

1

Anaerobic respiration happens in muscle cells and yeast cells.

The equation describes anaerobic respiration in muscle cells.



- (a) How can you tell from the equation that this process is anaerobic?

.....

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(1)

- (b) Exercise **cannot** be sustained when anaerobic respiration takes place in muscle cells.

Explain why.

.....

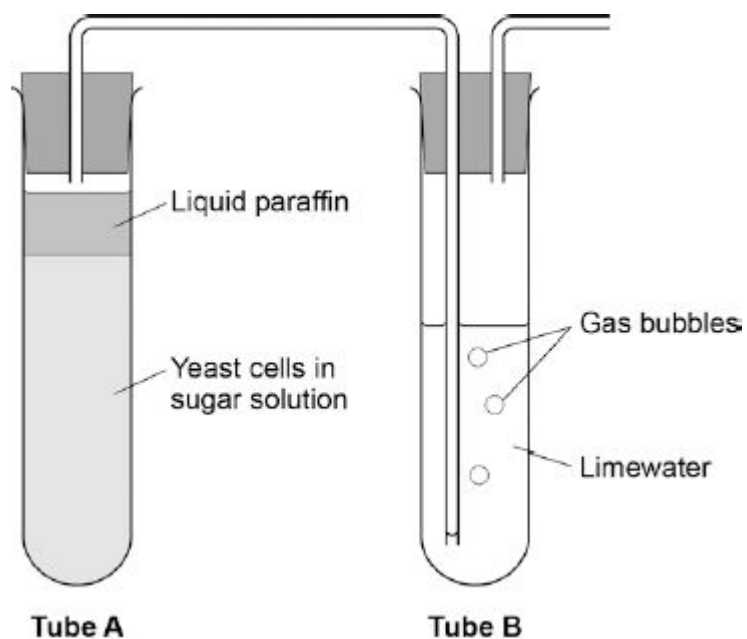
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(2)

- (c) The diagram below shows an experiment to investigate **anaerobic** respiration in yeast cells.



What gas will bubble into Tube **B**?

Tick **one** box.

Carbon dioxide

☐

Nitrogen

☐

Oxygen

☐

Water vapour

☐

(1)

- (d) Describe how you could use tube **B** to measure the rate of the reaction in tube **A**.

.....

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(2)

- (e) Anaerobic respiration in yeast is also called fermentation.

Fermentation produces ethanol.

Give **one** use of fermentation in the food industry.

.....

(1)
(Total 7 marks)

2 All living cells respire.

- (a) Respiration transfers energy from glucose for muscle contraction.

Describe how glucose from the small intestine is moved to a muscle cell.

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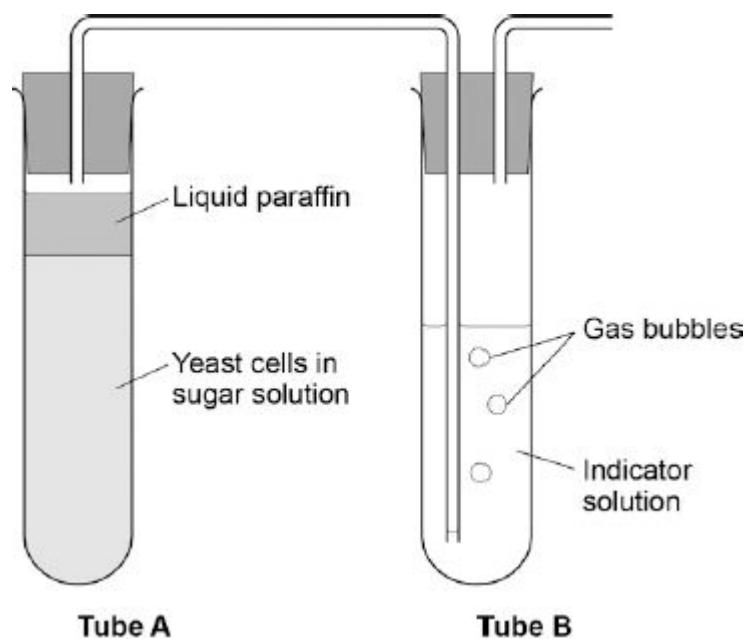
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(2)

- (b) The diagram below shows an experiment to investigate **anaerobic** respiration in yeast cells.



What is the purpose of the liquid paraffin in Tube **A**?

Tick **one** box.

To prevent evaporation

☐

To stop air getting in

☐

To stop the temperature going up

☐

To stop water getting in

☐

(1)

- (c) The indicator solution in Tube **B** shows changes in the concentration of carbon dioxide (CO_2).

The indicator is:

- **blue** when the concentration of CO_2 is very low
- **green** when the concentration of CO_2 is low
- **yellow** when the concentration of CO_2 is high.

What colour would you expect the indicator to be in Tube **B** during maximum rate of anaerobic respiration?

Tick **one** box.

Blue

☐

Green

☐

Yellow

☐

(1)

- (d) Suggest how the experiment could be changed to give a reproducible way to measure the rate of the reaction.

Include any apparatus you would use.

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(2)

- (e) Compare anaerobic respiration in a yeast cell with anaerobic respiration in a muscle cell.

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(3)
(Total 9 marks)

3

A gardener wants to add compost to the soil to increase his yield of strawberries.

The gardener wants to make his own compost.

- (a) An airtight compost heap causes anaerobic decay.

Explain why the gardener might be against producing compost using this method.

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(2)

- (b) The gardener finds this research on the Internet:

‘A carbon to nitrogen ratio of 25:1 will produce fertile compost.’

Look at the table below.

Type of material to compost	Mass of carbon in sample in g	Mass of nitrogen in sample in g	Carbon:nitrogen ratio
Chicken manure	8.75	1.25	7:1
Horse manure	10.00	0.50	20:1
Peat moss	9.80	0.20	X

Determine the ratio **X** in the table above.

.....

Ratio

(1)

- (c) Which type of material in the table above would be **best** for the gardener to use to make his compost?

Justify your answer.

.....

.....

(1)

- (d) Some of the leaves from the gardener's strawberry plant die.

The dead leaves fall off the strawberry plant onto the ground.

The carbon in the dead leaves is recycled through the carbon cycle.

Explain how the carbon is recycled into the growth of new leaves.

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(6)

(e) The diagram below shows two strawberries.

- Both strawberries were picked from the same strawberry plant.
- Both strawberries were picked 3 days ago.
- The strawberries were stored in different conditions.

Strawberry A



Strawberry B



A © sarahdoow/iStock/Thinkstock, B © Mariusz Vlack/iStock/Thinkstock

Give **three** possible reasons that may have caused strawberry **A** to decay.

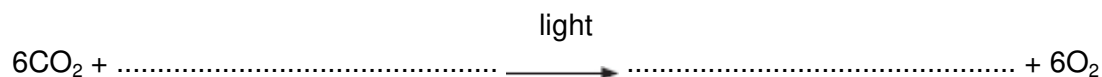
- 1
-
- 2
-
- 3
-

(3)
(Total 13 marks)

4

Photosynthesis needs light.

(a) Complete the **balanced symbol** equation for photosynthesis.



(2)

- (b) A green chemical indicator shows changes in the concentration of carbon dioxide (CO_2) in a solution.

The indicator solution is **green** when the concentration of CO_2 is normal.

The indicator solution turns **yellow** when the concentration of CO_2 is high.





The indicator solution turns **blue** when the concentration of CO_2 is very low or when there is no CO_2 .

The indicator solution does not harm aquatic organisms.

Students investigated the balance of respiration and photosynthesis using an aquatic snail and some pondweed.

The students set up four tubes, **A**, **B**, **C** and **D**, as shown in the table below.

The colour change in each tube, after 24 hours in the light, is recorded.

Tube A	Tube B	Tube C	Tube D
			
Indicator solution only	Indicator solution + pondweed	Indicator solution + snail	Indicator solution + pondweed + snail
Stays green	Turns blue	Turns yellow	Stays green

- (i) What is the purpose of **Tube A**?

.....

(1)

- (ii) Explain why the indicator solution in **Tube C** turns yellow.

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(2)

- (iii) Predict the result for **Tube D** if it had been placed in the dark for 24 hours and **not** in the light.

Explain your prediction.

Prediction.....

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Explanation.....

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(3)

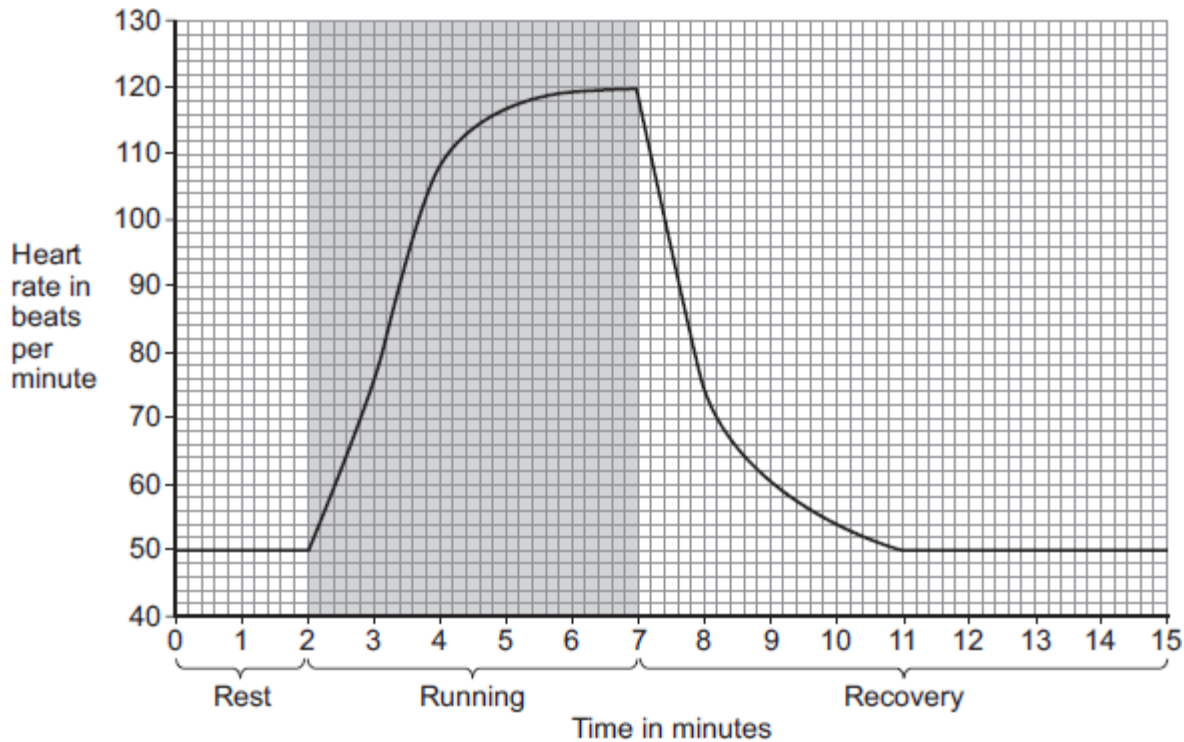
(Total 8 marks)

5

A student ran on a treadmill for 5 minutes.

The speed of the treadmill was set at 12 km per hour.

The graph below shows the effect of the run on the student's heart rate.



- (a) (i) What was the student's heart rate at rest?

..... beats per minute

(1)

- (ii) After the end of the run, how long did it take for the student's heart rate to return to the resting heart rate?

..... minutes

(1)

- (b) During the run, the student's muscles needed larger amounts of some substances than they needed at rest.

- (i) Which **two** of the following substances were needed in larger amounts during the run?

Tick (✓) **two** boxes.

carbon dioxide

☐

glucose

☐

lactic acid

☐

oxygen

☐

protein

☐

(2)

- (ii) Why are the two substances you chose in part (b)(i) needed in larger amounts during the run?

Tick (✓) **one** box.

To help make more muscle fibres

☐

To release more energy

☐

To help the muscles to cool down

☐

(1)

- (c) After exercise, a fit person recovers faster than an unfit person.

Let the student's heart rate at the end of exercise = **a**.

Let the student's heart rate after 2 minutes of recovery = **b**.

The table below shows how the difference between **a** and **b**, (**a – b**), is related to a person's level of fitness.

(a – b)	Level of fitness
< 22	Unfit
22 to 52	Normal fitness
53 to 58	Fit
59 to 65	Very fit
> 65	Top athlete

What is the student's level of fitness?

Use information from the graph and the table.

a = beats per minute

b = beats per minute

(a – b) = beats per minute

Level of fitness =

(3)

- (d) The student repeated the run with the treadmill set at 16 km per hour.

The student's heart rate took 3 minutes longer to return to the normal resting rate than when running at 12 km per hour.

Give reasons why it took longer to recover after running faster.

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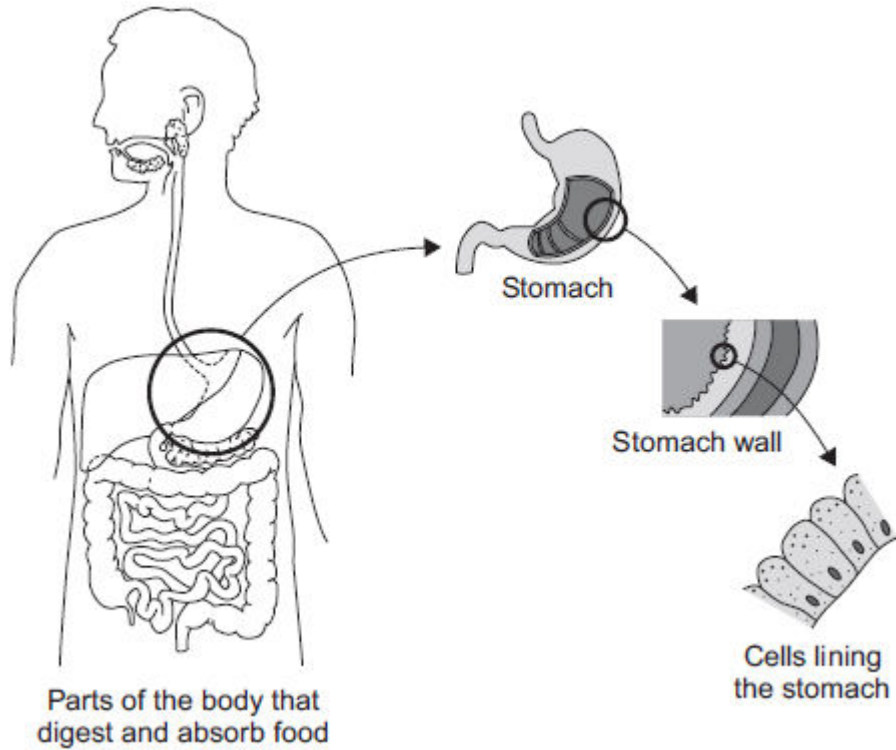
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(4)
(Total 12 marks)

6

The diagram below shows the parts of the body that digest and absorb food.
It also shows some details about the structure of the stomach.



(a) Complete the table to show whether each structure is an organ, an organ system or a tissue.

For each structure, tick (✓) **one** box.

Structure	Organ	Organ system	Tissue
Stomach			
Cells lining the stomach			
Mouth, oesophagus, stomach, liver, pancreas, small and large intestine			

(2)

(b) (i) The blood going to the stomach has a high concentration of oxygen.
The cells lining the stomach have a low concentration of oxygen.

Complete the following sentence.

Oxygen moves from the blood to the cells lining the stomach by
the process of

(1)

- (ii) What other substance must move from the blood to the cells lining the stomach so that respiration can take place?

Draw a ring around the correct answer.

glucose

protein

starch

(1)

- (iii) In which part of a cell does aerobic respiration take place?

Draw a ring around the correct answer.

cell membrane

mitochondria

nucleus

(1)

(Total 5 marks)

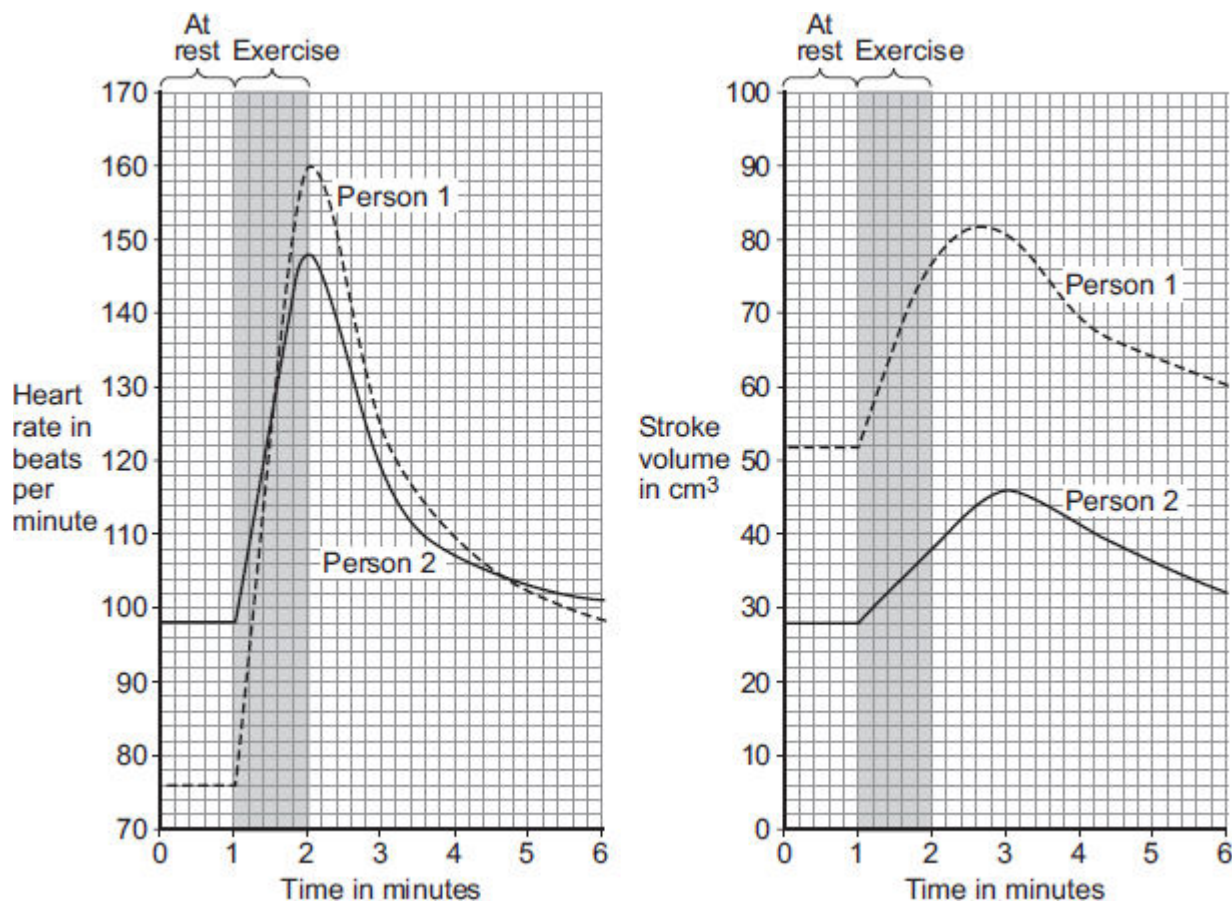
7

During exercise, the heart beats faster and with greater force.

