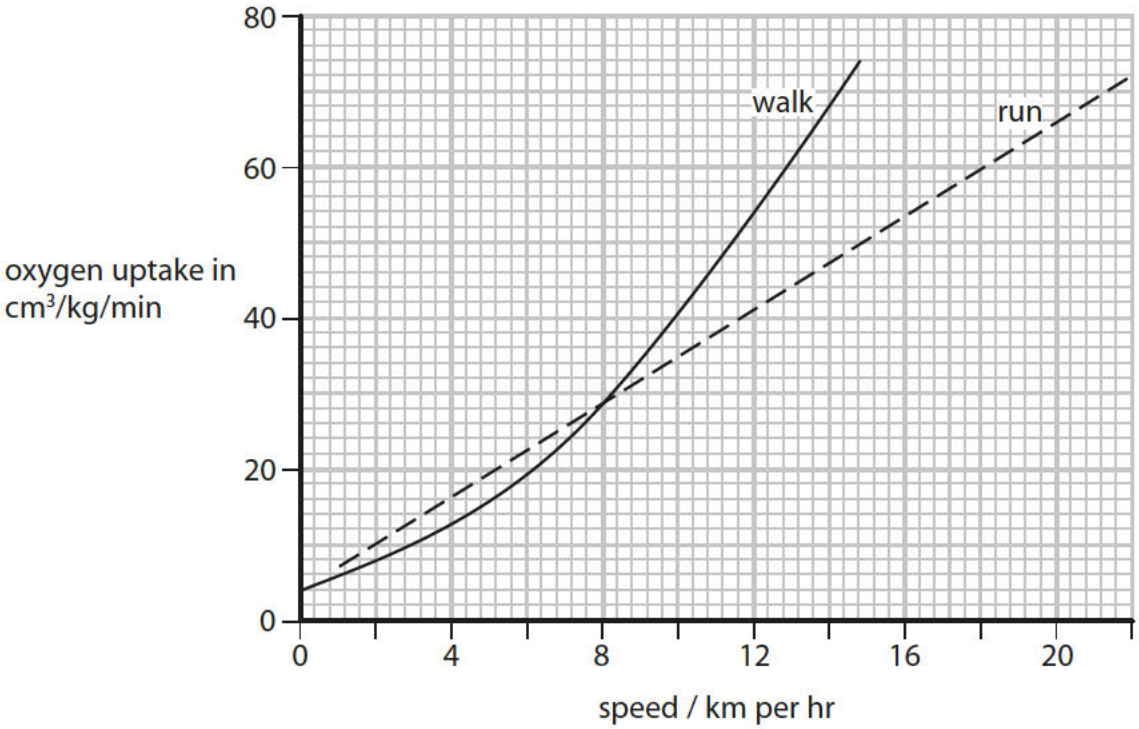
1 The graph shows the oxygen uptake for an athlete when walking and running.



(a) Compare the oxygen uptake when the athlete is walking and running at speeds from 6 to 10 km per hour.

(3)

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(b) (i) Complete the word equation for aerobic respiration.

(1)

oxygen + glucose ⟶ ..... + ...

(ii) Explain why oxygen uptake increases as an athlete runs at faster speeds.

(2)

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(iii) When athletes train hard they can respire anaerobically.

Which of the following statements about anaerobic respiration are true?

1. Lactic acid and carbon dioxide are produced.
2. Lactic acid can build up causing cramp.

Put a cross (☒) in the box next to your answer.

(1)

☐ **A** statement 1 only

☐ **B** statement 2 only

☐ **C** both statement 1 and 2

☐ **D** neither statement 1 nor 2.

(c) The heart rate and stroke volume of an athlete training at a high intensity were measured and their cardiac output was calculated.

The table shows the measurements before, after 2 weeks and after 4 weeks of training.

	heart rate / beats per minute	**stroke volume / dm^3**	**cardiac output / dm^3 per minute**
Before training	142	0.08	11.4
After 2 weeks training	164	0.10	16.4
After 4 weeks training		0.12	24.0

(i) Calculate the heart rate after 4 weeks of training.

