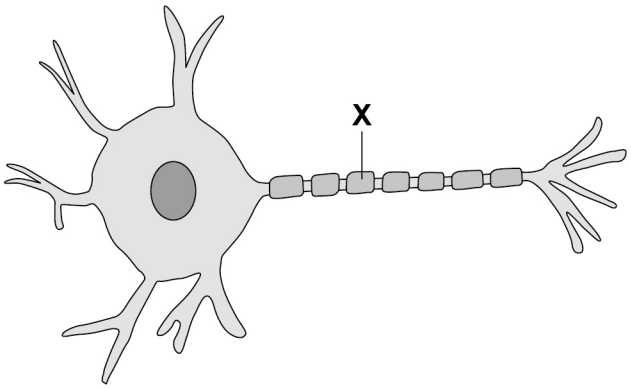
Answer **all** questions in the spaces provided.

0 1 Carpal tunnel syndrome is a condition where inflammation in the wrist can press on the neurones in the nerves and cause pain in the hand.

Figure 1 shows a diagram of a motor neurone.

Figure 1



0 1 . 1 State the name and function of structure **X**.

[2 marks]

Name _____

Function _____

_____

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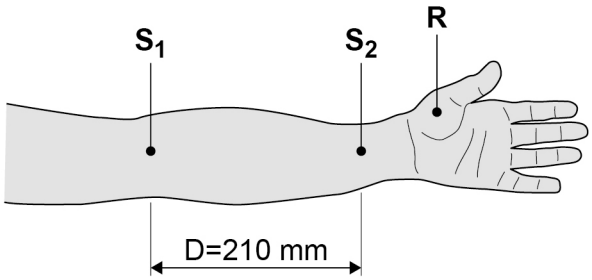
A doctor measures the speed of nerve impulses in the arm of a patient who has carpal tunnel syndrome.

A decrease in the speed of nerve impulses can show if a nerve is damaged.

Figure 2 shows the position of three electrodes, $\mathbf{S_1}$, $\mathbf{S_2}$ and **R**, on the arm of the patient.

Figure 2

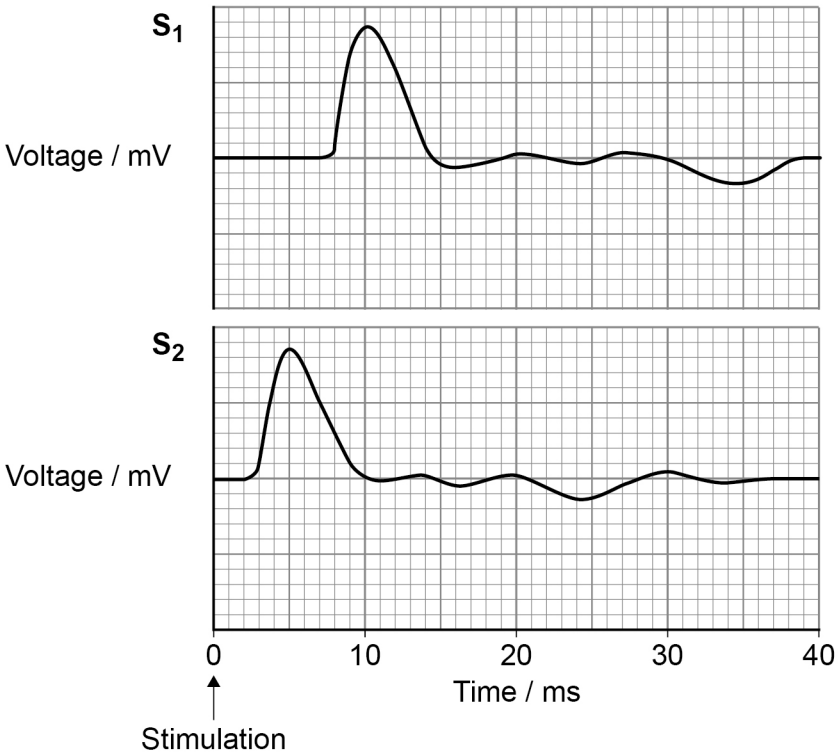


The doctor:

- attaches the electrodes to the skin at points $\mathbf{S_1}$, $\mathbf{S_2}$ and **R**
- measures the distance (**D**) between electrode $\mathbf{S_1}$ and $\mathbf{S_2}$
- gives a stimulus to electrode $\mathbf{S_1}$ and measures the time taken ($\mathbf{T_1}$) for the nerve impulse to reach electrode **R**
- gives a second stimulus to electrode $\mathbf{S_2}$ and measures the time taken ($\mathbf{T_2}$) for the nerve impulse to reach electrode **R**.