The 'heart rate' is the number of times the heart beats each minute. The volume of blood that travels out of the heart each time the heart beats is called the 'stroke volume'.

In an investigation, **Person 1** and **Person 2** ran as fast as they could for 1 minute. Scientists measured the heart rates and stroke volumes of **Person 1** and **Person 2** at rest, during the exercise and after the exercise.

The graph below shows the scientists' results.



- (a) The 'cardiac output' is the volume of blood sent from the heart to the muscles each minute.

$$\text{Cardiac output} = \text{Heart rate} \times \text{Stroke volume}$$

At the end of the exercise, **Person 1's** cardiac output = $160 \times 77 = 12\,320 \text{ cm}^3$ per minute.

Use information from **Figure above** to complete the following calculation of **Person 2's** cardiac output at the end of the exercise.

At the end of the exercise:

Person 2's heart rate = beats per minute

Person 2's stroke volume = cm^3

Person 2's cardiac output = cm^3 per minute

(3)

(b) **Person 2** had a much lower cardiac output than **Person 1**.

- (i) Use information from **Figure above** to suggest the **main** reason for the lower cardiac output of **Person 2**.

.....

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(1)

- (ii) **Person 1** was able to run much faster than **Person 2**.

Use information from **Figure above** and your own knowledge to explain why.

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(5)

(Total 9 marks)

8

Many runners drink sports drinks to improve their performance in races.

A group of students investigated the effects of three brands of sports drink, **A**, **B** and **C**, on the performance of three runners on a running machine. One of the runners is shown in the image below.



© Keith Brofsky/Photodisc/Thinkstock

Table 1 gives information for each drink.

Table 1

Nutrient per dm ³	Brand of sports drink		
	A	B	C
Glucose in g	63	31	72
Fat in g	9	0	2
Ions in mg	312	332	495

- (a) (i) In the investigation, performance was measured as the time taken to reach the point of exhaustion.

Exhaustion is when the runners could not run anymore.

All three runners:

- ran on a running machine until the point of exhaustion
- each drank 500 cm³ of a different brand of sports drink
- rested for 4 hours to recover
- ran on the running machine again and recorded how much time they ran until the point of exhaustion.

The speed at which the runners ran was the same and all other variables were controlled.

The students predicted that the runner drinking brand **B** would run for the shortest time on the second run before reaching the point of exhaustion.

Use information from **Table 1** to suggest an explanation for the students' prediction.

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(2)

- (ii) If the balance between ions and water in a runner's body is not correct, the runner's body cells will be affected.

Describe **one** possible effect on the cells if the balance between ions and water is **not** correct.

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.....

(1)

- (b) When running, a runner's body temperature increases.

Describe how the brain monitors body temperature.

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(3)

- (c) (i) **Table 2** is repeated here to help you answer this question.

Table 2

	Brand of sports drink		
Nutrient per dm ³	A	B	C
Glucose in g	63	31	72
Fat in g	9	0	2
Ions in mg	312	332	495

People with diabetes need to be careful about drinking too much sports drink.

Use information from **Table 2** to explain why drinking too much sports drink could make people with diabetes ill.

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(3)

- (ii) Other than paying attention to diet, how do people with diabetes control their diabetes?

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(1)

(Total 10 marks)

9

Freshwater streams may have different levels of pollution. The level of pollution affects which species of invertebrate will live in the water.

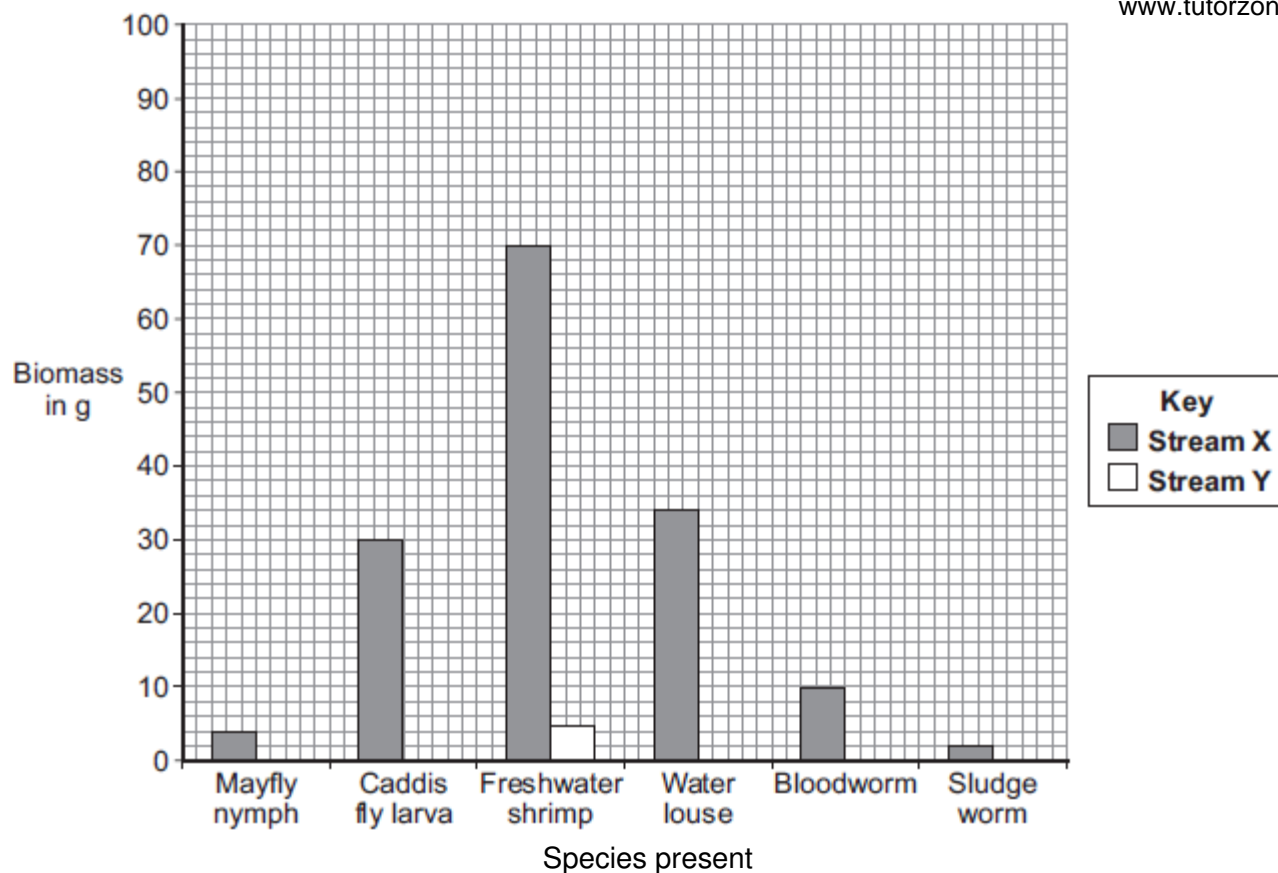
Table 1 shows the biomass of different invertebrate species found in two different streams, **X** and **Y**.

Table 1

	Biomass in g	
Invertebrate species	Stream X	Stream Y
Mayfly nymph	4	0
Caddis fly larva	30	0
Freshwater shrimp	70	5
Water louse	34	10
Bloodworm	10	45
Sludge worm	2	90
Total	150	150

- (a) The bar chart below shows the biomass of invertebrate species found in **Stream X**.
- (i) Complete the bar chart by drawing the bars for water louse, bloodworm and sludge worm in **Stream Y**.

Use the data in **Table 1**.



(2)

(ii) **Table 2** shows which invertebrates can live in different levels of water pollution.

Table 2

Pollution level	Invertebrate species likely to be present
Clean water	Mayfly nymph
Low pollution	Caddis fly larva, Freshwater shrimp
Medium pollution	Water louse, Bloodworm
High pollution	Sludge worm

Which stream, **X** or **Y**, is more polluted?

Use the information from **Table 1** and **Table 2** to justify your answer.

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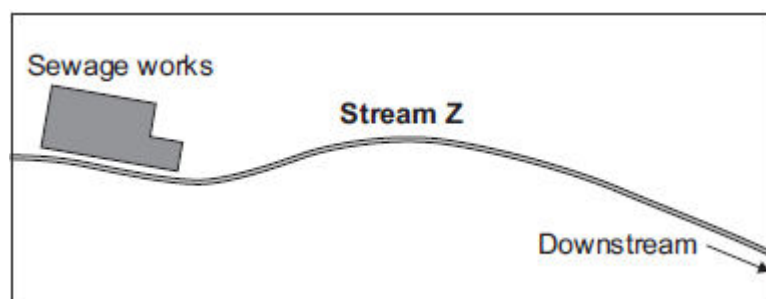
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(2)

- (b) There is a sewage works near another stream, **Z**.



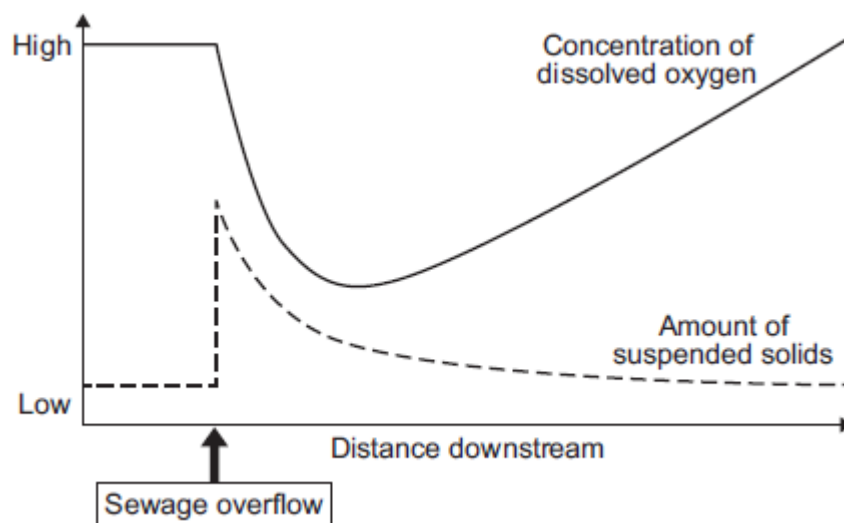
An accident caused sewage to overflow into **Stream Z**.

Two weeks later scientists took samples of water and invertebrates from the stream.

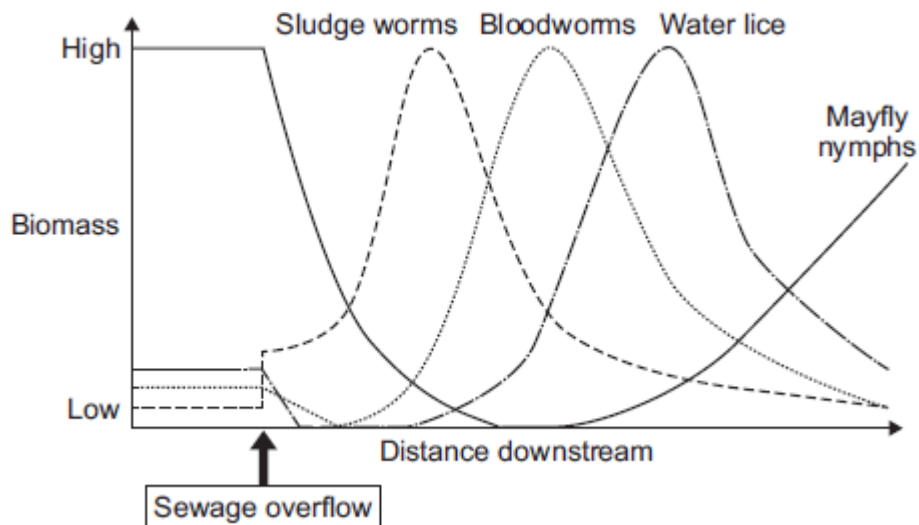
They took samples at different distances downstream from where the sewage overflowed.

The scientists plotted the results shown in **Graphs P** and **Q**.

Graph P: change in water quality downstream of sewage overflow



Graph Q: change in invertebrates found downstream of sewage overflow



- (i) Describe the patterns shown in **Graph P**.

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(4)

- (ii) Describe the relationship between dissolved oxygen and the survival of mayfly nymphs in **Stream Z**. Suggest a reason for the pattern you have described.

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(3)

- (c) Many microorganisms are present in the sewage overflow.

Explain why microorganisms cause the level of oxygen in the water to decrease.

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.....

(2)

(Total 13 marks)

10

Figure 1 shows an athlete running on a treadmill.

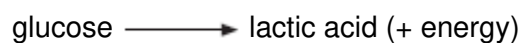
Figure 1



© Starush/istock/Thinkstock

After running for several minutes, the athlete's leg muscles began to ache. This ache was caused by a high concentration of lactic acid in the muscles.

(a) The equation shows how lactic acid is made.



Name the process that makes lactic acid in the athlete's muscles.

.....

(1)

- (b) Scientists investigated the production of lactic acid by an athlete running at different speeds.

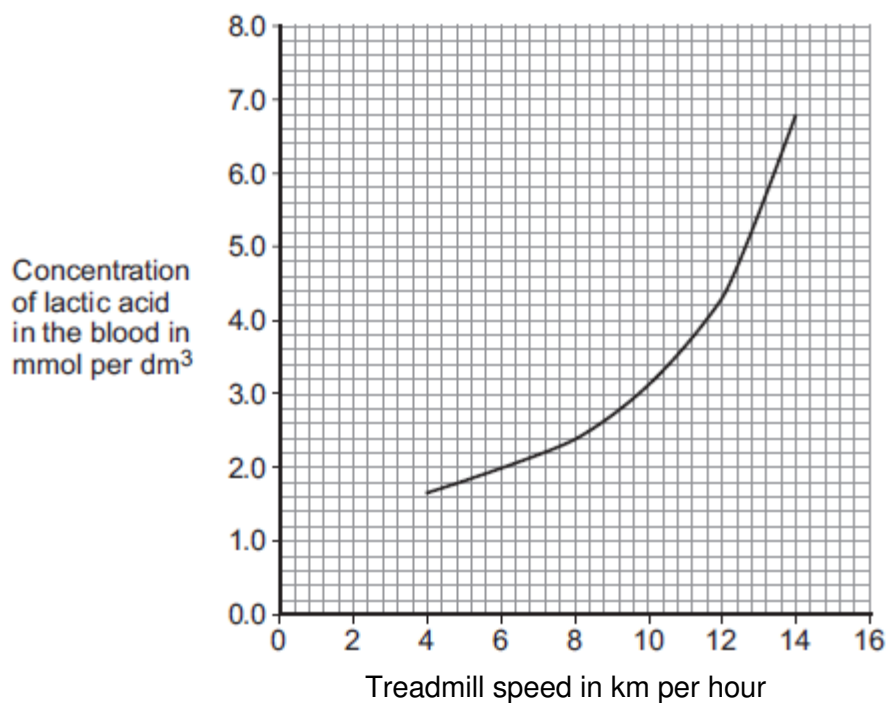
In the investigation:

- the athlete ran on the treadmill at 4 km per hour
- the scientists measured the concentration of lactic acid in the athlete's blood after 2 minutes of running.

The investigation was repeated for different running speeds.

Figure 2 shows the scientists' results.

Figure 2



- (i) How much more lactic acid was there in the athlete's blood when he ran at 14 km per hour than when he ran at 8 km per hour?

.....

.....

.....

Answer = mmol per dm³

(2)

- (ii) Why is more lactic acid made in the muscles when running at 14 km per hour than when running at 8 km per hour?

.....

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.....

.....

(3)
(Total 6 marks)

11

Scientists investigated how exercise affects blood flow to different organs in the body.

The scientists made measurements of blood flow to different organs of:

- a person resting in a room at 20°C
- the same person, in the same room, doing vigorous exercise at constant speed on an exercise cycle.

The table shows the scientists' results.

Organ	Blood flow in cm ³ per minute whilst ...	
	resting	doing vigorous exercise
Brain	750	750
Heart	250	1000
Muscles	1200	22 000
Skin	500	600
Other	3100	650

- (a) In this investigation, it was better to do the exercise indoors on an exercise cycle than to go cycling outdoors on the road.

Suggest **two** reasons why.

Do **not** include safety reasons.

1

.....

.....

2

.....

.....

(2)

- (b) Blood flow to **one** organ did **not** change between resting and vigorous exercise.

Which organ?

(1)

- (c) (i) How much more blood flowed to the muscles during vigorous exercise than when resting?

.....

Answer = cm³ per minute

(2)

- (ii) Name **two** substances needed in larger amounts by the muscles during vigorous exercise than when resting.

1

2

(2)

- (iii) Tick (✓) **one** box to complete the sentence.

The substances you named in part (c)(ii) helped the muscles to

make more lactic acid.

☐

respire aerobically.

☐

make more glycogen.

☐

(1)

- (iv) The higher rate of blood flow to the muscles during exercise removed larger amounts of waste products made by the muscles.

Which **two** substances need to be removed from the muscles in larger amounts during vigorous exercise?

Tick (✓) **two** boxes.

Amino acids

☐

Carbon dioxide

☐

Glycogen

☐

Lactic acid

☐

(2)

- (d) The total blood flow was much higher during exercise than when resting.

One way to increase the total blood flow is for the heart to pump out a larger volume of blood each beat.

Give **one** other way to increase the blood flow.