(2)

..... beats per minute

(ii) Explain how the higher cardiac output after 4 weeks of training increased the rate of aerobic respiration.

(2)

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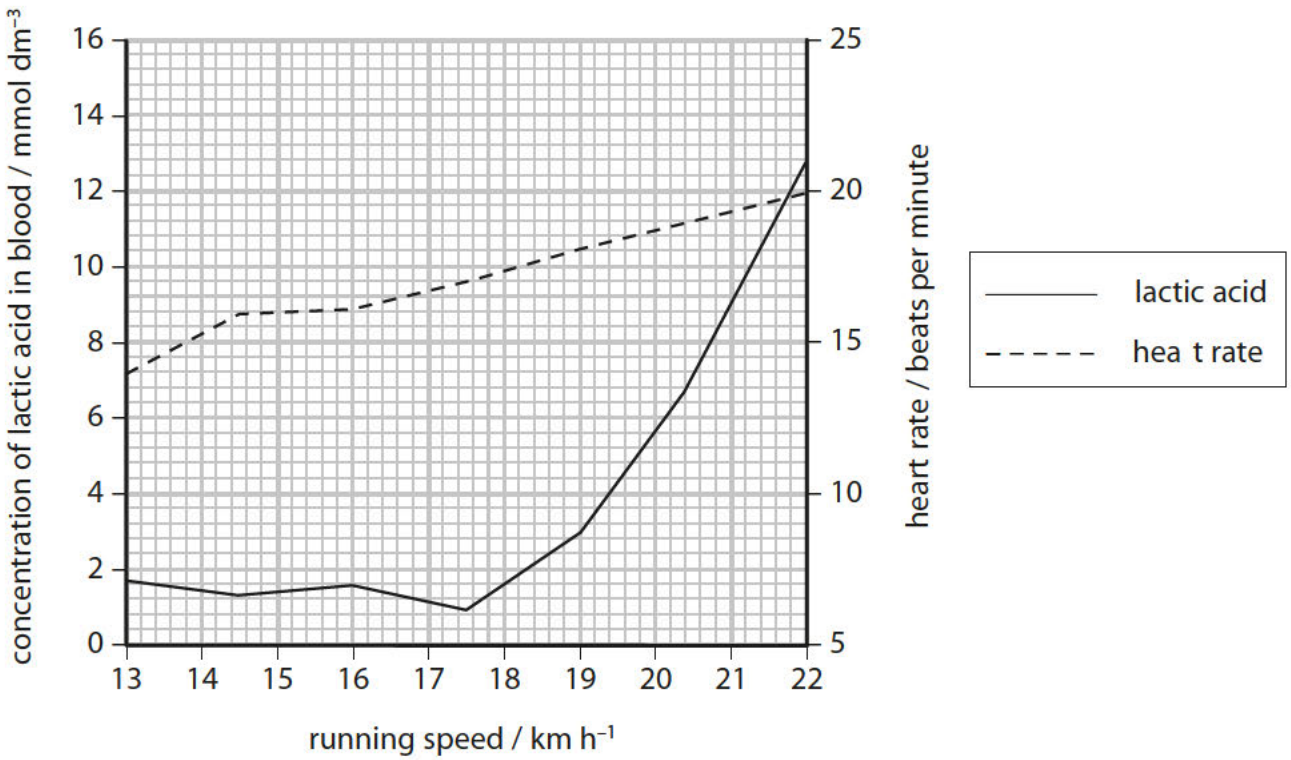
(Total for Question 1 = 11 marks)

2 In an investigation, a person ran at different speeds.

(a) The graph shows the concentration of lactic acid in the blood and the heart rate of this person while running.



(i) When the running speed is 22 km h^{-1}, the stroke volume of the runner is 0.18 dm^3.