Figure 3 shows the change in voltage detected by electrode **R**.

Figure 3



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The speed of nerve impulses (C_v) can be calculated using the equation:

$$C_v = \frac{D}{T_1 - T_2}$$

where C_v = speed of nerve impulses
D = distance
T_1 = time taken for the nerve impulse from electrode S_1 to reach electrode R
T_2 = time taken for the nerve impulse from electrode S_2 to reach electrode R

0 1 . 2 Calculate the speed of nerve impulses. Use information from **Figures 2** and **3**.

[2 marks]

C_v = _____ ms^{-1}

0 1 . 3 Explain how stimulation of the electrode at S_2 initiates an action potential in a neurone of the nerve.

[3 marks]

_____

_____

_____

_____

_____

_____

_____

_____

_____

7

Turn over for the next question

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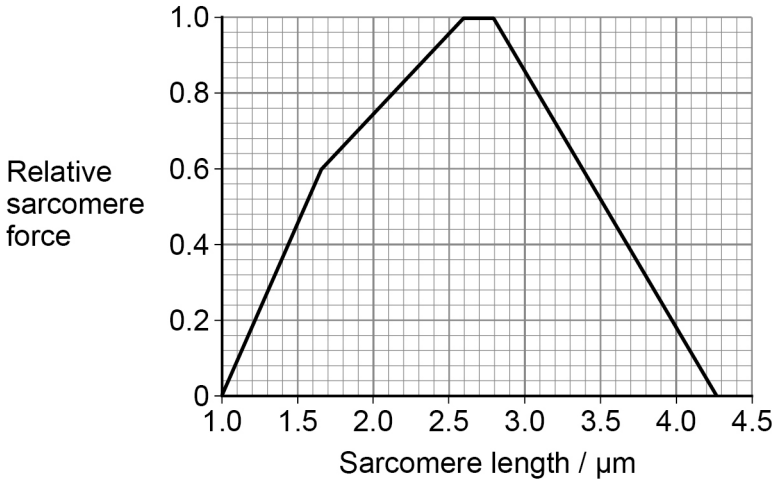
0 2 The biceps is a muscle in the upper arm. As the biceps contracts, the length of the sarcomeres in the myofibrils of the muscle gets shorter.

The change in the length of a sarcomere causes a change in the relative sarcomere force generated.

Figure 4 shows the change in relative sarcomere force as the sarcomere changes in length.

Figure 4



0 2 . 1 The relative sarcomere force initially increases as the sarcomere becomes shorter due to an increased number of cross-bridges being formed.

Suggest why the relative sarcomere force begins to decrease again when the sarcomere is shorter than 2.6 μm

[1 mark]

_____

_____

_____

0 2 . 2 State the sarcomere lengths that can produce a relative sarcomere force of 0.8

Use information from **Figure 4**.

[1 mark]

_____ μm and _____ μm

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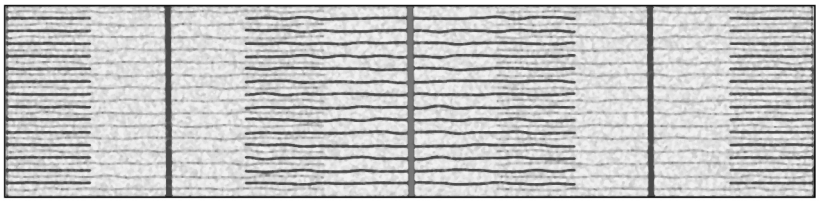
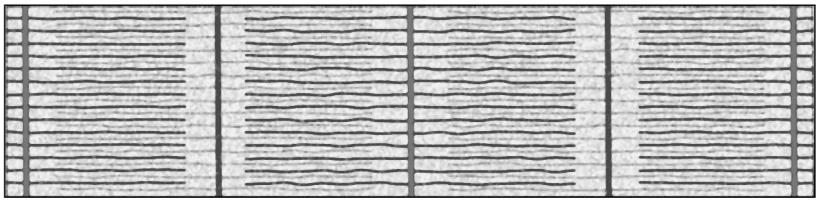
0 2 . 3 **Figure 5** shows sarcomeres from two different myofibrils as seen with an electron microscope.

Figure 5



A



B

Give **two** pieces of evidence that sarcomere **A** is from a relaxed muscle.

Use **Figure 5** to support your answer.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

Question 2 continues on the next page

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0 2 . 4 Aerobic respiration produces ATP.

Describe how ATP is used in muscle contraction.