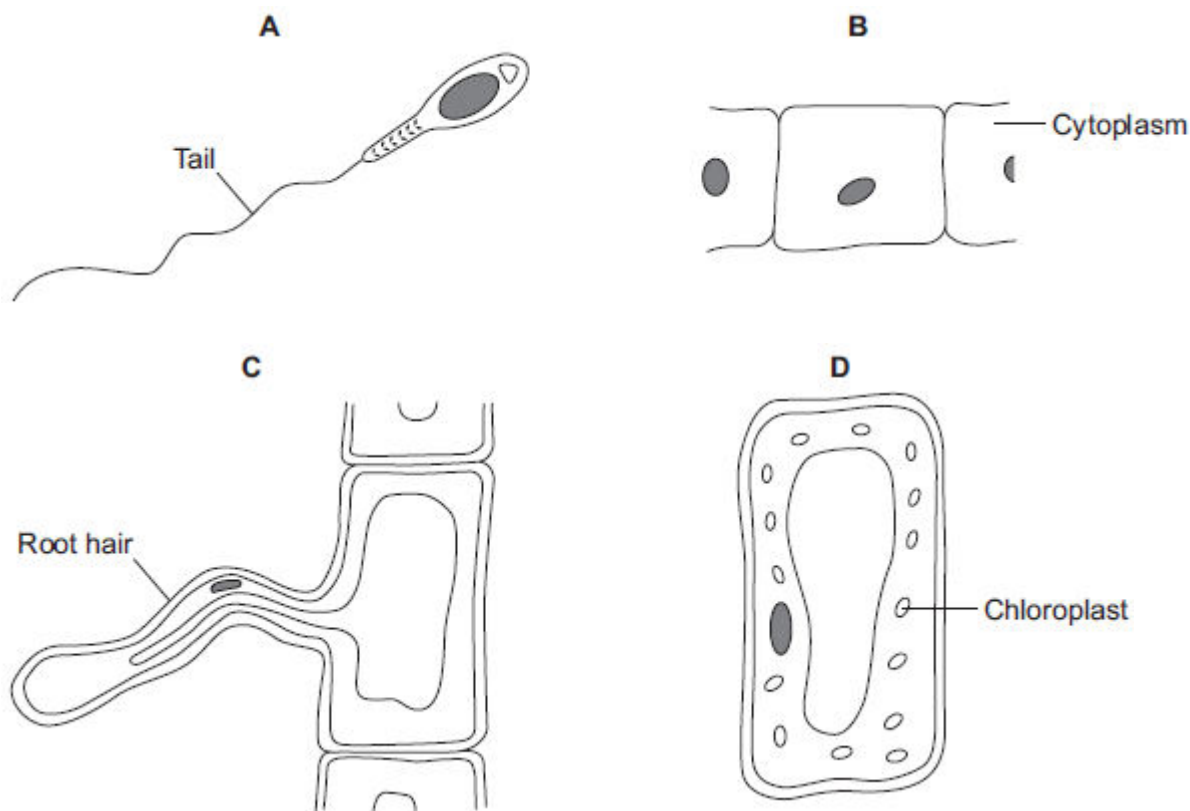
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.....

(1)
(Total 11 marks)

12

The diagrams show four types of cell, **A**, **B**, **C** and **D**.
Two of the cells are plant cells and two are animal cells.



- (a) (i) Which **two** of the cells are plant cells?

Tick (✓) **one** box.

A and B

☐

A and D

☐

C and D

☐

(1)

(ii) Give **one** reason for your answer.

.....

.....

(1)

(b) (i) Which cell, **A**, **B**, **C** or **D**, is adapted for swimming?

(1)

(ii) Which cell, **A**, **B**, **C** or **D**, can produce glucose by photosynthesis?

(1)

(c) Cells **A**, **B**, **C** and **D** all use oxygen.

For what process do cells use oxygen?

Draw a ring around **one** answer.

osmosis

photosynthesis

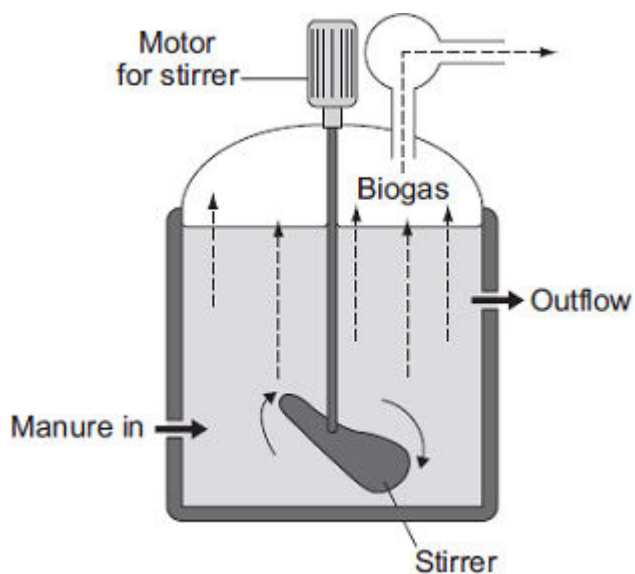
respiration

(1)

(Total 5 marks)

13

The diagram shows one type of biogas generator.



- (a) With this type of biogas generator, the concentration of solids that are fed into the reactor must be kept very low.

Suggest **one** reason for this.

Tick (✓) **one** box.

A higher concentration contains too little oxygen.

☐

A higher concentration would be difficult to stir.

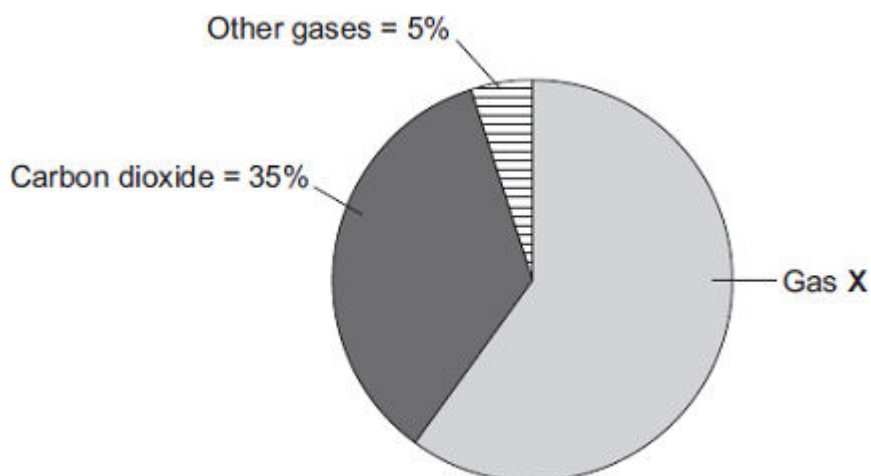
☐

A higher concentration contains too much carbon dioxide.

☐

(1)

- (b) The pie chart shows the percentages of the different gases found in the biogas.



Gas **X** is the main fuel gas found in the biogas.

- (i) What is the name of gas **X**?

Draw a ring around **one** answer.

methane

nitrogen

oxygen

(1)

- (ii) What is the percentage of gas **X** in the biogas?

Show clearly how you work out your answer.

.....

.....

Percentage of gas **X** =

(2)

- (c) If the biogas generator is not airtight, the biogas contains a much higher percentage of carbon dioxide.

Draw a ring around **one** answer in each part of this question.

- (i) The air that leaks in will increase the rate of

aerobic respiration.

anaerobic respiration.

fermentation.

(1)

ammonia.

nitrogen.

oxygen.

- (ii) The process in part (c)(i) occurs because the air contains

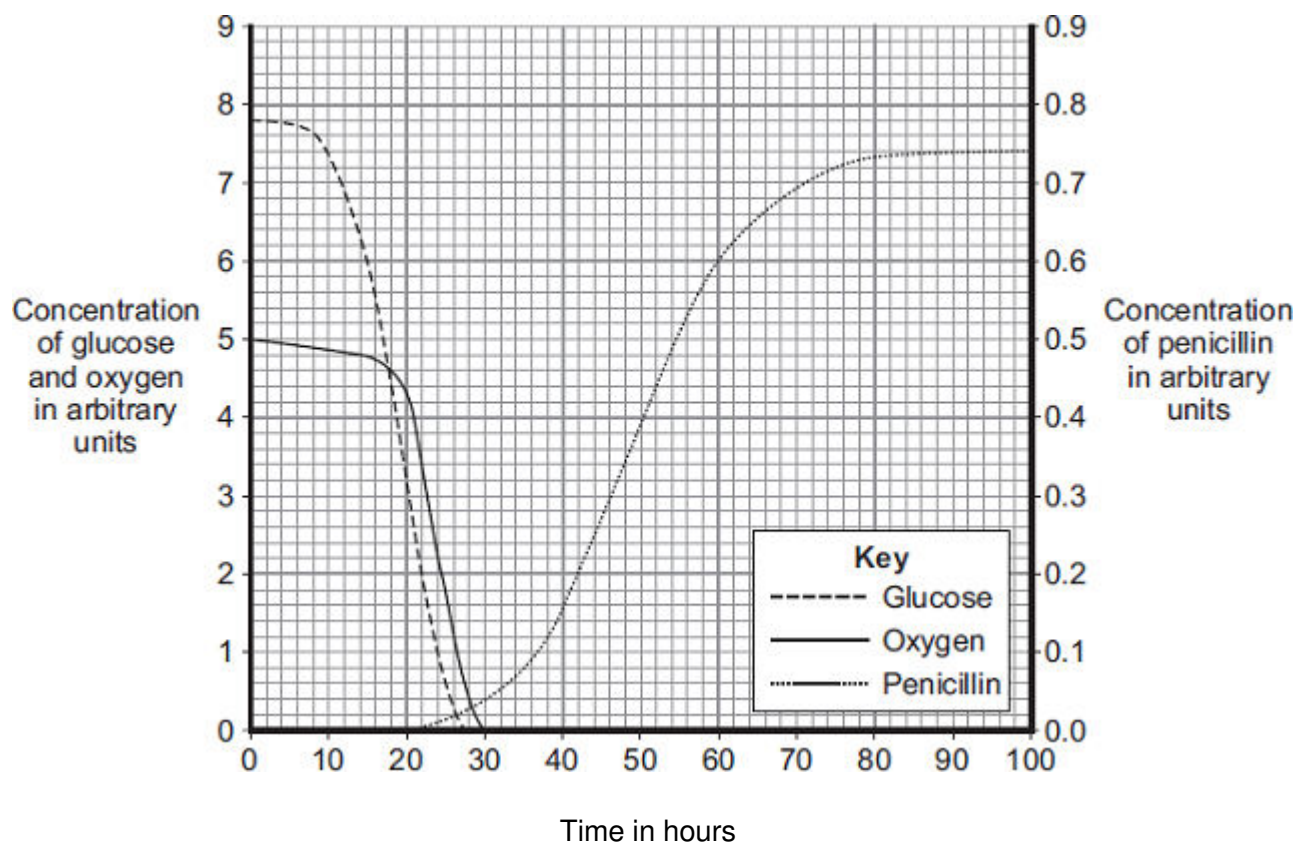
(1)

(Total 6 marks)

14

The mould *Penicillium* can be grown in a fermenter. *Penicillium* produces the antibiotic penicillin.

The graph shows changes that occurred in a fermenter during the production of penicillin.



- (a) During which time period was penicillin produced most quickly?

Draw a ring around **one** answer.

0 – 20 hours

40 – 60 hours

80 – 100 hours

(1)

- (b) (i) Describe how the concentration of glucose in the fermenter changes between 0 and 30 hours.

.....

.....

.....

.....

(2)

- (ii) How does the change in the concentration of oxygen in the fermenter compare with the change in concentration of glucose between 0 and 30 hours?

Tick (✓) **two** boxes.

The oxygen concentration changes after the glucose concentration.

☐

The oxygen concentration changes before the glucose concentration.

☐

The oxygen concentration changes less than the glucose concentration.

☐

The oxygen concentration changes more than the glucose concentration.

☐

(2)

- (iii) What is the name of the process that uses glucose?

Draw a ring around **one** answer.

distillation

filtration

respiration

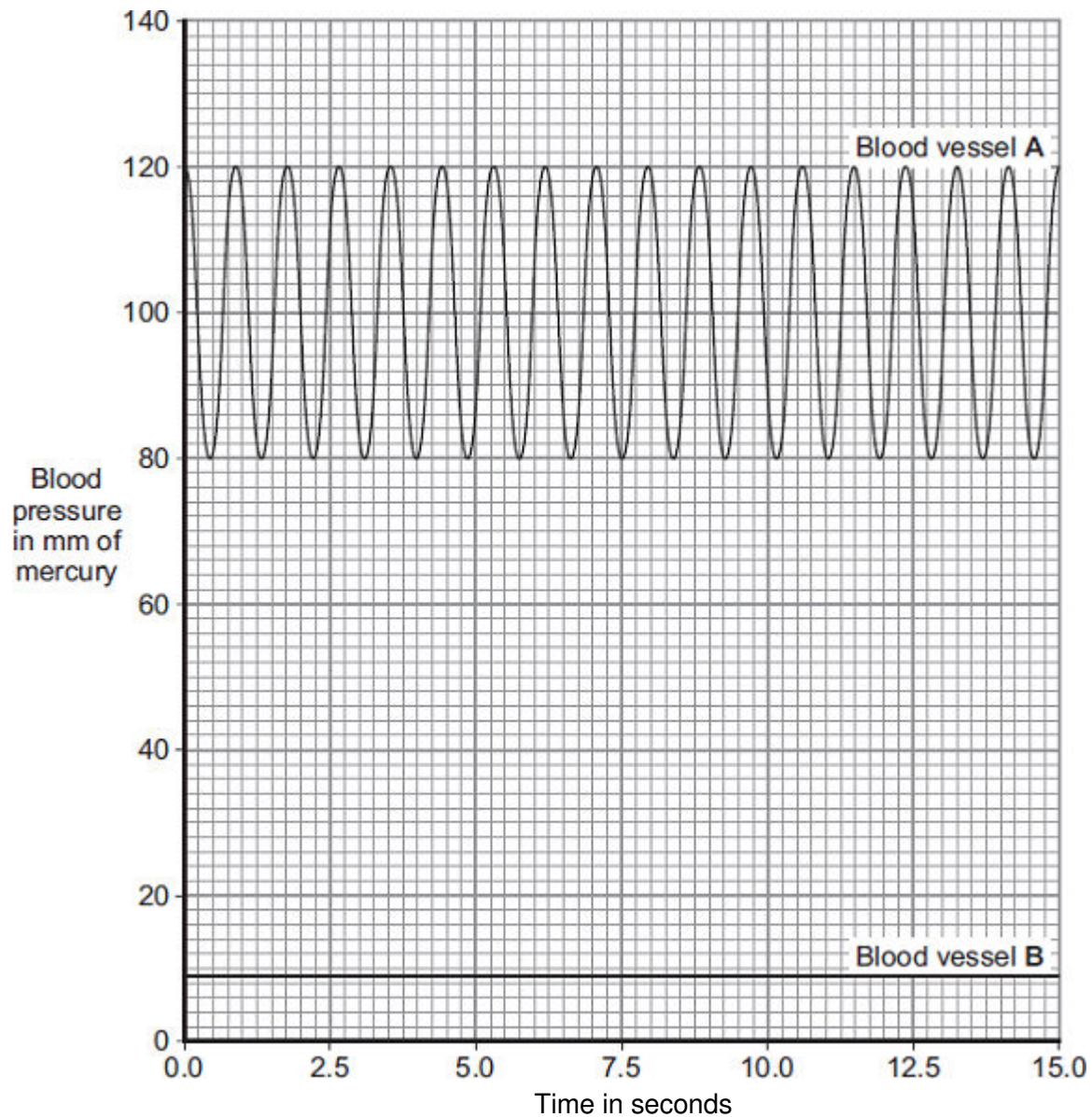
(1)

(Total 6 marks)

15

The heart pumps the blood around the body. This causes blood to leave the heart at high pressure.

The graph shows blood pressure measurements for a person at rest.
The blood pressure was measured in an artery and in a vein.



- (a) Which blood vessel, **A** or **B**, is the artery?

Blood vessel

Give **two** reasons for your answer.

Reason 1

.....

Reason 2

.....

(2)

(b) Use information from the graph to answer these questions.

(i) How many times did the heart beat in 15 seconds?

(1)

(ii) Use your answer from part (b)(i) to calculate the person's heart rate per minute.

.....

.....

Heart rate = beats per minute

(1)

(c) During exercise, the heart rate increases.

The increased heart rate supplies useful substances to the muscles at a faster rate.

Name **two** useful substances that must be supplied to the muscles at a faster rate during exercise.

1

2

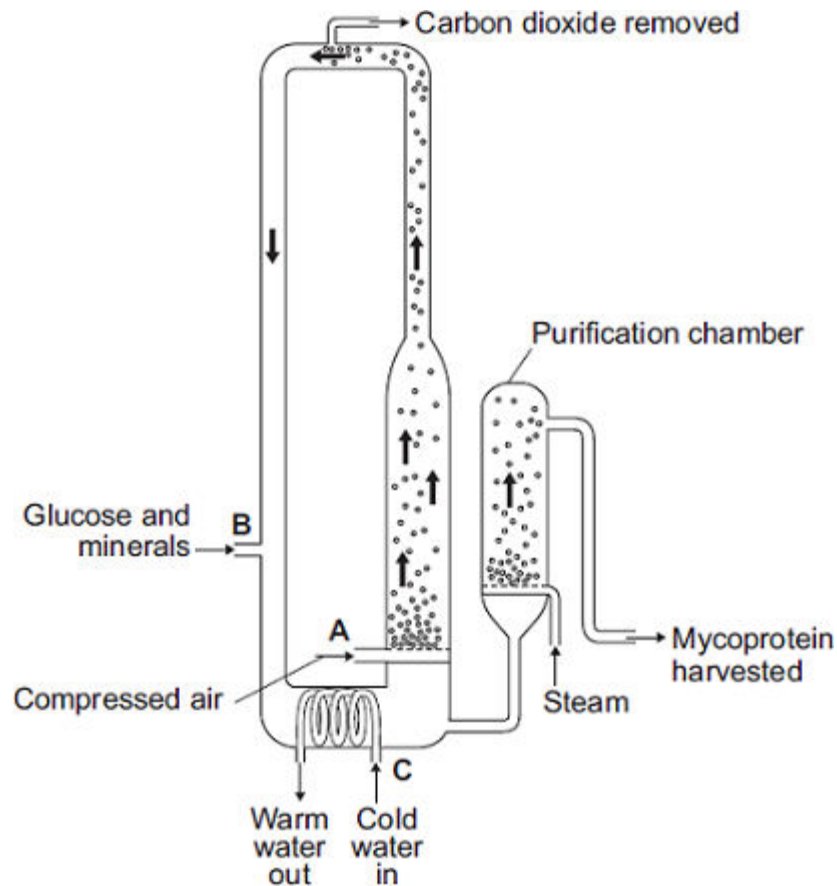
(2)

(Total 6 marks)

16

The diagram shows a fermenter. This fermenter is used for growing the fungus *Fusarium*.

Fusarium is used to make mycoprotein.



- (a) Bubbles of air enter the fermenter at **A**.

Give **two** functions of the air bubbles.

1.....

.....

2.....

.....

(2)

- (b) Why is glucose added to the fermenter?

.....

.....

(1)

- (c) The fermenter is prevented from overheating by the cold water flowing in through the heat exchanger coils at **C**.

Name the process that causes the fermenter to heat up.

.....

(1)

- (d) It is important to prevent microorganisms other than *Fusarium* growing in the fermenter.

- (i) Why is this important?

.....

.....

(1)

- (ii) Suggest **one** way in which contamination of the fermenter by microorganisms could be prevented.

.....

.....

(1)

- (e) Human cells cannot make some of the amino acids which we need. We must obtain these amino acids from our diet.

The table shows the amounts of four of these amino acids present in mycoprotein, in beef and in wheat.

Name of amino acid	Amount of amino acid per 100 g in mg			Daily amount needed by a 70 kg human in mg
	Mycoprotein	Beef	Wheat	
Lysine	910	1600	300	840
Methionine	230	500	220	910
Phenylalanine	540	760	680	980
Threonine	610	840	370	490

A diet book states that mycoprotein is the best source of amino acids for the human diet.