Calculate the cardiac output of the runner using the equation.

cardiac output = stroke volume × heart rate

(2)

answer = ... dm^3 per minute

(ii) Complete the sentence by putting a cross (☒) in the box next to your answer.

When the heart rate is at its maximum the concentration of lactic acid in the blood is

(1)

☒ **A** 11.2 mmol dm^{-3}

☒ **B** 12.8 mmol dm^{-3}

☒ **C** 200.0 mmol dm^{-3}

☒ **D** 210.0 mmol dm^{-3}

(iii) Complete the sentence by putting a cross (☒) in the box next to your answer.

(1)

The graph shows that

☒ **A** as the heart rate increases the concentration of lactic acid increases

☒ **B** as the concentration of lactic acid increases the heart rate decreases

☒ **C** the concentration of lactic acid increases as running speed increases

☒ **D** the concentration of lactic acid is not dependent on heart rate

(iv) Explain why the concentration of lactic acid changes at running speeds greater than 18 km h^{-1}.

(3)

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(b) After running the person rested.

Explain why the concentration of lactic acid in the blood changes whilst resting.

(3)

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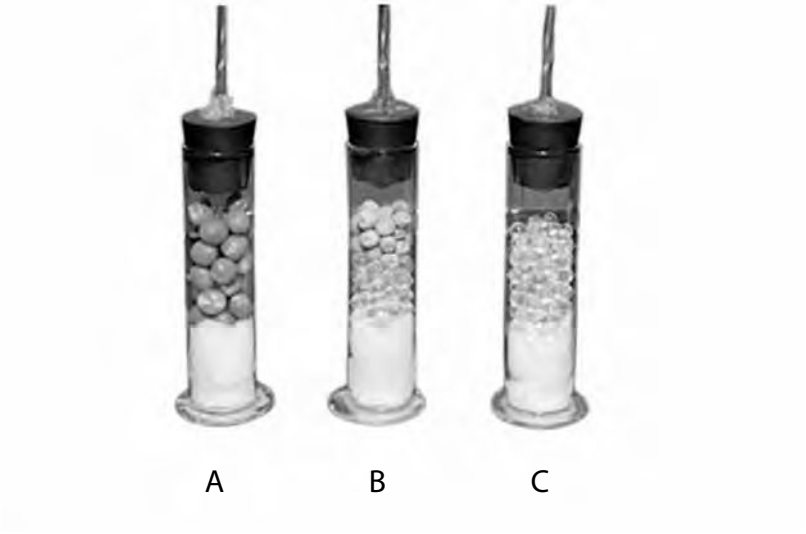
(Total for Question 2 = 10 marks)

3 Figure 11 shows the equipment used for measuring respiration in peas.



(Source: Martin Shields/Science Photo Library)

Figure 11

- Respirometer A contains germinating peas.
- Respirometer B contains peas that are not germinating.
- Respirometer C contains glass beads.

All three respirometers are placed in a water bath at 25 °C for 30 minutes.
The reduction in oxygen levels in each respirometer is measured using a data logger.

(a) Explain why the respirometers are placed in a water bath at 25 °C.

(2)

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(b) A student recorded the change in oxygen levels in the germinating peas over a 30-minute period.

The results are shown below.

A 10 mins (–0.8) ml, 20 mins (–1.6) ml, 30 mins (–2.4) ml

B 10 mins (–0.1) ml, 20 mins (–0.1) ml, 30 mins (–0.1) ml

C No change

(i) Complete the table for these results.

(2)

(ii) Calculate the rate of oxygen consumption per second for the results in respirometer A.

(2)

..... ml/second

(iii) Explain why respirometer A has the highest rate of oxygen consumption.

(2)

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(c) Some respirometers read the movement of a bubble along capillary tubing.

Carbon dioxide can affect the measuring of oxygen used in this type of respirometer.

State a chemical that could be placed in the respirometer that would stop carbon dioxide affecting the experiment.

(1)

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(Total for Question 3 = 9 marks)