[3 marks]

0 2 . 5 During anaerobic respiration hydrogen ions (H^+) are produced.

Hydrogen ions in the muscles inhibit the binding of calcium ions (Ca^{2+}) to the proteins in the sarcomere.

Explain how an increase in hydrogen ions causes a reduction in the force of contraction of a muscle.

[3 marks]

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Question 2 continues on the next page

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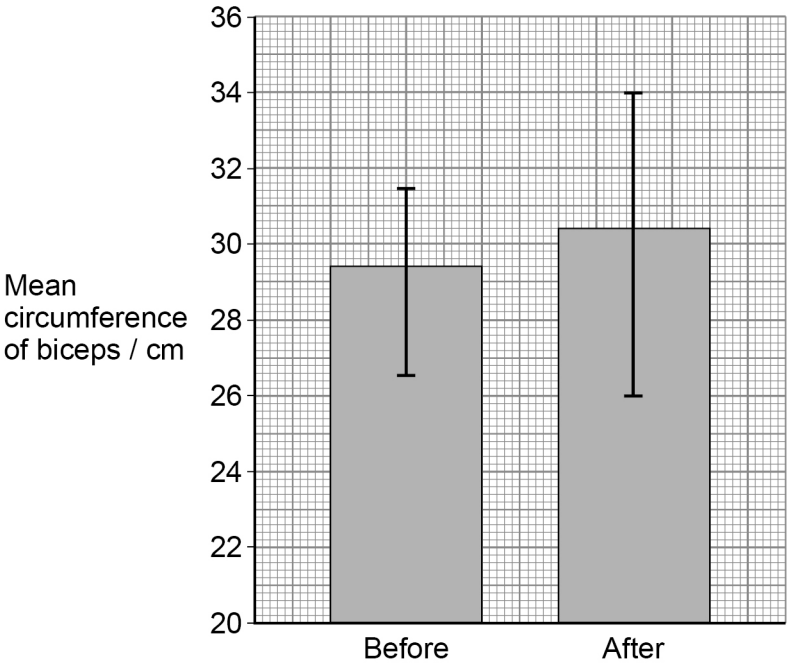
0 2 . 6 Students investigate the effect of weight training on the circumference of the biceps.

The students use a tape measure around the upper arm to record the circumference of the biceps.

This is repeated for all the students, and the mean circumference of the biceps is recorded before the investigation and again after 12 weeks of weight training.

Figure 6 shows the mean circumference of the biceps with range bars.

Figure 6



Calculate the percentage increase in the mean circumference of the biceps.

Give your answers to **3** significant figures.

[2 marks]

Percentage increase = _____ %

Do not write outside the box

0 2 . 7 State **two** conclusions that the students can make about the results of the investigation in **Figure 6**.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

14

Turn over for the next question

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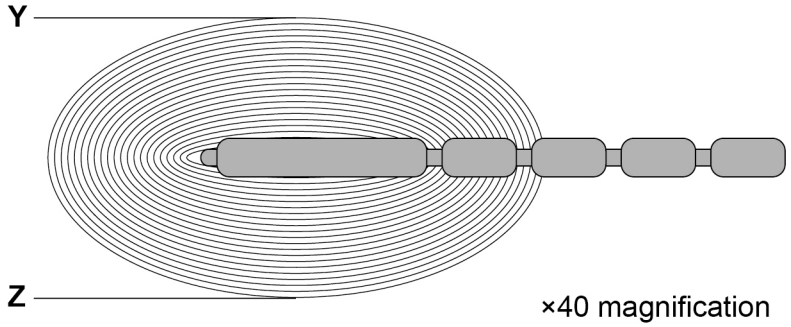
0 3 Pacinian corpuscles are receptors under the skin that detect changes in pressure.

Figure 7 shows a diagram of a Pacinian corpuscle as seen under an electron microscope.

Figure 7



0 3 . 1 Calculate the actual distance **Y**–**Z** in **Figure 7**.

Give your answer in micrometres.

[2 marks]

Actual distance = _____ μm

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Scientists investigate the function of a Pacinian corpuscle.