Evaluate this statement.

Remember to include a conclusion in your evaluation.

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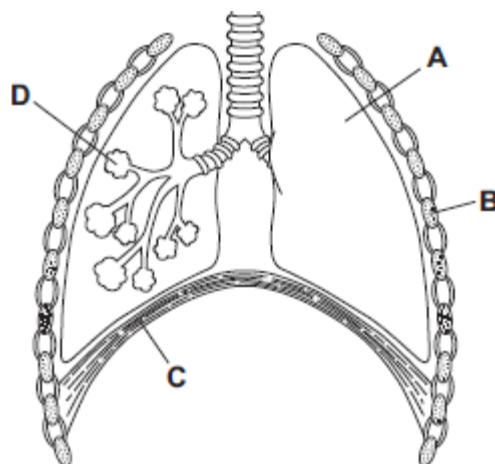
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(4)
(Total 10 marks)

17

(a) **Diagram 1** shows part of the breathing system.

Diagram 1



- (i) Use words from the box to name the parts labelled **A**, **B**, **C** and **D**.

alveolus	diaphragm	lung	rib	trachea
-----------------	------------------	-------------	------------	----------------

A

B

C

D

(4)

- (ii) Parts **B** and **C** move when we breathe **in**.

Part **B** moves

Part **C** moves

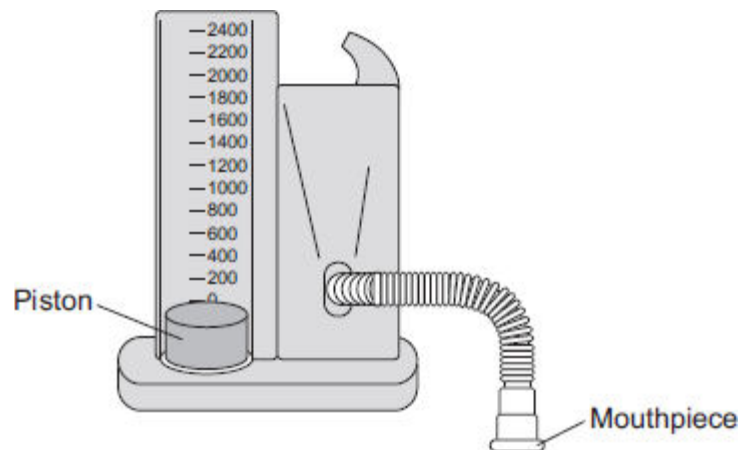
(2)

- (b) A student used the apparatus shown in **Diagram 2** to measure the maximum volume of air that he could breathe in one breath.

When the student breathes in, the piston moves upwards.

The piston moves back down after the student has breathed out.

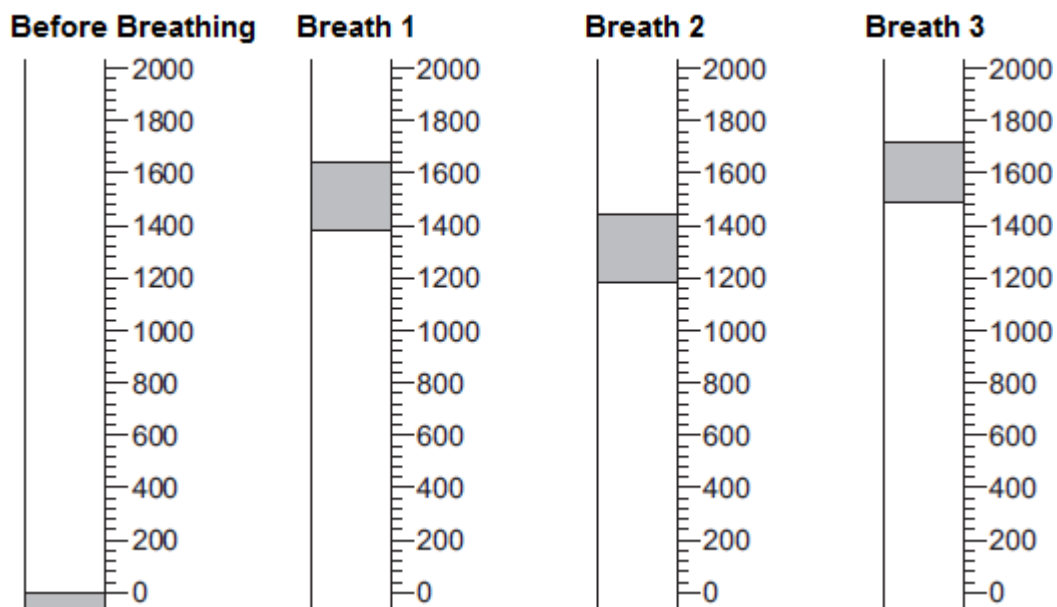
Diagram 2



The student breathes in through the apparatus three times.

The drawings show the position of the piston after each of the three breaths.

The volumes are measured in cm^3 .



- (i) Read the volume of each breath and write the volume in the table.

	Breath 1	Breath 2	Breath 3
Volume in cm^3

(3)

- (ii) Calculate the mean volume of air breathed in.

.....

.....

Mean volume of air breathed in = cm^3

(2)

- (c) A teacher asks the student to investigate if students who take part in sports activities can breathe in a larger volume of air than students who do not take part.

Describe briefly how the student could use the **same** apparatus to do the investigation.

.....

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.....

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(3)

- (d) **Photograph 1** shows a different piece of apparatus used to measure the volume of air that a person can breathe in one breath.

Photograph 1



© Digital Vision/Photodisc

When the student breathes out through the apparatus the pointer on the scale moves. The pointer stays in the same position when the student has finished.

Explain **one** advantage, apart from size, of using this apparatus rather than the apparatus described in part (b).

.....

.....

.....

.....

(2)

- (e) **Photograph 2** shows one type of mechanical ventilator.

Photograph 2



© Emine Donmaz/iStock

- (i) Use information from **Photograph 2** to suggest how this type of ventilator works.

.....

.....

.....

.....

(2)

- (ii) Use information from **Photograph 2** to suggest two disadvantages of this type of ventilator.

1.....

.....

2.....

.....

(2)
(Total 20 marks)

18

The photograph shows an athlete at the start of a race.



© Wavebreakmedia Ltd./Thinkstock

- (a) The athlete's sense organs contain special cells.
These special cells detect changes in the environment.
- (i) **List A** shows changes in the environment.

List B shows some of the athlete's sense organs.

Draw **one** line from each change in the environment in **List A** to the sense organ detecting the change in **List B**.

List A Change in the environment	List B Sense organ
Sight of the finishing line	Ear
Sound of the starting gun	Nose
Pressure of the ground on the fingers	Eye
	Skin

(3)

- (ii) Which cells detect changes in the environment?

Tick (✓) **one** box.

Gland cells

☐

Muscle cells

☐

Receptor cells

☐

(1)

- (b) During the race, the concentration of sugar in the athlete's blood decreases.

Why?

.....

.....

(1)

- (c) Some athletes use anabolic steroids to improve performance.

- (i) Draw a ring around the correct answer to complete the sentence.

Anabolic steroids increase

breathing rate.

growth of muscles.

heart rate.

(1)

- (ii) Sporting regulations ban the use of anabolic steroids.

Suggest **one** reason why.

.....

.....

(1)

(Total 7 marks)

19

One factor that may affect body mass is *metabolic rate*.

- (a) (i) What is meant by *metabolic rate* ?

.....

.....

(1)

(ii) Metabolic rate is affected by the amount of activity a person does.

Give **two** other factors that may affect a person's metabolic rate.

1.....

.....

2.....

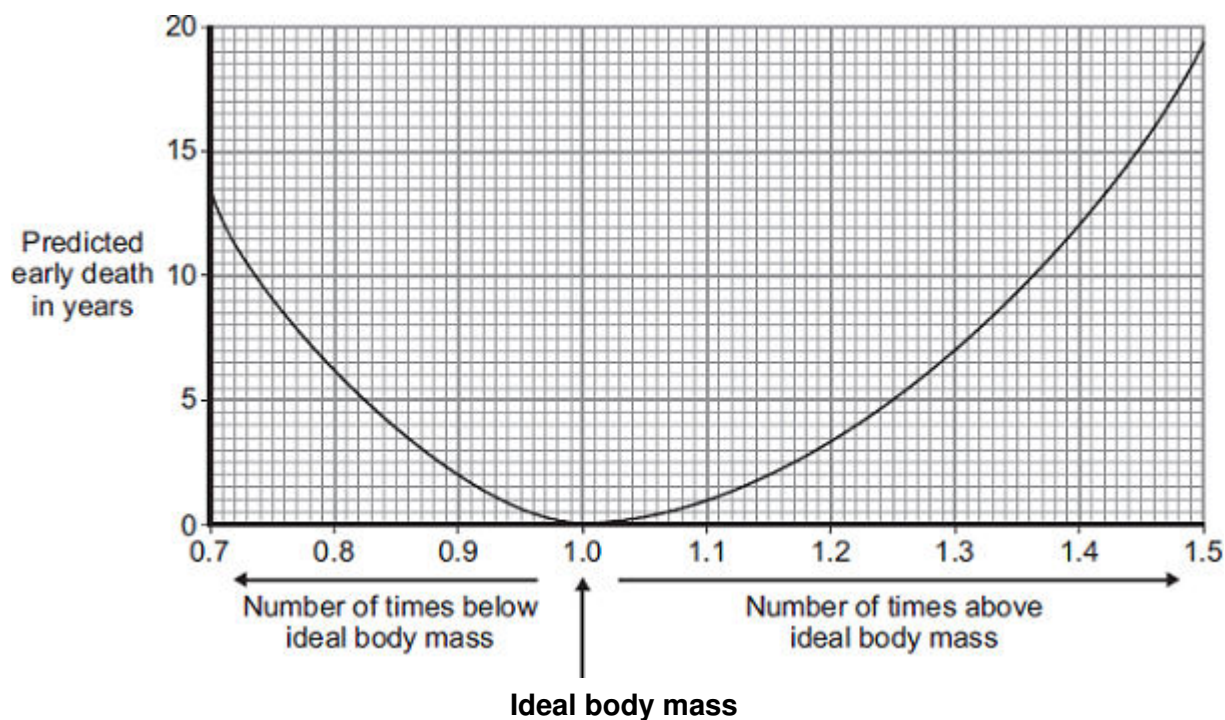
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(2)

- (b) Predicted early death is the number of years that a person will die before the mean age of death for the whole population. The predicted early death of a person is affected by their body mass.

Scientists have calculated the effect of body mass on predicted early death.

The graph shows the results of the scientists' calculations.



The number of times above or below ideal body mass is given by the equation:

$$\frac{\text{Actual body mass}}{\text{Ideal body mass}}$$

In the UK the mean age of death for women is 82.

A woman has a body mass of 70 kg. The woman's ideal body mass is 56 kg.

- (i) Use the information from the graph to predict the age of this woman when she dies.

.....

Age at death = years

(2)

- (ii) The woman could live longer by changing her lifestyle.

Give **two** changes she should make.

1.....

.....

2.....

.....

(2)

(Total 7 marks)

20

- (a) Use words from the box to complete the equation for aerobic respiration.

alcohol

glucose

lactic acid

water

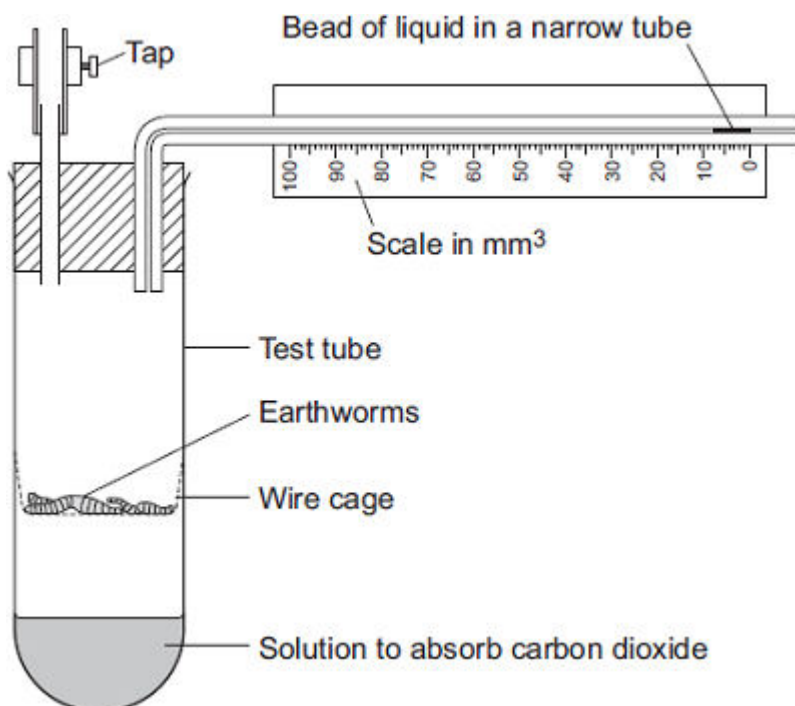
..... + oxygen \longrightarrow carbon dioxide + (+ energy)

(2)

- (b) Some students investigated the effect of temperature on the rate of aerobic respiration in earthworms.

The diagram shows the apparatus the students used.

When the tap is closed, the bead of liquid moves to the left as the earthworms take in oxygen.



The students put the test tube into a water bath at 20°C for 10 minutes. They left the tap open during this time.

Why did the students put the test tube in the water bath at 20°C for 10 minutes?

Tick (✓) **one** box.

Because the air contains more oxygen at 20°C.

☐

Because the air contains less carbon dioxide at 20°C.

☐

So the earthworms' body temperature would change to 20°C.

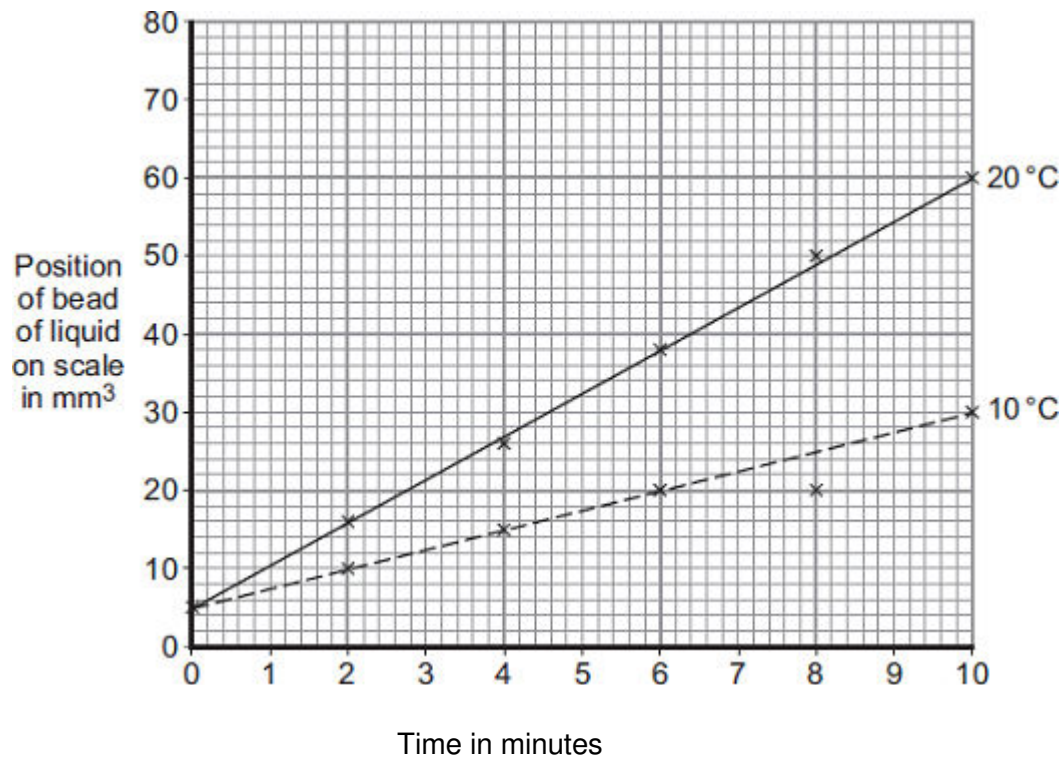
☐

(1)

(c) The students then:

- closed the tap
- started a stopwatch
- recorded the position of the bead of liquid every 2 minutes for 10 minutes
- repeated the experiment at 10°C.

The graph shows the students' results.



(i) How much oxygen did the earthworms take in during the 10 minutes at 20°C?

Use information from the graph to work out your answer.

.....

Volume of oxygen taken in = mm^3

(2)

- (ii) The earthworms took in this volume of oxygen in 10 minutes.

Use your answer from part (c)(i) to calculate how much oxygen the earthworms took in each minute.

.....

.....

Volume of oxygen taken in = mm³ per minute

(1)

- (iii) The earthworms took in less oxygen each minute at 10°C than they took in at 20°C.

Explain why.

.....

.....

.....

.....

(2)

- (d) When drawing the line on the graph for the experiment at 10°C, the students ignored the reading at 8 minutes.

- (i) Suggest why they ignored the reading at 8 minutes.

.....

.....

(1)

- (ii) One student suggested they should repeat the experiment twice more at each temperature.

How would repeating the experiment improve the investigation?

.....

.....

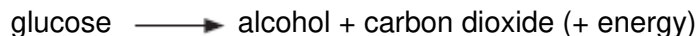
(1)

(Total 10 marks)

21

- (a) Yeast cells can respire anaerobically.

The equation for anaerobic respiration in yeast is:



Give **one** way in which anaerobic respiration in yeast cells is different from anaerobic respiration in human muscle cells.

.....

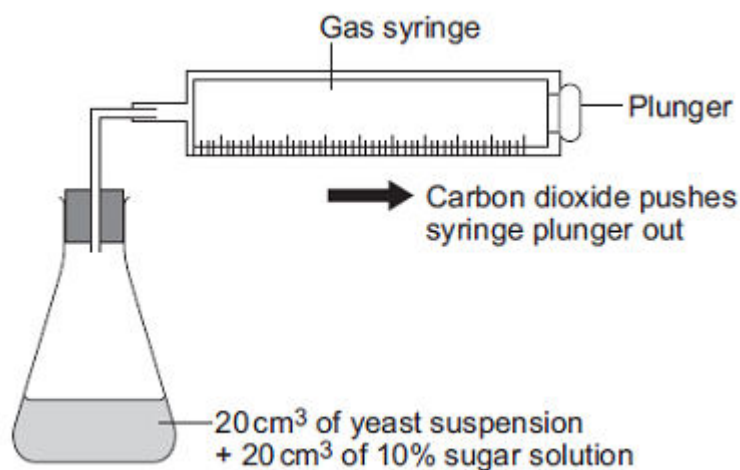
(1)

- (b) Yeast can use other types of sugar instead of glucose.
 Some scientists investigated the effect of three different types of sugar on the rate of anaerobic respiration in yeast.