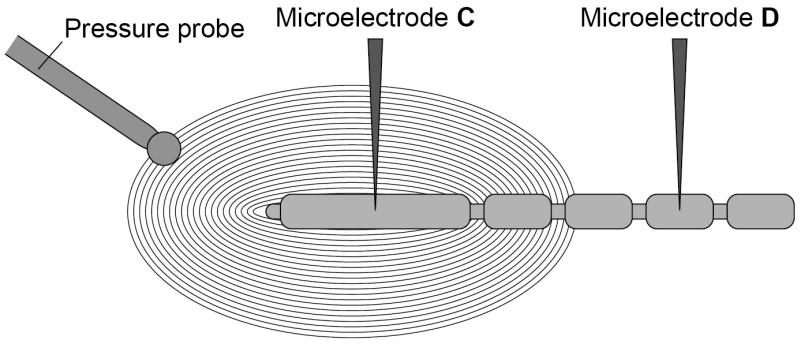
The scientists:

- put two microelectrodes, **C** and **D**, on a Pacinian corpuscle as shown in **Figure 8**
- apply three different levels of pressure to the Pacinian corpuscle using a pressure probe
- record if there is an increase in voltage at microelectrodes **C** and **D**.

The three levels of pressure are:

- light pressure
- medium pressure
- high pressure.

Figure 8



Pressure applied by probe	Increase in voltage at microelectrode C	Increase in voltage at microelectrode D
Light	Yes	No
Medium	Yes	No
High	Yes	Yes

Question 3 continues on the next page

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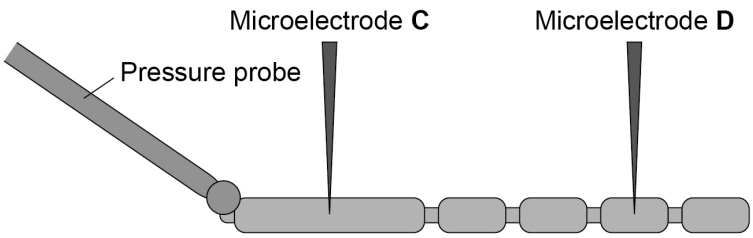
The scientists remove the outer layers of the corpuscle and repeat the investigation, as shown in **Figure 9**.

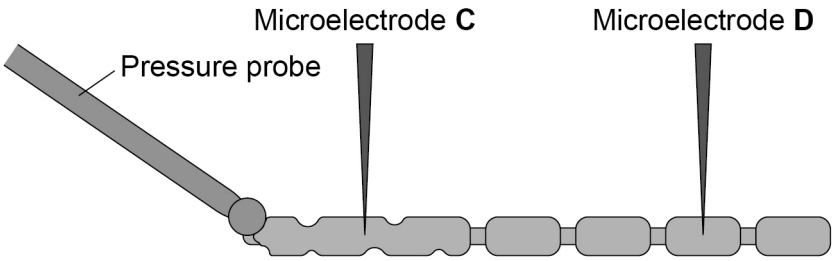
Figure 9



Pressure applied by probe	Increase in voltage at microelectrode C	Increase in voltage at microelectrode D
Light	Yes	No
Medium	Yes	No
High	Yes	Yes

The scientists damage the end of the neurone and repeat the investigation, as shown in **Figure 10**.

Figure 10



Pressure applied by probe	Increase in voltage at microelectrode C	Increase in voltage at microelectrode D
Light	Yes	No
Medium	Yes	No
High	Yes	No

Do not write outside the box

0 3 . 2 Give **three** conclusions the scientists could make about the results of this investigation.

[3 marks]

1 _____

_____

_____

2 _____

_____

_____

3 _____

_____

_____

0 3 . 3 Another group of scientists want to repeat the investigation.

Suggest what additional information the first group of scientists would need to provide.

[1 mark]

_____

_____

_____

6

Turn over for the next question

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0 4 . 1 Mammals have different types of stem cell during their development, each with different properties.

Complete **Table 1**.

[3 marks]

Table 1

Type of stem cell	**Stage of development where these stem cells are found**	**Property of these stem cells**
	Embryo	
		Can be used to make one type of cell
Pluripotent		

0 4 . 2 Suggest **two** reasons why the use of stem cells from adults has increased but the use of stem cells from embryos has not.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

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0 4 . 3 In one type of leukaemia the bone marrow of a patient produces blood cells that do not work correctly.

To treat this type of leukaemia:

- the patient's bone marrow is destroyed
- bone marrow stem cells from a healthy person are given to the patient
- the patient is given immunosuppressant drugs that weaken their immune system.

Explain why each part of the treatment is important.

[3 marks]

8

Turn over for the next question

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0 5 Changes to the heart rate can be controlled by part of the brain.

0 5 . 1 Describe how increased carbon dioxide concentration in the blood causes an increase in the heart rate.

[4 marks]

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Changes to the heart rate can also be controlled by the hormone, adrenaline.

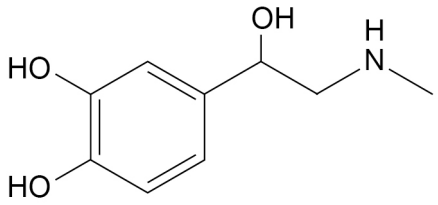
Adrenaline binds to receptors on heart muscle cells, increasing blood pressure.

A drug called sotalol can be used to reduce high blood pressure.

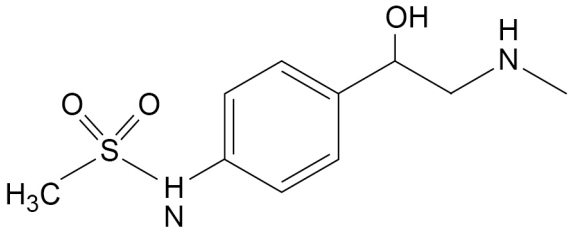
Figure 11 shows part of the structure of adrenaline and of the drug sotalol.

Figure 11

Adrenaline



Sotalol



0 5 . 2 Suggest how sotalol reduces high blood pressure.

Use information from **Figure 11**.

[3 marks]

Question 5 continues on the next page

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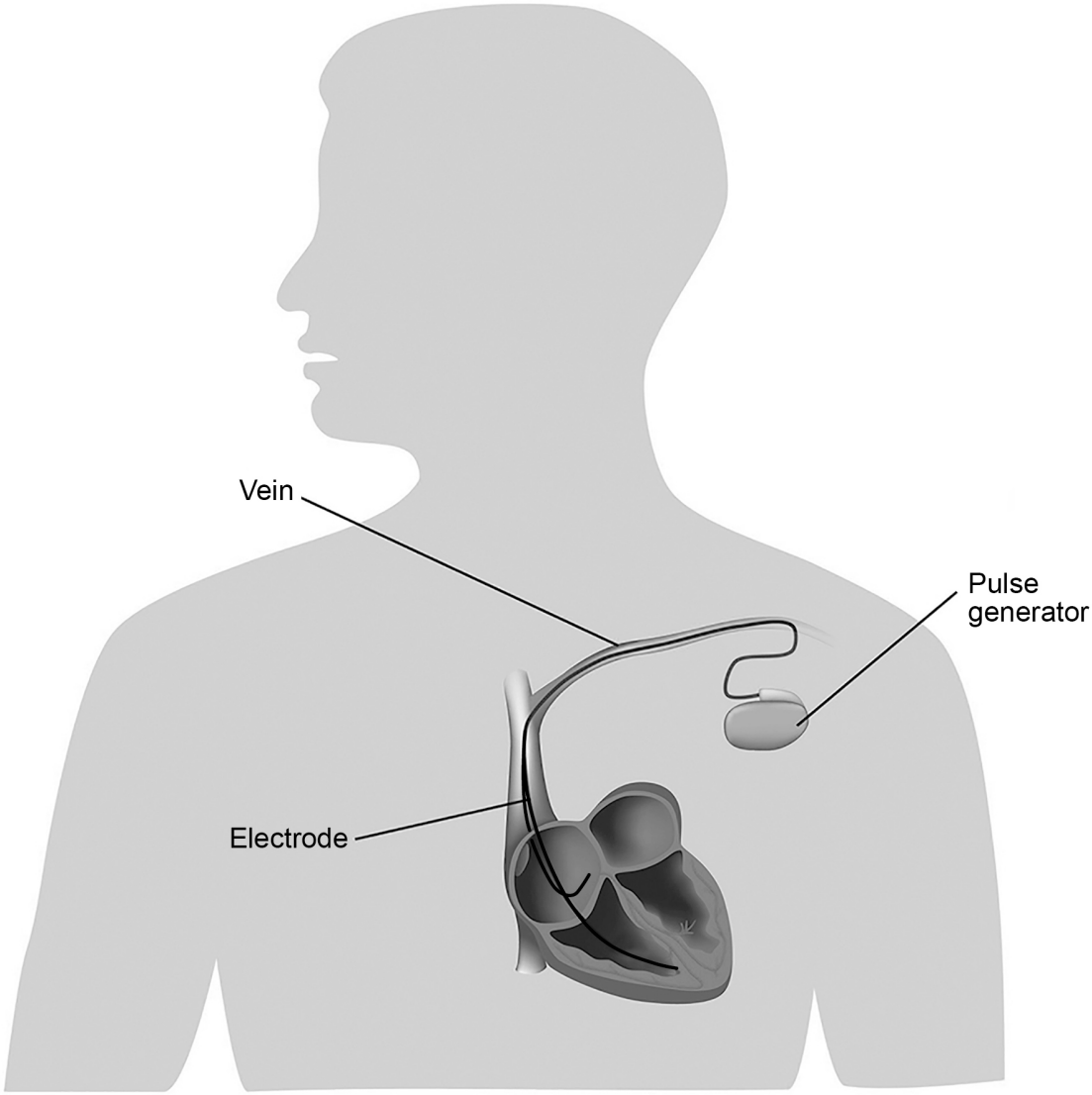
With some medical conditions the heart beats too slowly. This can be treated with an artificial pacemaker that stimulates the heart to beat. The pacemaker delivers two separate pulses of electricity per heartbeat, one pulse after the other pulse.