The scientists:

- used the apparatus shown in **Diagram 1** with glucose sugar
- kept the apparatus at 20 °C
- repeated the investigation with fructose sugar and then with mannose sugar
- repeated the investigation with water instead of the sugar solution.

Diagram 1

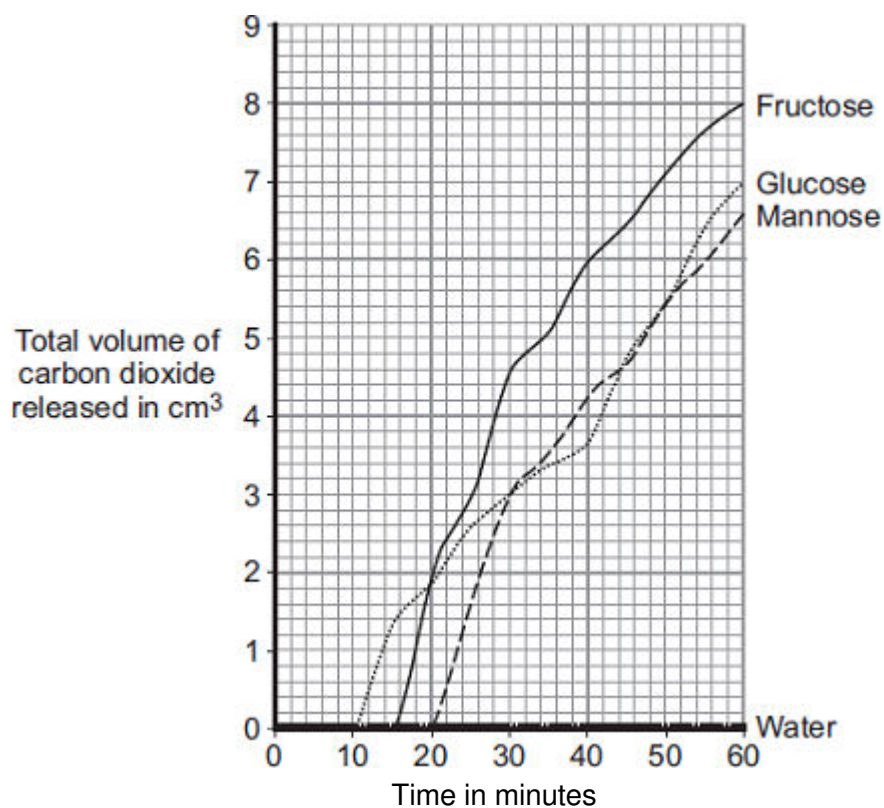


- (i) Give **two** control variables the scientists used in this investigation.

.....

(2)

(ii) The graph shows the scientists' results.



From this information, a company decided to use fructose to produce alcohol and **not** mannose or glucose.

Explain the reason for the company's choice.

.....

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.....

.....

(2)
(Total 5 marks)

Some students investigated the best temperature for gas production by yeast.

The students set up the apparatus as shown in **Diagram 1**.

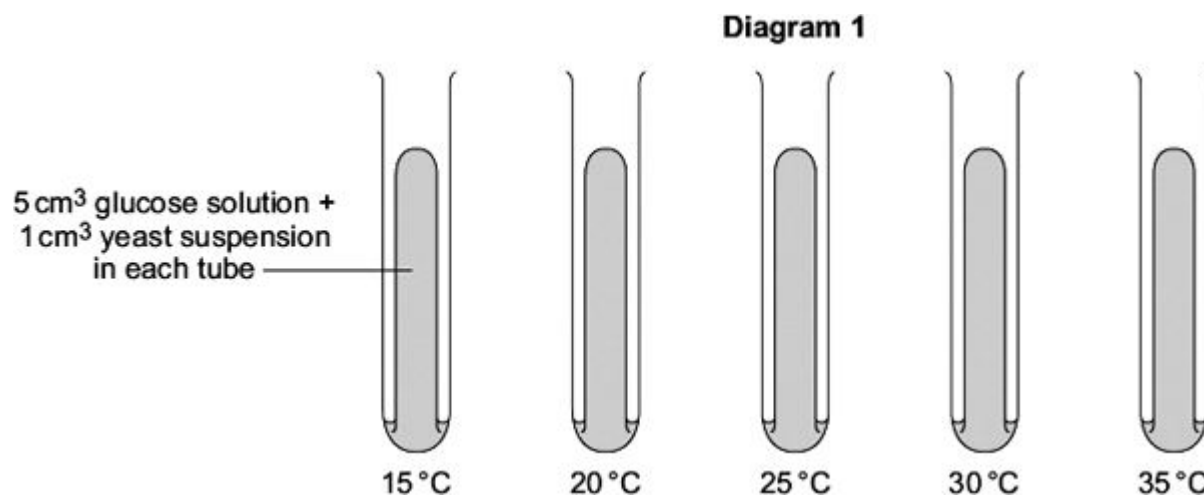
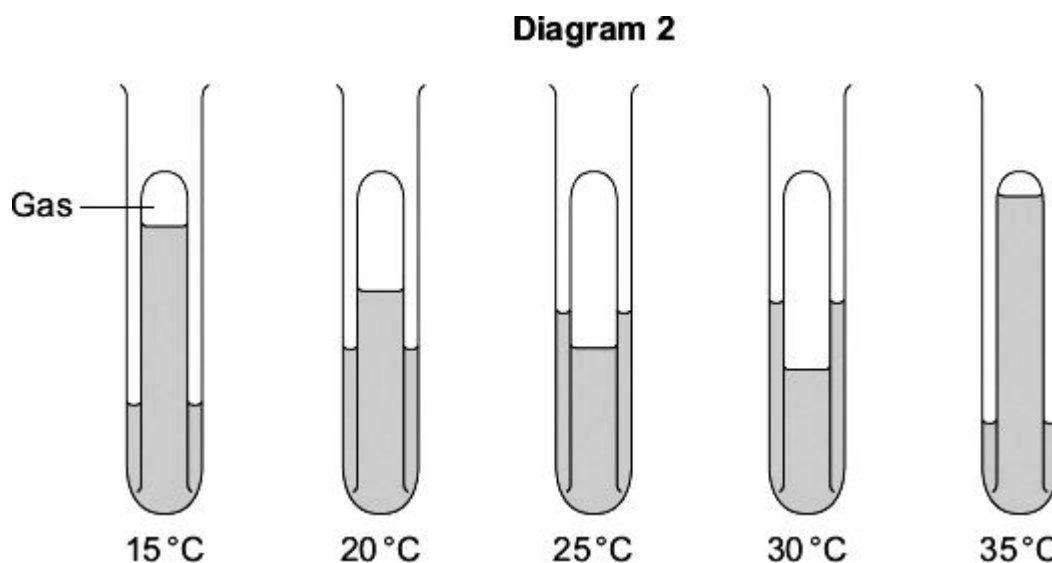


Diagram 2 shows the results after one hour.



(a) In each apparatus the yeast produced a gas.

(i) Name this gas.

.....

(1)

(ii) Name the process which produces this gas.

.....

(1)

- (b) One student said that the best temperature for the yeast to produce the gas was 30 °C.

What is the evidence for this in **Diagram 2**?

.....

.....

(1)

- (c) A second student said that the investigation might not have produced reliable results.

- (i) What should the students do next to check the reliability of their results?

.....

.....

(1)

- (ii) How would the students then know if their results were reliable?

.....

.....

(1)

- (d) A third student said that the investigation might not have produced an accurate value for the best temperature for gas production.

What should the students do next to check that 30 °C was an accurate value for the best temperature?

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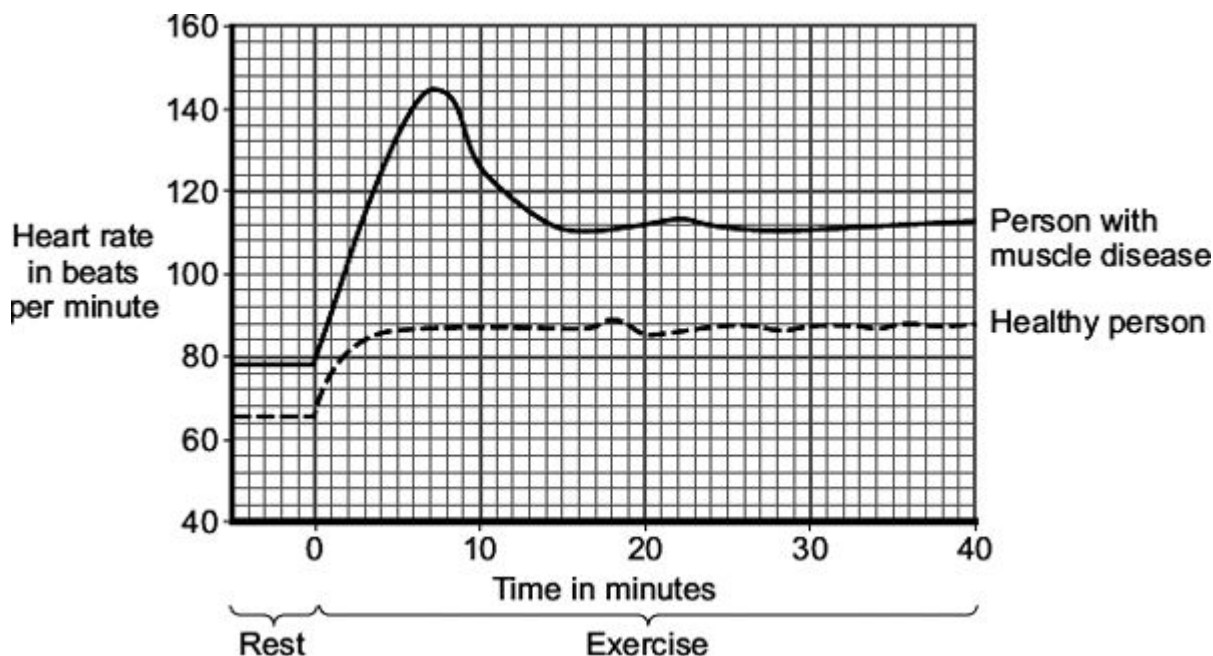
(2)

(Total 7 marks)

23

Two people did the same amount of gentle exercise on an exercise cycle. One person had a muscle disease and the other had healthy muscles.

The graph shows the effect of the exercise on the heart rates of these two people.



- (a) Describe **three** ways in which the results for the person with the muscle disease are different from the results for the healthy person.

To gain full marks in this question you need to include data from the graph in your answer.

1

.....

2

.....

3

.....

(3)

- (b) The blood transports glucose to the muscles at a faster rate during exercise than when a person is at rest.

- (i) Name **one** other substance that the blood transports to the muscles at a faster rate during exercise.

.....

(1)

- (ii) People with the muscle disease are not able to store glycogen in their muscles.

The results shown in the graph for the person with the muscle disease are different from the results for the healthy person.

Suggest an explanation for the difference in the results.

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(3)
(Total 7 marks)

24

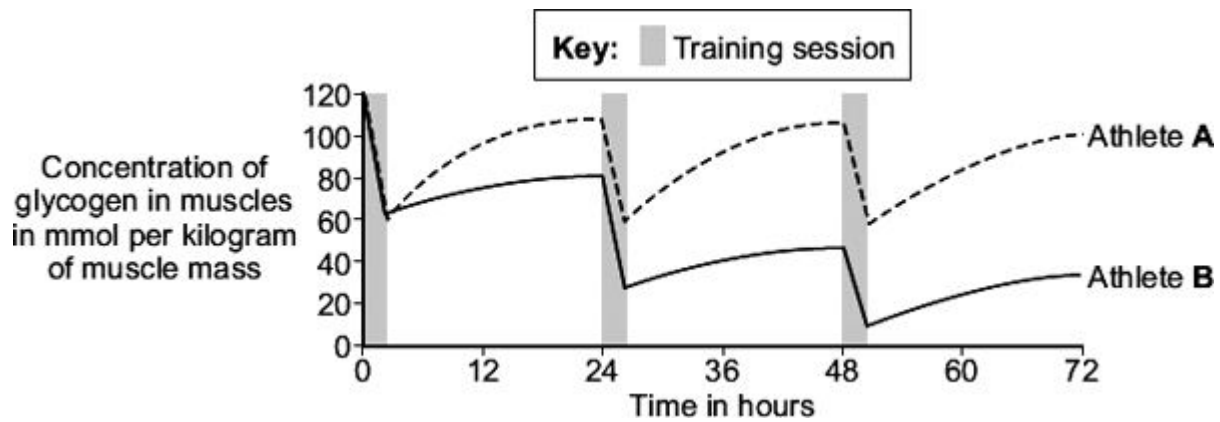
Glycogen is stored in the muscles.

Scientists investigated changes in the amount of glycogen stored in the muscles of two 20-year-old male athletes, **A** and **B**.

Athlete **A** ate a high-carbohydrate diet. Athlete **B** ate a low-carbohydrate diet.

Each athlete did one 2-hour training session each day.

The graph shows the results for the first 3 days.



- (a) (i) Give **three** variables that the scientists controlled in this investigation.

.....

.....

.....

.....

.....

.....

(3)

- (ii) Suggest **two** variables that would be difficult to control in this investigation.

.....

.....

.....

.....

(2)

- (iii) Describe **one** way in which the results of Athlete **B** were different from the results of Athlete **A**.

.....

.....

(1)

- (b) Both athletes were training to run a marathon.

Which athlete, **A** or **B**, would be more likely to complete the marathon?

Use information from the graph to explain your answer.

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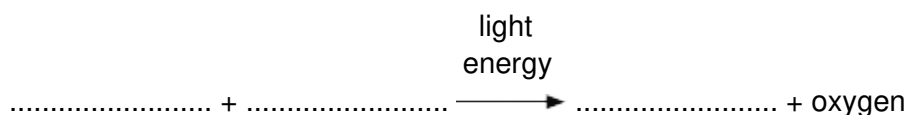
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(4)
(Total 10 marks)

25

- (a) Complete the equation for photosynthesis.



(2)

- (b) Scientists investigated how temperature affects the rate of photosynthesis. The scientists grew some orange trees in a greenhouse. They used discs cut from the leaves of the young orange trees.

The scientists used the rate of oxygen production by the leaf discs to show the rate of photosynthesis.

- (i) The leaf discs did not produce any oxygen in the dark.

Why?

.....

.....

(1)

- (ii) The leaf discs took in oxygen in the dark.

Explain why.

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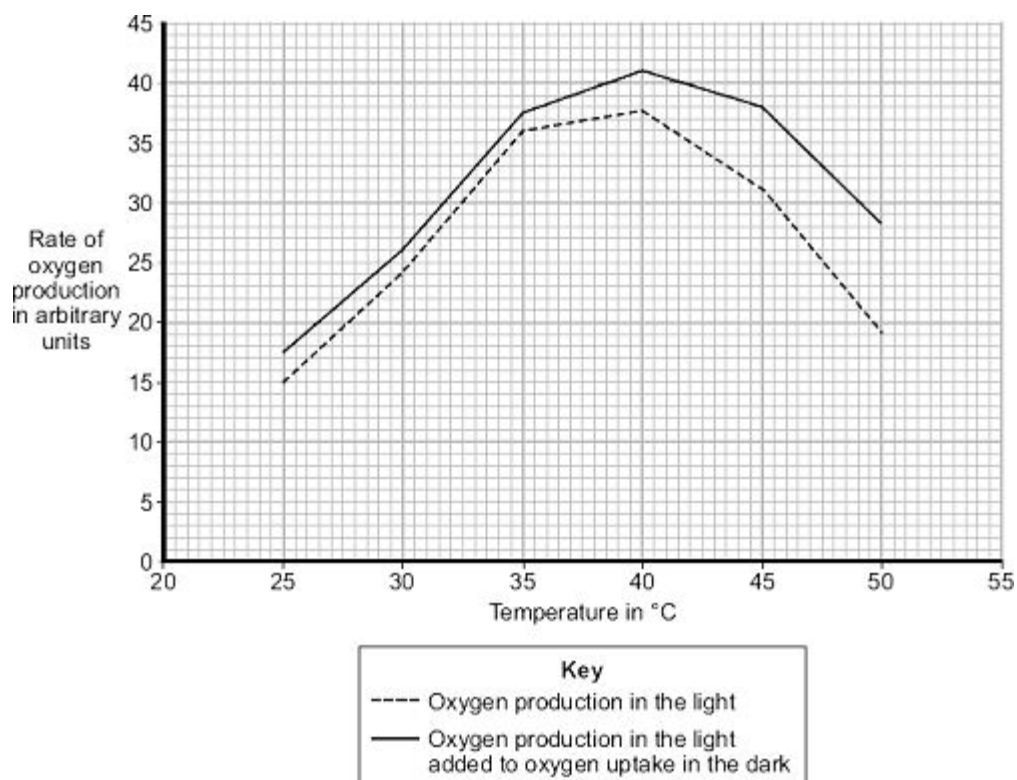
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(2)

- (c) In their investigation, the scientists measured the rate of oxygen release by the leaf discs in the light. The scientists then measured the rate of oxygen uptake by the leaf discs in the dark.

The graph shows the effect of temperature on

- oxygen production in the light
- oxygen production in the light added to oxygen uptake in the dark.



Use the information from the graph to answer each of the following questions.

- (i) Describe the effect of temperature on oxygen production in the light.

.....

.....

.....

.....

(2)

- (ii) Explain the effect of temperature on oxygen production in the light when the temperature is increased:

from 25 °C to 35 °C

.....

.....

.....

from 40 °C to 50 °C.

.....

.....

.....

(2)

- (d) A farmer in the UK wants to grow orange trees in a greenhouse. He wants to sell the oranges he produces at a local market.
He decides to heat the greenhouse to 35 °C.

Explain why he should **not** heat the greenhouse to a temperature higher than 35 °C.
Use information from the graph in your answer.