An artificial pacemaker has:

- a pulse generator inserted under the skin of the chest
- electrodes that go inside the heart chambers.

Figure 12 shows the position of an artificial pacemaker in the chest.

Figure 12



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0 5 . 3 Describe how the two pulses from the pacemaker will make the heart beat at a normal rate.

[4 marks]

0 5 . 4 A battery powers the pulse generator of the artificial pacemaker. This battery lasts 10 years.

Suggest **one** advantage of placing the pulse generator under the skin rather than inside the heart.

[1 mark]

12

Turn over for the next question

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0 6 Phototropism is a plant growth response to light.

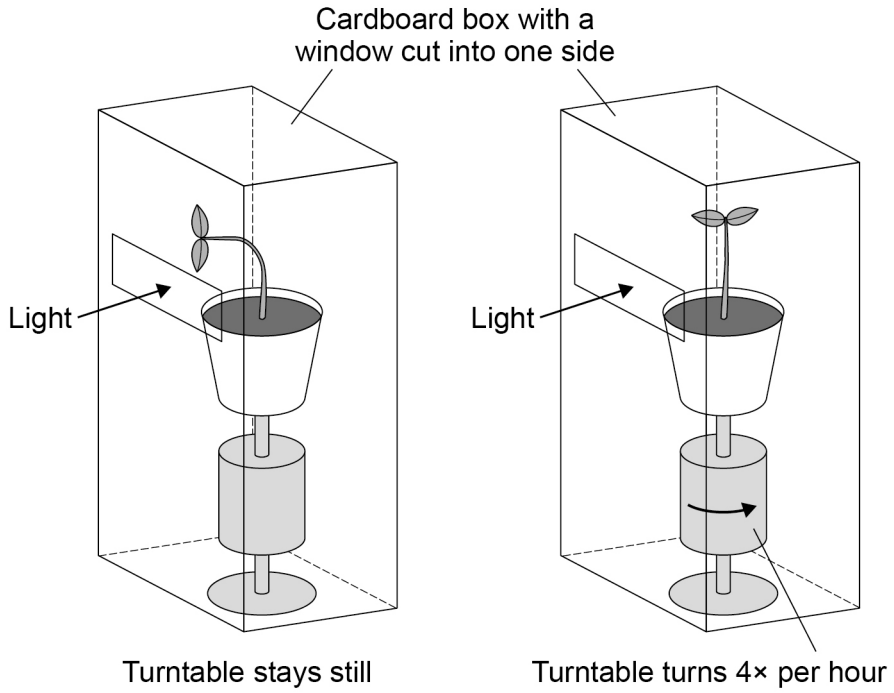
A student investigates the response of seedlings to light.

The student:

- selects two seedlings with vertical stems
- puts one seedling on a turntable that stays still, as shown in **Figure 13**
- puts the other seedling on a turntable that turns four times per hour, as shown in **Figure 14**
- covers each seedling with a cardboard box with a window cut into one side.

Figure 13 and **Figure 14** show the plants after 3 days.

Figure 13 **Figure 14**



0 6 . 1 Give the reason why the student puts each seedling in a box with a window cut into one side.

[1 mark]

_____

_____

_____

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0 6 . 2 Give the reason why the student puts the seedling in **Figure 14** on a rotating turntable.

[1 mark]

0 6 . 3 The student thinks that the plant growth substance indoleacetic acid (IAA) causes the results shown in **Figure 13** and in **Figure 14**.

Describe how IAA could cause these results.

[3 marks]

0 6 . 4 The student concludes that all parts of plants show positive phototropism.

Give **one** reason in support of this conclusion and **one** reason against this conclusion.

[2 marks]

In support

Against

Do not write outside the box

0 6 . 5 The student wants to know if all wavelengths (colours) of light cause positive phototropism.

Describe an investigation to test which colours of light cause positive phototropism.

[4 marks]

0 6 . 6 IAA is part of a group of plant growth substances called auxins.

Some artificial auxins are used to kill weed plants.