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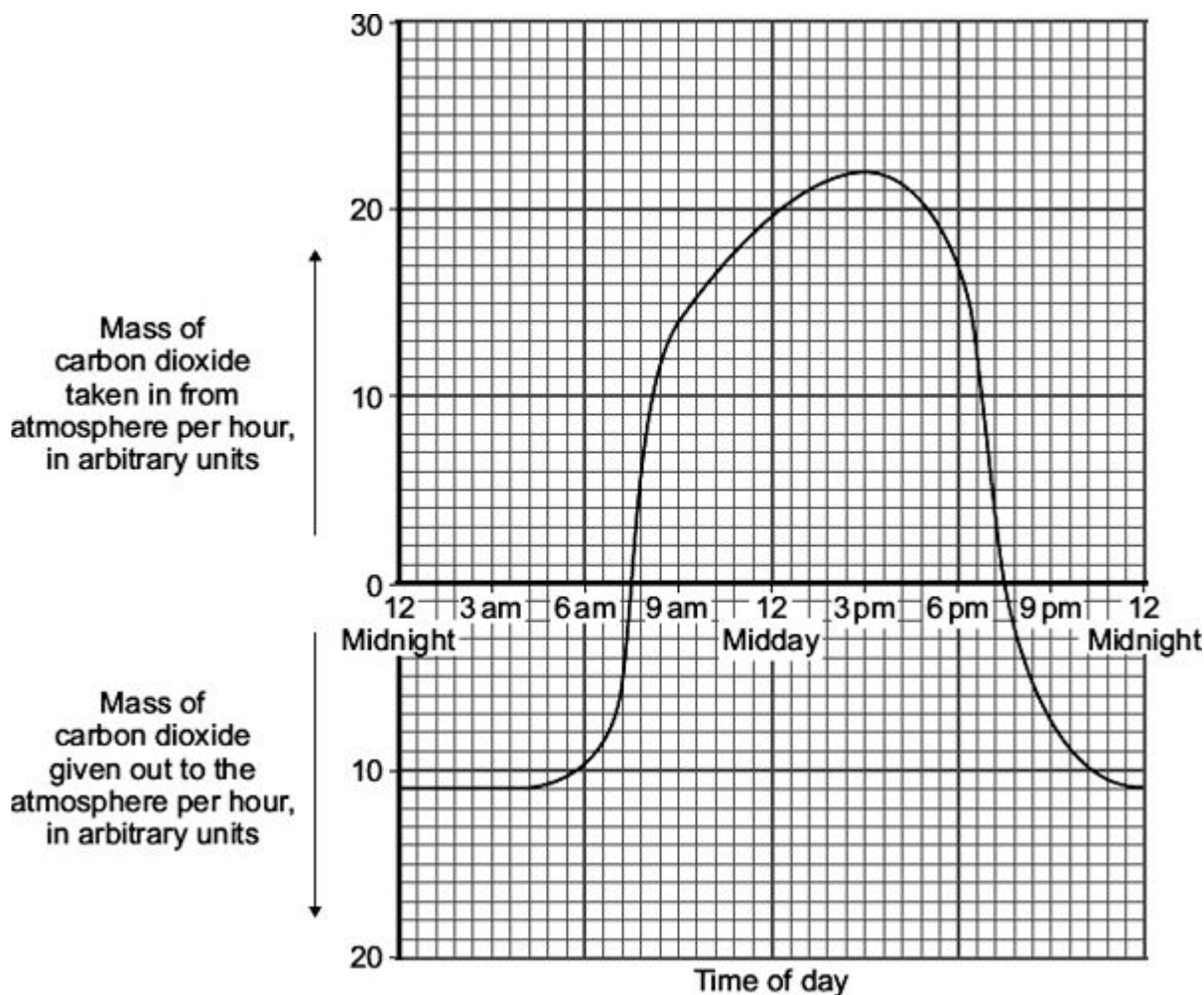
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(3)
(Total 12 marks)

26

The graph shows the uptake of carbon dioxide and the release of carbon dioxide by a bean plant on a hot summer's day.



- (a) At which **two** times in the day did the rate of photosynthesis exactly match the rate of respiration in the bean plant?

1 2

(1)

- (b) The bean plant respire at the same rate all through the 24 hour period.

- (i) How much carbon dioxide is released each hour during respiration?

..... arbitrary units

(1)

- (ii) How much carbon dioxide is used by photosynthesis in the hour beginning at 3 pm?

.....

.....

Answer = arbitrary units

(1)

- (c) Over the 24 hour period, the total amount of carbon dioxide taken in by the bean plant was greater than the total amount of carbon dioxide given out by the bean plant.

Explain, in detail, why this was important for the bean plant.

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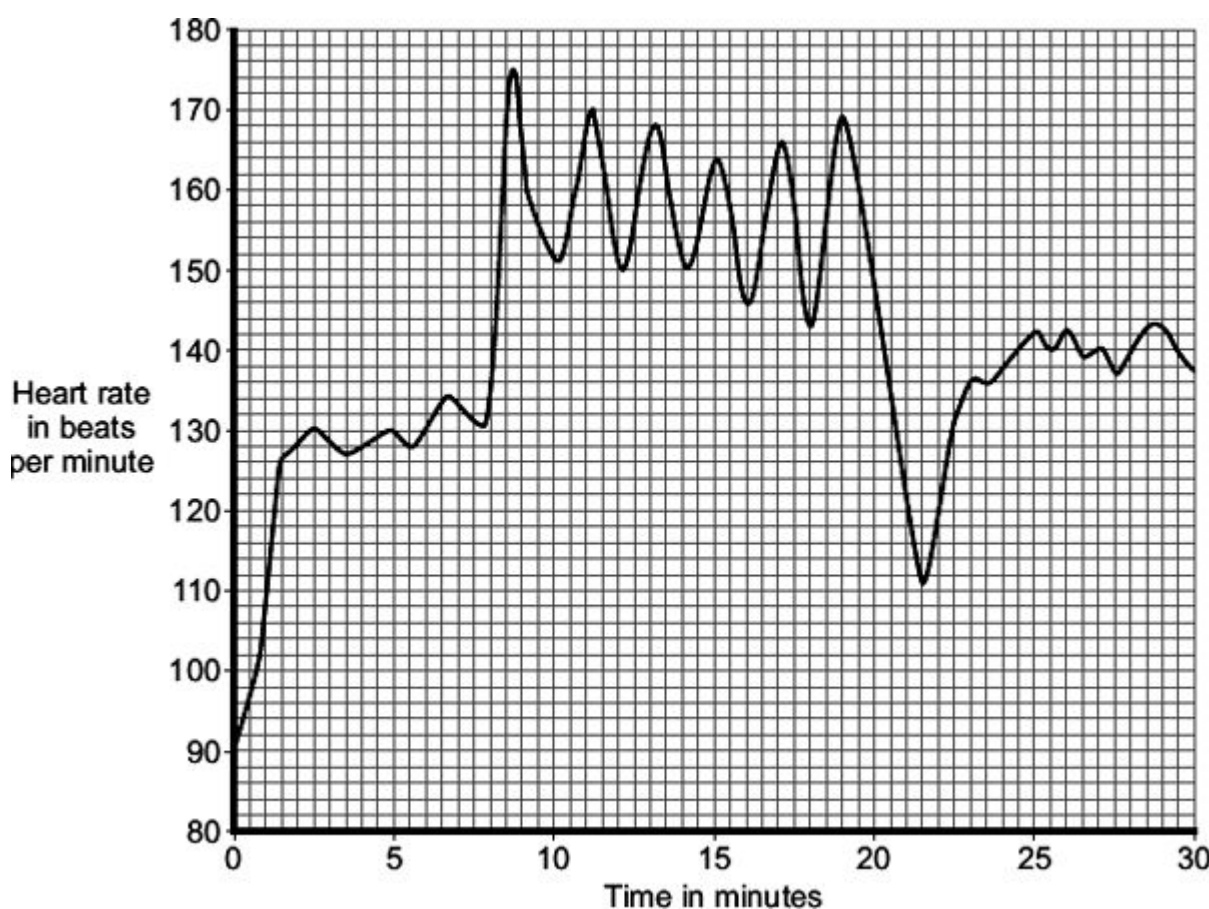
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(2)
(Total 5 marks)

27

One type of training exercise involves alternating periods of walking and running.

The graph shows how an athlete's heart rate changed during one 30-minute training session.



(a) (i) The athlete ran 6 times during the 30-minute training session.

Describe the evidence for this in the graph.

.....
.....

(1)

(ii) Immediately after the final run, the athlete rested for a short time before he started to walk again.

For how many minutes did this rest last?

..... minutes

(1)

- (b) The heart rate increases during exercise.

This increase in heart rate increases blood flow to the muscles.

Explain, as fully as you can, why this increase in heart rate is necessary.

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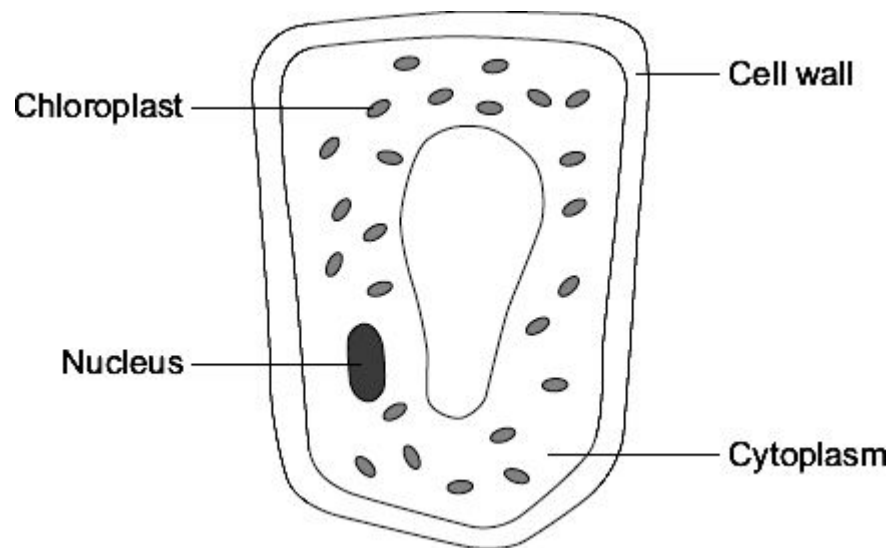
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(4)
(Total 6 marks)

The diagram shows a plant cell from a leaf.



- (a) **List A** gives the names of three parts of the cell.
List B gives the functions of parts of the cell.

Draw a line from each part of the cell in **List A** to its function in **List B**.

List A
Parts of the cell

Nucleus

Cytoplasm

Chloroplast

List B
Functions

Where most of the chemical reactions take place

Absorbs light energy to make food

Strengthens the cell

Controls the activities of the cell

(3)

- (b) Respiration takes place in the cell.

Draw a ring around the correct answer to complete the sentence.

All cells use respiration to release

energy
oxygen.
sugar.

(1)
(Total 4 marks)

29

The table shows the volume of blood flowing through different organs at three levels of exercise.

Organ(s)	Volume of blood flowing through organ(s) in cm ³ per minute		
	Light exercise	Moderate exercise	Heavy exercise
Gut	1 100	600	300
Kidneys	900	600	250
Brain	750	750	750
Heart muscles	350	750	1 000
Skeletal muscles	4 500	12 500	22 000
Skin	1 500	1 900	600
Other	400	500	100
Total	9 500	17 600	25 000

- (a) (i) Which organ has a constant flow of blood through it?

.....

(1)

- (ii) Which organ has the greatest reduction in the volume of blood supplied during heavy exercise compared with light exercise?

.....

(1)

(iii) What proportion of the blood flows through the heart muscle during heavy exercise?

.....

(1)

(b) The volume of blood flowing through the skeletal muscles increases greatly during exercise.

Give **two** ways in which the body brings about this increase.

1

.....

2

.....

(2)

(c) During exercise, the concentration of carbon dioxide in the blood increases.

Explain what causes this increase.

.....

.....

.....

.....

.....

.....

(3)

(Total 8 marks)

30

Muscles need energy during exercise.

Draw a ring around the correct answer in parts (a) and (b) to complete each sentence.

(a) (i) The substance stored in the muscles and used during exercise is

glycogen.

lactic acid.

protein.

(1)

- (ii) The process that releases energy in muscles is

digestion.
respiration.
transpiration.

(1)

- (b) The table shows how much energy is used by two men of different masses when swimming at different speeds.

Speed of swimming in metres per minute	Energy used in kJ per hour	
	34 kg man	70 kg man
25	651	1155
50	1134	2103

- (i) When the 34 kg man swims at 50 metres per minute instead of at 25 metres per minute,

the extra energy he uses each hour is

36 kJ.
483 kJ.
948 kJ.

(1)

- (ii) When swimming at 50 metres per minute, each man's heart rate is faster than when swimming at 25 metres per minute.

A faster heart rate helps to supply the muscles with more

carbon dioxide.
glycogen.
oxygen.

(1)

- (iii) During the exercise the arteries supplying the muscles would

constrict.
dilate.
pump harder.

(1)

- (c) When a person starts to swim, the breathing rate increases.

Give **one** way in which this increase helps the swimmer.

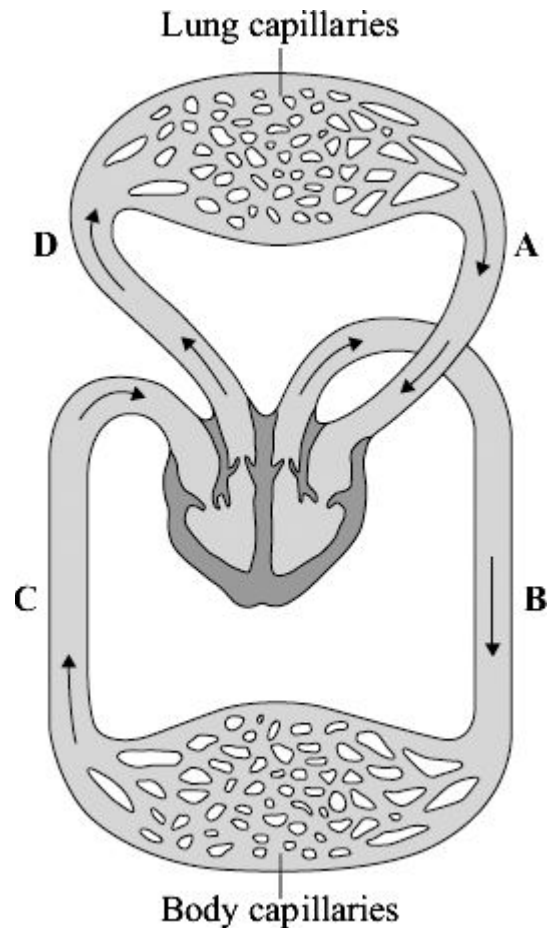
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(1)
(Total 6 marks)

31

The diagram shows the human circulation system.



- (a) (i) Give the letter of **one** blood vessel that is an artery.

(1)

- (ii) Give the letter of **one** blood vessel that carries oxygenated blood.

(1)

- (b) During exercise, the heart rate increases.

Explain, as fully as you can, why this increase is necessary.

.....

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(4)
(Total 6 marks)

32

Lactic acid production during exercise affects an athlete's performance.

Explain why lactic acid is produced during exercise.

.....

.....

.....

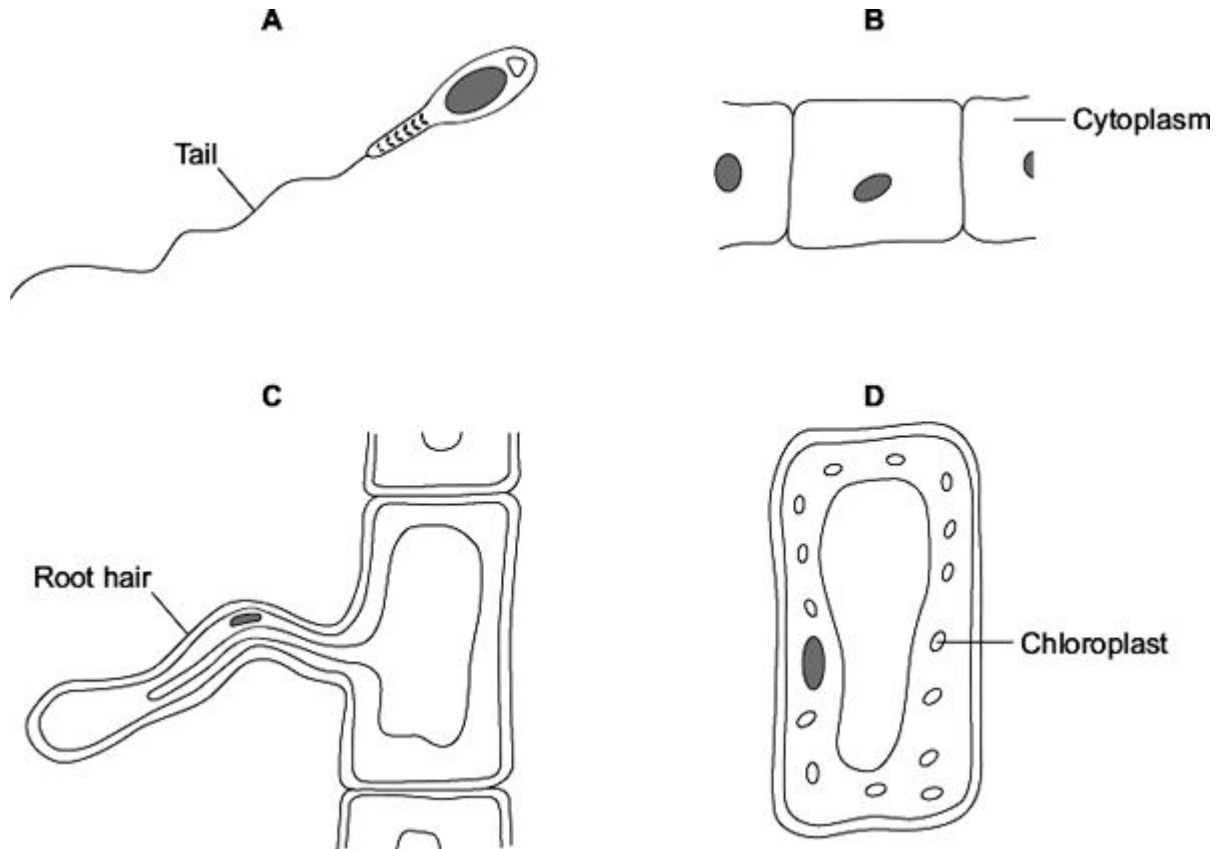
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(Total 2 marks)

33

The diagrams show four types of cell, **A**, **B**, **C** and **D**.
Two of the cells are plant cells and two are animal cells.



- (a) (i) Which **two** of the cells are plant cells?

Tick (✓) **one** box.

A and B

☐

A and D

☐

C and D

☐

(1)

- (ii) Which part is found **only** in plant cells?

Draw a ring around **one** answer.

cell membrane

cell wall

nucleus

(1)

- (b) (i) Which cell, **A**, **B**, **C** or **D**, is adapted for swimming?

(1)

- (ii) Which cell, **A**, **B**, **C** or **D**, can produce glucose by photosynthesis?

(1)

- (c) Cells **A**, **B**, **C** and **D** all use oxygen.

For what process do cells use oxygen?

Draw a ring around **one** answer.

osmosis

photosynthesis

respiration

(1)

(Total 5 marks)

34

This question is about what happens during decay.

Draw a ring around the correct word to complete each sentence.

- (a) After living things die, they are decayed by

animals.
microorganisms.
plants.

(1)

- (b) Decay happens faster when there is plenty of oxygen and conditions are

cold.
dry.
moist.

(1)

- (c) During decay carbon dioxide is produced by

osmosis.
respiration.
photosynthesis.

(1)

(d) Decay releases mineral salts into the soil.

These mineral salts are absorbed by plant

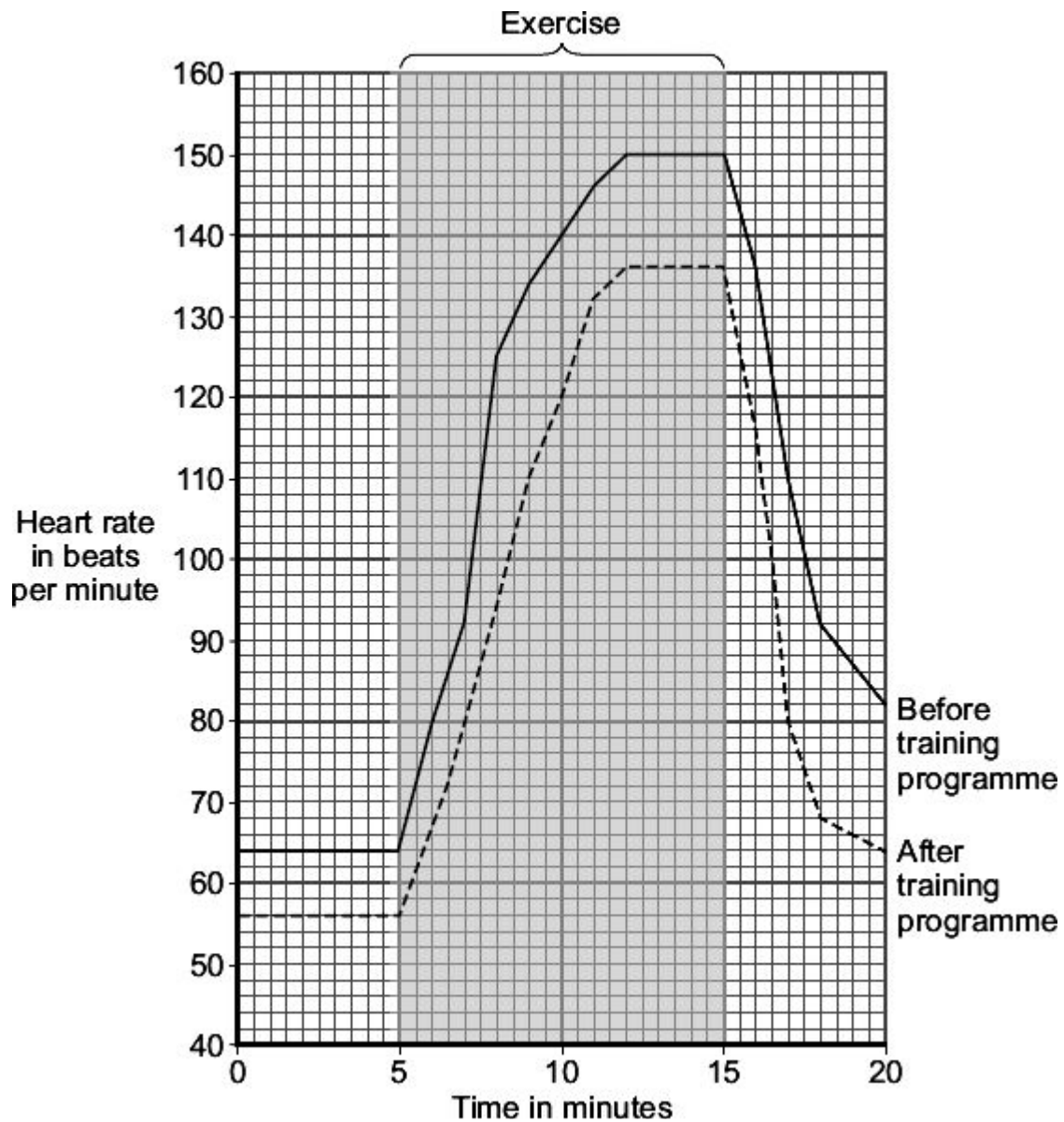
leaves.
roots.
stems.

(1)
(Total 4 marks)

35

An athlete did a 6-month training programme.

The graph shows the effect of the same amount of exercise on his heart rate before and after the training programme.



- (a) (i) What was the maximum heart rate of the athlete during exercise before the training programme?

..... beats per minute

(1)

- (ii) Give **two** differences between the heart rate of the athlete before and after the training programme.

After the training programme

Difference 1

.....

Difference 2

.....

(2)

- (b) Which **two** substances need to be supplied to the muscles in larger amounts during exercise?

Tick (✓) **two** boxes.

Carbon dioxide

☐

Glucose

☐

Lactic acid

☐

Oxygen

☐

Urea

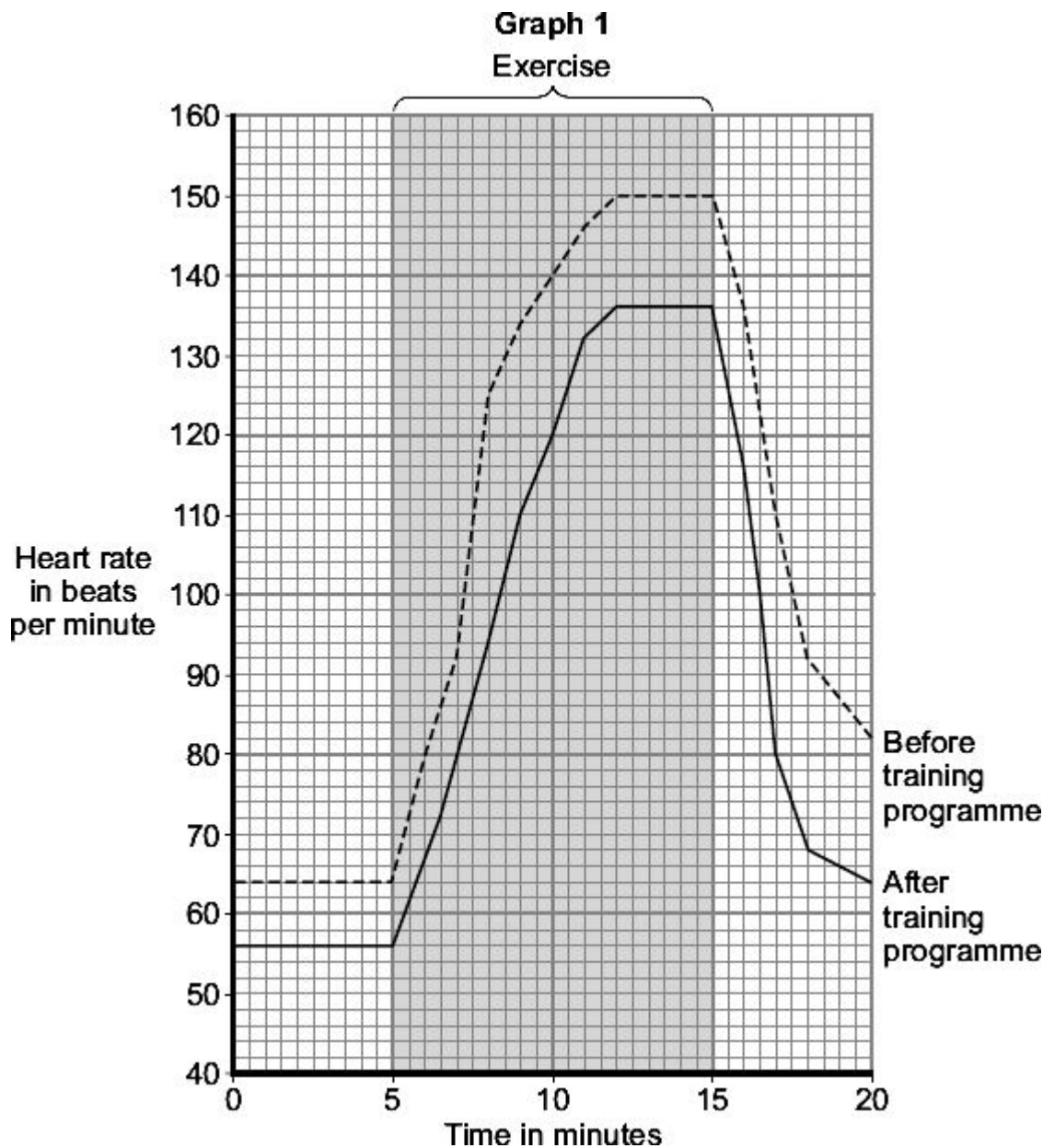
☐

(2)
(Total 5 marks)

36

An athlete carried out a 6-month training programme.

Graph 1 shows the effect of the same amount of exercise on his heart rate before and after the training programme.



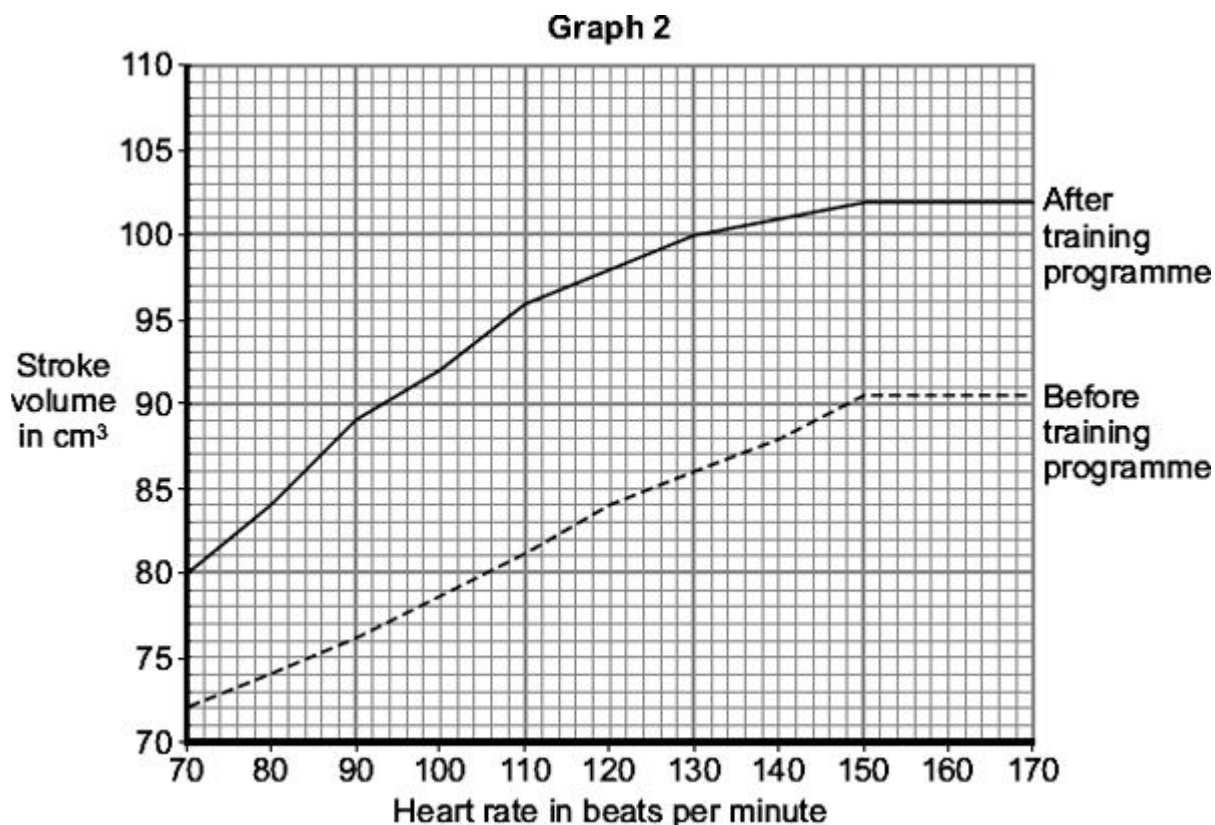
- (a) (i) Use **Graph 1** to find the heart rate of the **trained** athlete 5 minutes after the start of the exercise.

Heart rate = beats per minute

(1)

The stroke volume of the heart is the volume of blood pumped out of the left side of the heart in one heart beat.

Graph 2 shows the relationship between the stroke volume and the heart rate before and after the athlete did the training programme.



- (ii) The *cardiac output* is defined as

$$\text{cardiac output} = \text{heart rate} \times \text{stroke volume}$$

Calculate the cardiac output of the **trained** athlete 5 minutes after the start of the exercise. Use your answer to part (a)(i), and information from **Graph 2**.

Show clearly how you work out your answer.

.....

.....

Cardiac output = cm³ blood per minute

(2)

- (b) **Graph 1** shows that, for the same amount of exercise, the heart of the trained athlete was beating more slowly than it did before the training programme.

Use information from **Graph 2** to explain why.

.....

.....

.....

.....

(2)

- (c) An increased cardiac output will provide more oxygen and more glucose to the working muscles.

Explain how this helps the athlete during exercise.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(Total 9 marks)

37

- (a) The table shows the effect of exercise on the action of one person's heart.

	At rest	During exercise
Heart rate in beats per minute	72	165
Volume of blood leaving the heart in each beat in cm^3	75	120
Heart output in cm^3 per minute	5400	

- (i) Calculate the heart output for this person during exercise.

Show clearly how you work out your answer.

.....

.....

.....

.....

Answer = cm^3 per minute

(2)

- (ii) During exercise, more oxygen is carried to the working muscles.

Explain why this is helpful during exercise.

.....

.....

.....

.....

.....

(2)

- (b) Give **two** other changes in the body that help to increase the amount of oxygen delivered to the working muscles during exercise.

1

.....

2

.....

(2)

(Total 6 marks)

38

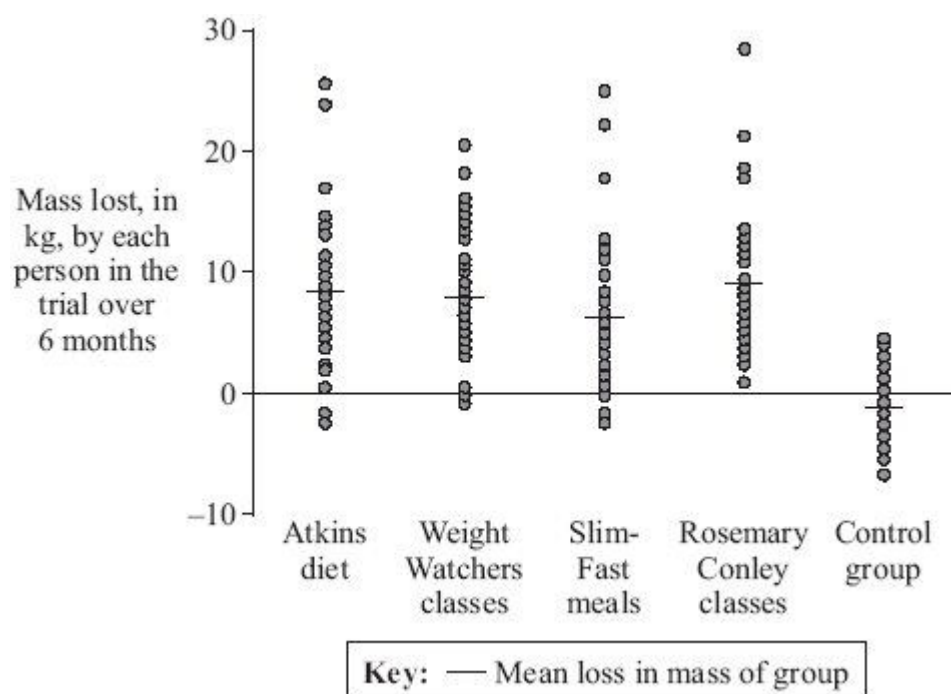
Many people who are overweight try slimming programmes.

A research study evaluated four different slimming programmes over 6 months.

Scientists selected a group of 40 people for each slimming programme and a control group.

Each of the five groups was matched for age, gender and mass.

The graph shows the results of the study.



Adapted from British Medical Journal, 2006, volume 332, pages 1309 –1314.

- (a) Give **two** control variables that were used in this study.

1

2

(2)

- (b) Give **two** conclusions that can be drawn from the results of this study.

1

.....

2

.....

(2)

- (c) The costs of the four programmes were:

- Atkins book cost £3
- Rosemary Conley classes cost £140 for 6 months
- Weight Watchers classes cost £170 for 6 months
- Twice-daily Slim-Fast meal replacements cost £240 for 6 months.

Use this information and the graph to answer this question.

Which is the most cost effective of the four programmes?

.....

Explain the reason for your answer.

.....

.....

.....

.....

(2)

- (d) Some slimming programmes include daily exercise.

Explain how daily exercise helps a person to lose mass.

.....

.....

.....

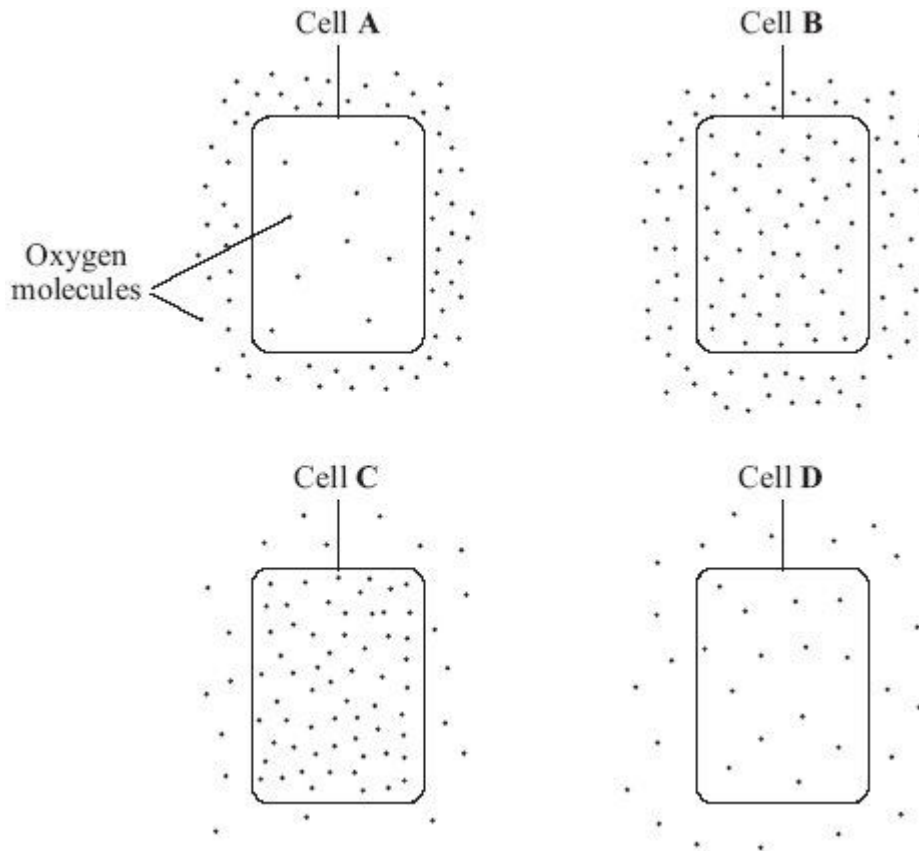
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(2)

(Total 8 marks)

39

- (a) The diagrams show cells containing and surrounded by oxygen molecules. Oxygen can move into cells or out of cells.