These artificial auxins cause a build-up of a different plant growth substance called abscisic acid (ABA).

Suggest how artificial auxins that cause a build-up of ABA kill the weeds.

[2 marks]

13

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Turn over for the next question

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0 7 A student investigates the effect of different exercise intensities on body temperature and on the time taken to lower body temperature back to the resting level.

The student puts 30 people into groups at random (10 per group). Each group takes part in low- or medium- or high-intensity exercise.

Each person rides an exercise bicycle for 30 minutes.

The student measures body temperature:

- at rest
- at the end of the exercise and
- every 15 minutes during recovery.

Table 2 shows the mean body temperatures for each group.

Table 2

	Mean body temperature / °C					
Exercise Intensity	At rest	End of exercise	Recovery 15 min	Recovery 30 min	Recovery 45 min	Recovery 60 min
Low	36.9	37.8	37.6	37.2	36.9	36.9
Medium	36.9	38.6	38.0	37.6	37.3	36.9
High	36.9	39.0	38.3	37.8	37.4	37.1

0 7 . 1 Describe the effect of exercise intensity on:

- body temperature
- the time taken for body temperature to return to the resting level.

Use information from **Table 2**.

[2 marks]

Body temperature _____

_____

_____

Time taken _____

_____

_____

Do not write outside the box

The student repeats the investigation, but this time measures the temperature of the leg muscles:

- at rest
- at the end of the exercise and
- every 15 minutes during recovery.

Table 3 shows the mean leg muscle temperatures for each group.

Table 3

	Mean temperature of leg muscles / °C					
Exercise Intensity	At rest	End of exercise	Recovery 15 min	Recovery 30 min	Recovery 45 min	Recovery 60 min
Low	33.8	37.0	36.0	35.8	35.2	34.6
Medium	33.8	37.8	37.0	36.0	34.9	34.2
High	33.8	38.3	37.1	36.0	35.0	34.2

0 7 . 2 The student concludes that the results in **Table 2** and **Table 3** show that temperature is dependent on exercise intensity.

Evaluate the student's conclusion.

Use information from **Table 2** and **Table 3**.

[3 marks]

Question 7 continues on the next page

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A different student investigates two different methods of recovery from exercise.

All the people exercise at high intensity on exercise bicycles for 30 minutes.

For the recovery time the people are randomly put into two groups:

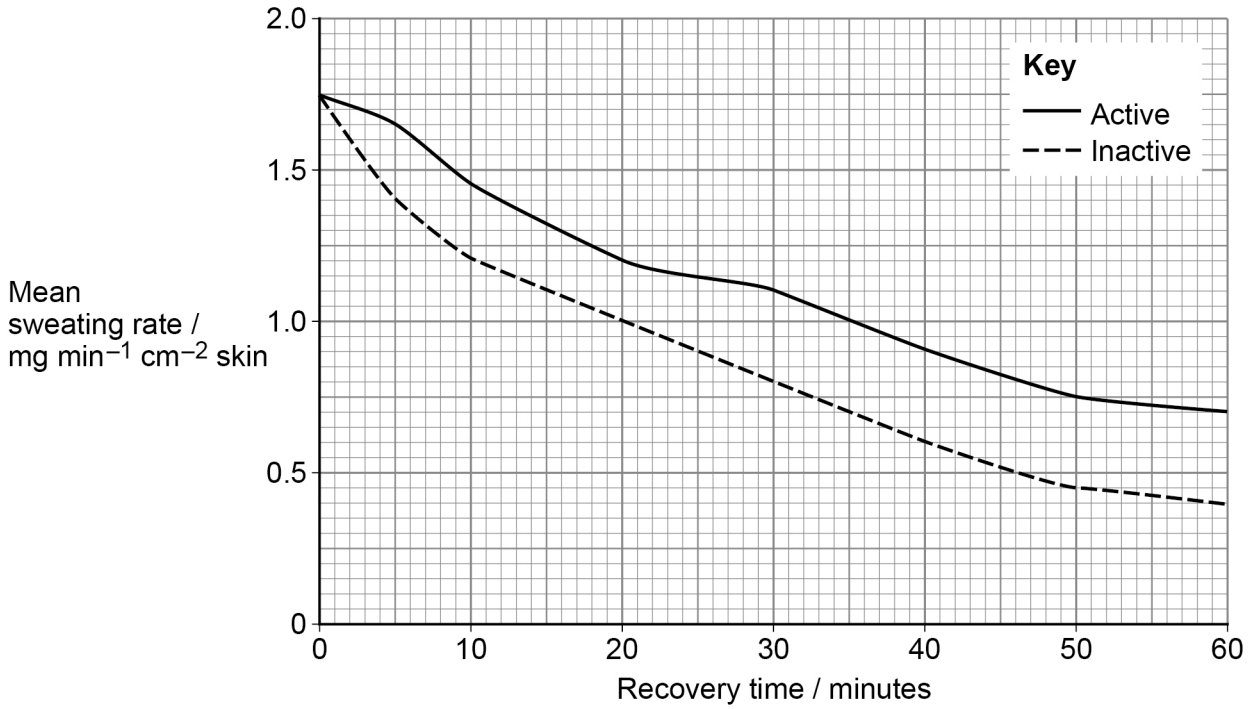
- the active group where the people cycle slowly during recovery
- the inactive group where the people sit on the exercise bicycles but do not cycle during recovery.