Into which cell, **A**, **B**, **C** or **D**, will oxygen move the fastest?

Write your answer, **A**, **B**, **C** or **D**, in the box.

(1)

- (b) Draw a ring around the correct word to complete each sentence.

- (i) Oxygen is taken into cells by the process of

diffusion
osmosis
respiration

(1)

- (ii) Cells need oxygen for

breathing
photosynthesis
respiration

(1)

(iii) The parts of cells that use up the most oxygen are the

membranes
mitochondria
nuclei

(1)

(iv) Some cells produce oxygen in the process of

diffusion
photosynthesis
respiration

(1)

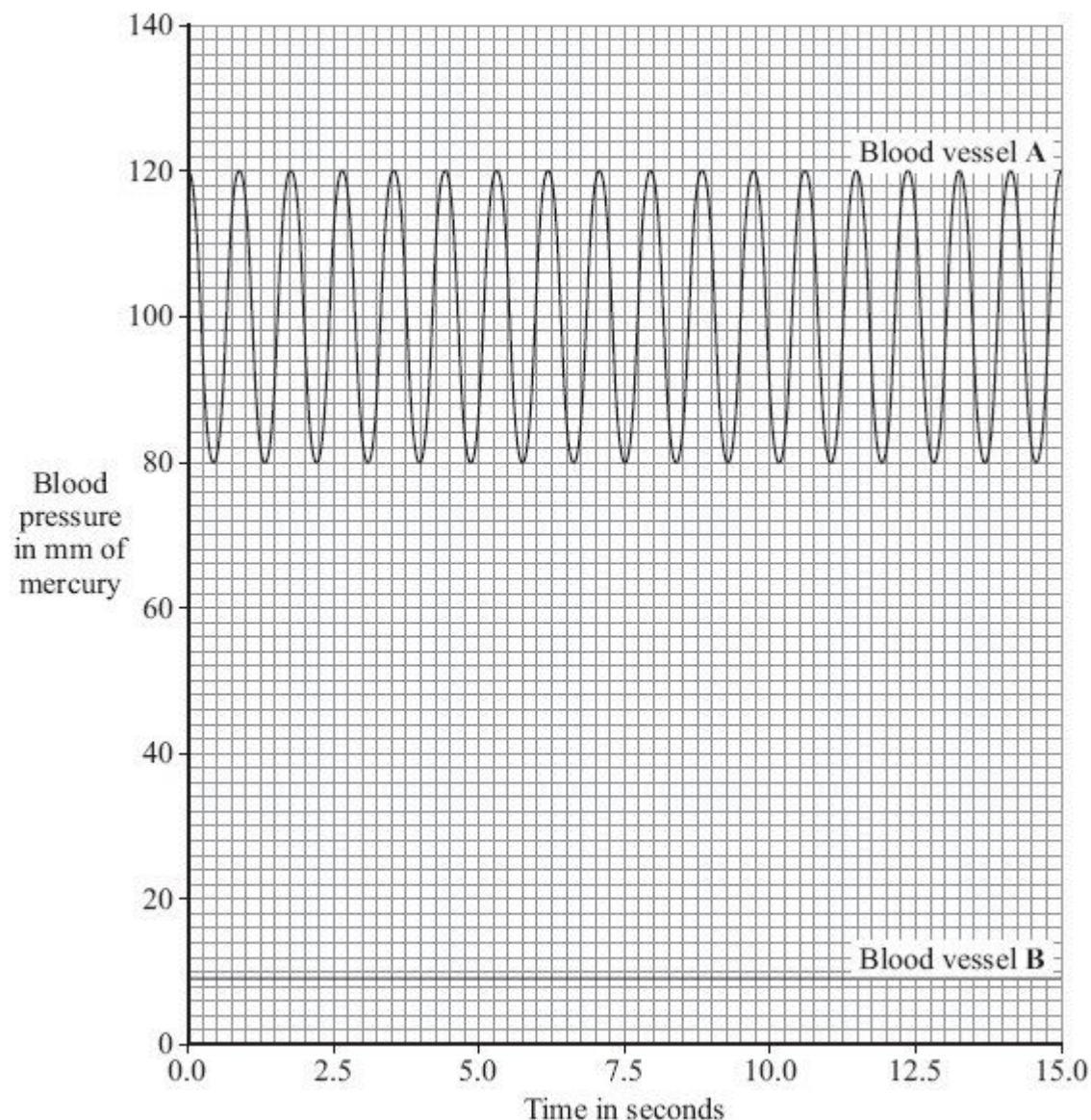
(Total 5 marks)

40

The heart pumps blood around the body. This causes blood to leave the heart at high pressure.

The graph shows blood pressure measurements for a person at rest.

The blood pressure was measured in an artery and in a vein.



- (a) Which blood vessel, **A** or **B**, is the artery?

Blood vessel

Give **two** reasons for your answer.

Reason 1

.....

Reason 2

.....

(2)

(b) Use information from the graph to answer these questions.

(i) How many times did the heart beat in 15 seconds?

(1)

(ii) Use your answer from part (b)(i) to calculate the person's heart rate per minute.

.....

.....

Heart rate = beats per minute

(1)

(c) During exercise, the heart rate increases. This supplies useful substances to the muscles and removes waste materials from the muscles at a faster rate.

(i) Name **two** useful substances that must be supplied to the muscles at a faster rate during exercise.

1

2

(2)

(ii) Name **one** waste substance that must be removed from the muscles at a faster rate during exercise.

.....

(1)

(Total 7 marks)

41

- (a) The concentration of sulfate ions was measured in the roots of barley plants and in the water in the surrounding soil.

The table shows the results.

	Concentration of sulfate ions in mmol per dm ³
Roots of barley plants	1.4
Soil	0.15

Is it possible for the barley roots to take up sulfate ions from the soil by diffusion?

Draw a ring around your answer. **Yes / No**

Explain your answer.

.....

.....

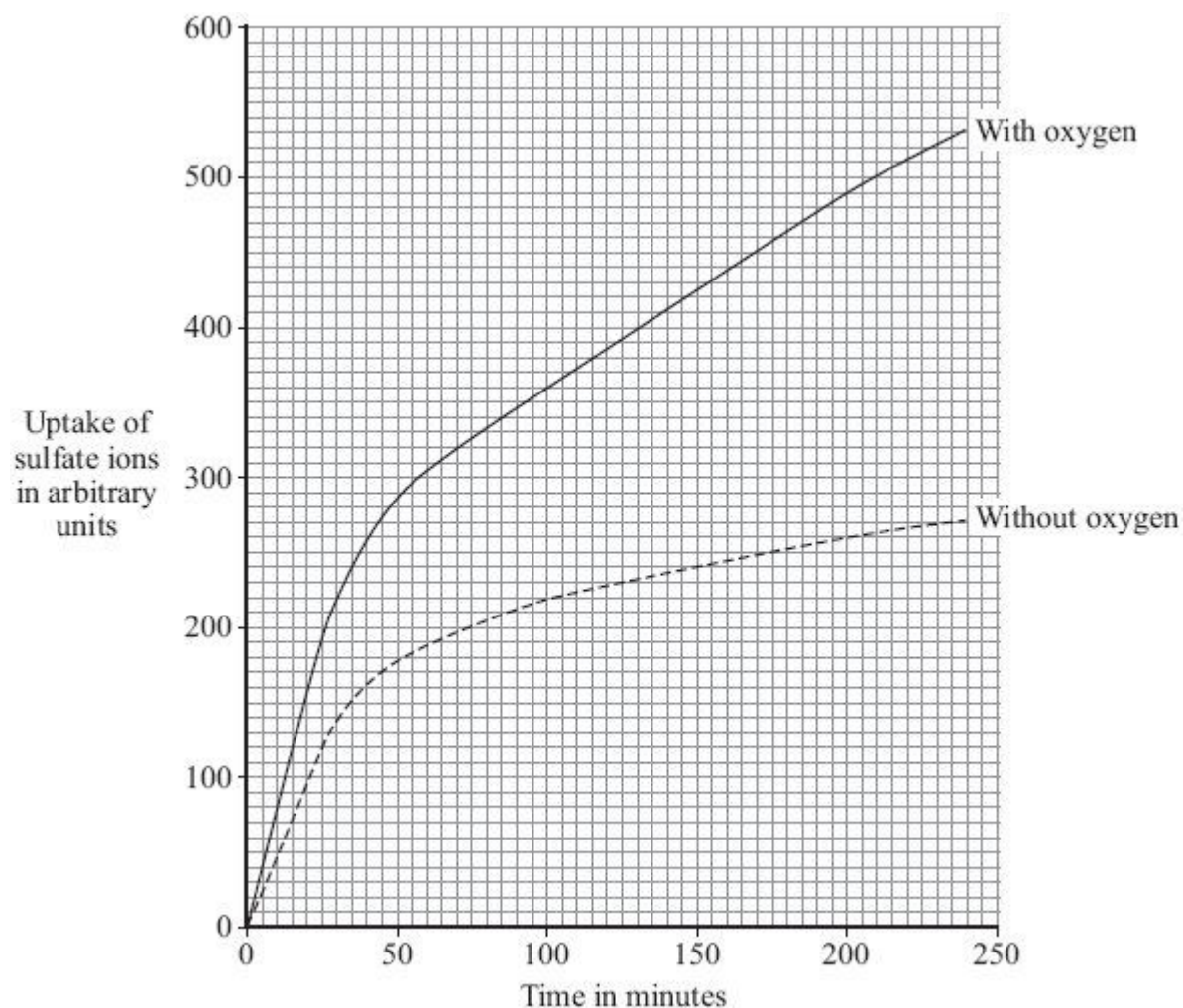
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(2)

- (b) Some scientists investigated the amounts of sulfate ions taken up by barley roots in the presence of oxygen and when no oxygen was present.

The graph below shows the results.



- (i) The graph shows that the rate of sulfate ion uptake between 100 and 200 minutes, **without** oxygen, was 0.4 arbitrary units per minute.

The rate of sulfate ion uptake between 100 and 200 minutes, **with** oxygen, was greater.

How much greater was it? Show clearly how you work out your answer.

.....

Answer arbitrary units

(2)

- (ii) The barley roots were able to take up more sulfate ions with oxygen than without oxygen.

Explain how.

.....

.....

.....

.....

.....

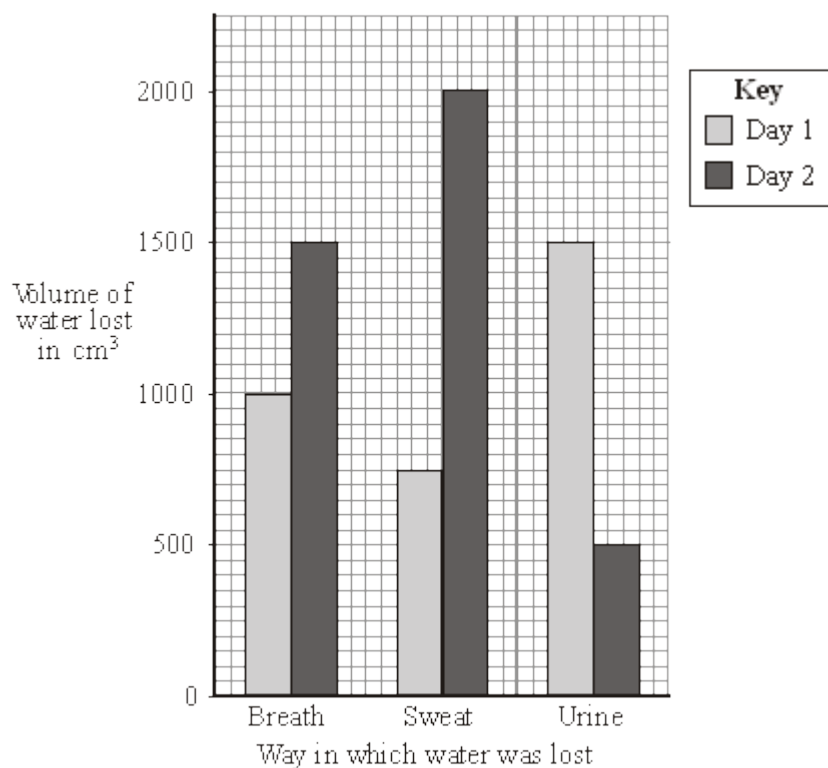
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(3)
(Total 7 marks)

42

The bar chart shows the amount of water lost from the body of a student on two different days.

The student ate the same amount of food and drank the same amount of liquid on the two days. The temperature of the surroundings was similar on the two days.



- (a) The total volume of water lost on day 1 was 3250 cm³.

How much water was lost on day 2? Show all your working.

.....

..... cm³

(2)

- (b) The student did much more exercise on one of the days than on the other.

On which day did he do more exercise? Day

Give **two** reasons for your answer.

1

.....

2

.....

(2)

- (c) (i) Which **one** of these is a chemical reaction that produces water in the body?

Put a tick (✓) in the box next to your choice.

Breathing ☐

Osmosis ☐

Respiration ☐

Sweating ☐

(1)

- (ii) How does sweating help the body?

.....

.....

(1)

- (iii) If the body loses more water than it gains, it becomes dehydrated.
The concentration of the solution surrounding the body cells increases.
This causes the cells to lose water.

By which process do cells lose water?

Put a tick (✓) in the box next to your choice.

Breathing ☐

Osmosis ☐

Respiration ☐

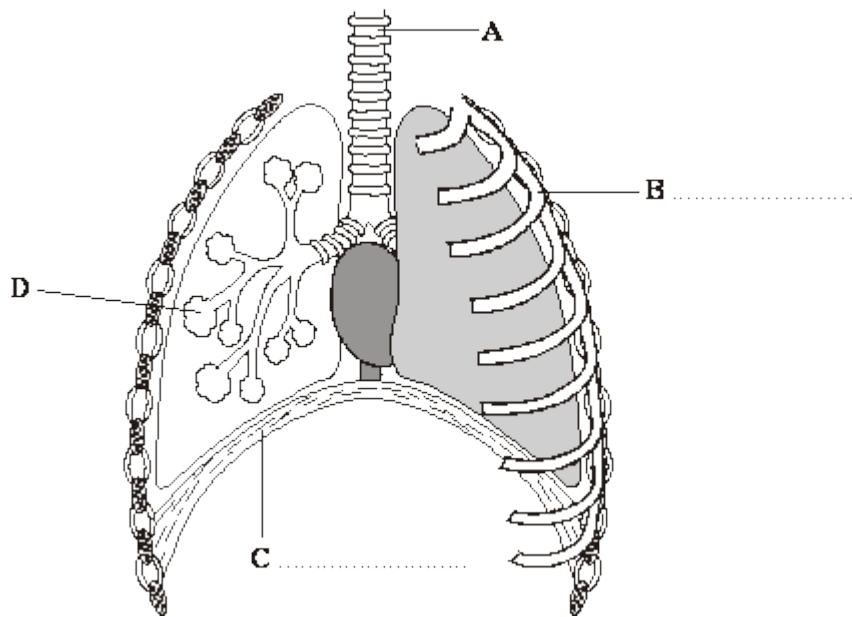
Sweating ☐

(1)

(Total 7 marks)

43

The diagram shows the human breathing system.



- (a) On the diagram, label structures **B** and **C**.

Choose your answers from the list in the box.

alveoli	diaphragm	rib	trachea
---------	-----------	-----	---------

(2)

- (b) (i) Which letter, **A**, **B**, **C** or **D**, shows the site of gas exchange?

(1)

- (ii) Which **one** of the following gases has a higher concentration in exhaled air than in inhaled air?

Draw a circle around **one** answer.

carbon dioxide

nitrogen

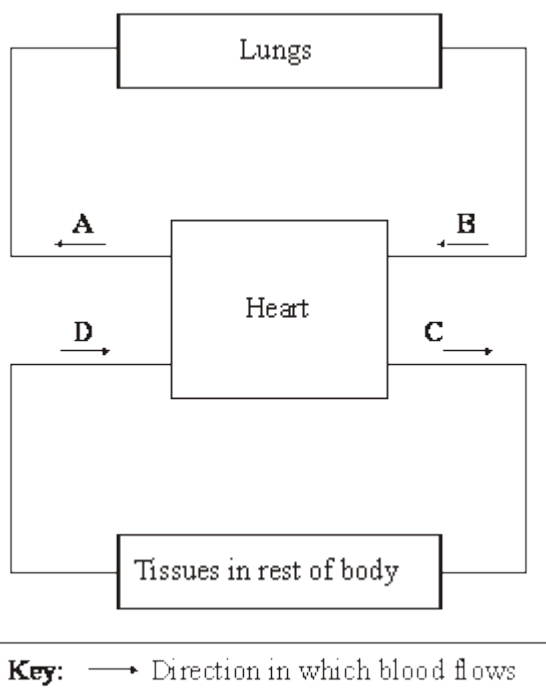
oxygen

(1)

(Total 4 marks)

44

The diagram represents the human blood circulation system.



(a) **A, B, C** and **D** are blood vessels.

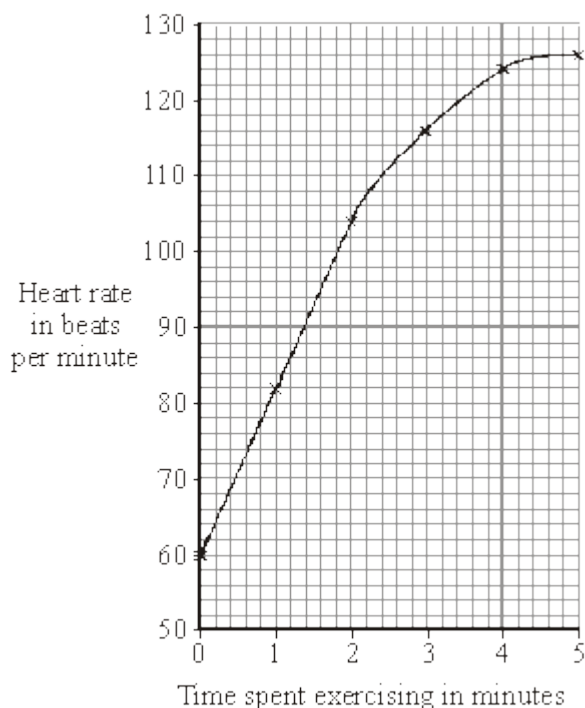
(i) Give the letter of **one** blood vessel that is an artery.

(1)

(ii) Give the letter of **one** blood vessel that is a vein.

(1)

(b) A student pedalled an exercise cycle at constant speed for 5 minutes. The student's heart rate was recorded at one-minute intervals during the exercise. The results are shown in the graph.



(i) What was the student's heart rate before the exercise began?

..... per minute

(1)

(ii) How long was it before the student's heart rate reached 124 beats per minute?

..... minutes

(1)

(c) Which of the following parts of the blood carries most oxygen?

Draw a circle around **one** answer.

plasma

red blood cells

white blood cells

(1)

(Total 5 marks)