The student:

- measures the amount of sweat produced by each person during recovery
- calculates a sweating rate for each person
- calculates a mean sweating rate for each group.

Figure 15 shows the mean sweating rate for the different types of recovery.

Figure 15



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0 7 . 3 People in the active group lower their temperature to resting body temperature more quickly than people in the inactive group.

Explain why.

Use information from **Figure 15**.

[3 marks]

Question 7 continues on the next page

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Vigorous exercise at high external temperature can cause heat stroke.

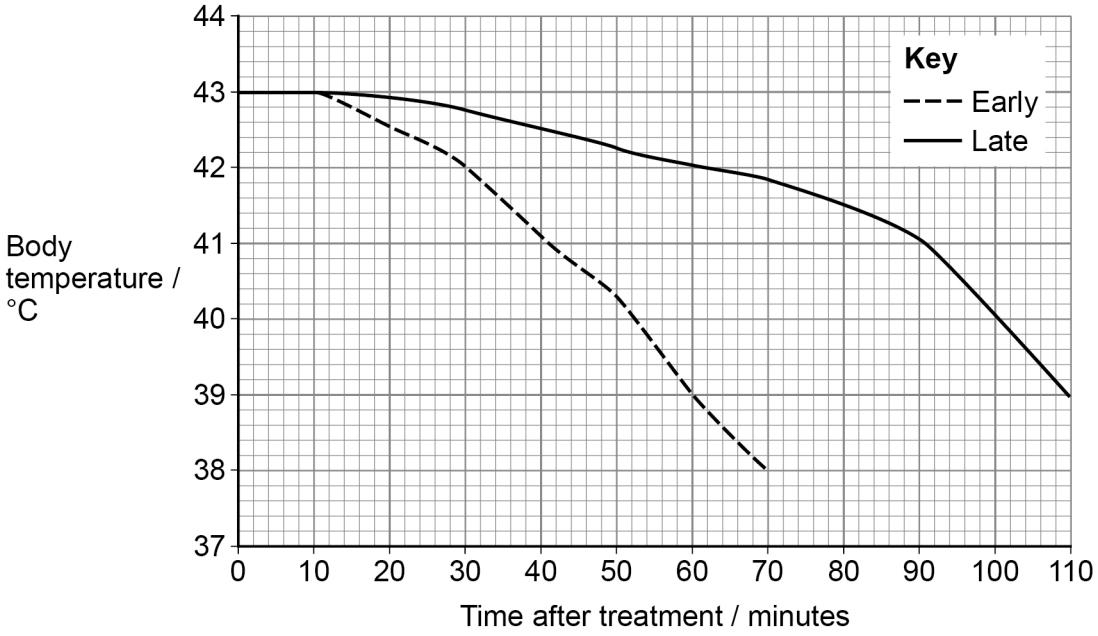
A body temperature above 40.5 °C for more than an hour can cause heat stroke. If a person does not get medical help, heat stroke can cause multiple organ failure and death.

Figure 16 shows the effect of the same treatment given to patients at risk of heat stroke.

Early treatment starts within 10 minutes of symptoms occurring.

Late treatment starts after 50 minutes of symptoms occurring.

Figure 16



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0 7 . 4 Patients given early treatment for heat stroke are less likely to suffer serious medical problems.

Explain why. Use data from **Figure 16**.

[3 marks]

0 7 . 5 A body temperature that stays above 37 °C for a long time can cause damage to cells.

Give **two** examples of how a high temperature can damage cells.

[2 marks]

Question 7 continues on the next page

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0 7 . 6 In patients with heat stroke, some of the usual homeostatic control mechanisms fail and they are unable to cool their bodies quickly enough.

Symptoms of heat stroke include pale skin and muscle cramps.

Suggest why.

[2 marks]

15

END OF QUESTIONS

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