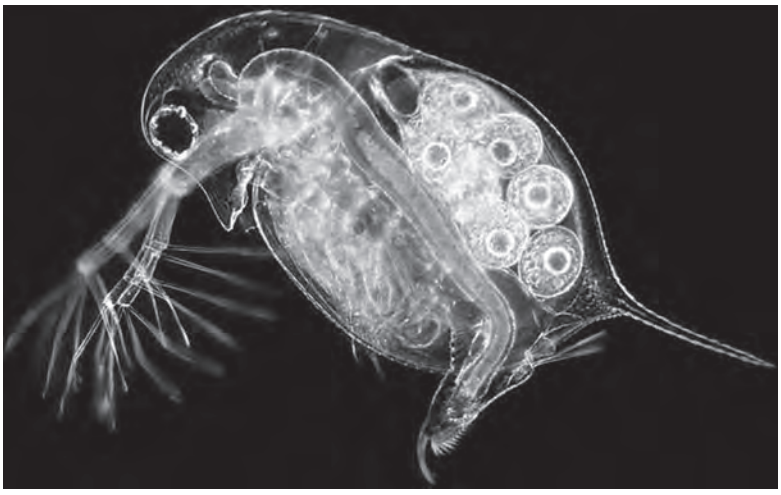
1 The photograph below shows *Daphnia* (a water flea). *Daphnia* can be used to investigate the effect of chemicals on heart rate.



Magnification ×30

(a) (i) Give **two** reasons why *Daphnia* is a suitable organism for investigating the effect of chemicals on heart rate.

(2)

1 .....

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2 .....

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(ii) State **two** variables that you would need to control for a valid investigation into the effect of caffeine on the heart rate of *Daphnia*.

Describe how to control each of these variables.

(4)

1. Variabl .....

How to control .....

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2. Variabl .....

How to control .....

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(b) Explain why many small animals, such as *Daphnia,* have a heart.

(3)

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(Total for Question 1 = 9 marks)

2 Physiological changes occur when a person carries out a period of exercise, such as running 800 metres.

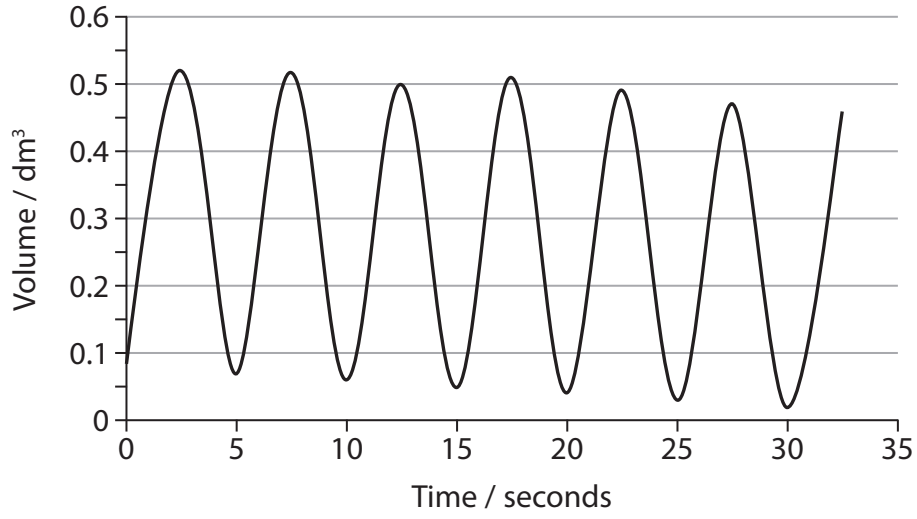
(a) One physiological change will be an increase in cardiac output.

Describe the changes in the heart that bring about an increase in cardiac output.

(4)

(b) The respiratory system will also undergo physiological changes during a period of exercise.

The spirometer trace shown below was recorded when an adult was at rest. This trace can be used to calculate the resting breathing rate and tidal volume of the adult.



(i) Place a cross in the box (☒) that correctly identifies the approximate value for resting breathing rate and tidal volume for this adult.

(2)

Approximate value for	**0.1 dm^3**	**0.5 dm^3**	**6 dm^3 min^{-1}**	**6 breaths min^{-1}**	**12 breaths min^{-1}**
Resting breathing rate	☒	☒	☒	☒	☒
Resting tidal volume	☒	☒	☒	☒	☒

(ii) Describe how a spirometer trace recorded immediately after a short period of exercise would differ from this trace.

(2)

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(c) A student used a spirometer to compare the resting breathing rate of musicians who play trumpets with musicians who play violins.

Suggest **two** variables the student should have considered when selecting the musicians, to make the study valid.

(2)

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(Total for Question 2 = 10 marks)

3 Human hearts contain muscle that is myogenic. Exercise and other activities can affect heart rate.

(a) Explain what is meant by the term **myogenic**.

(2)

(b) Explain how an electrocardiogram (ECG) can be used to calculate a person's heart rate.

(3)

*(c) Workers in the brewing industry may be at risk due to the carbon dioxide released by yeast fermentation.

Atmospheric air contains between 0.03% and 0.04% carbon dioxide.

A concentration of 5% carbon dioxide in the air causes a change in the heart rate of people exposed to this concentration.

Explain why a carbon dioxide concentration of 5% causes a change in heart rate.

(5)

(Total for Question 3 = 10 marks)

4 A human heart can work effectively for over a hundred years but many people throughout the world have heart problems.

(a) Explain how the sinoatrial node (SAN) ensures that oxygenated blood enters the aorta.

(4)

*(b) The treadmill test can be used to diagnose heart problems.

This test requires a person to walk on a treadmill whilst an electrocardiogram (ECG) is recorded.

The angle of the treadmill is raised to increase the level of exercise. The photograph below shows a person carrying out the treadmill test.

Explain how the heart rate of this person is controlled as the level of exercise increases during this test.

(6)

(c) The ECG below was recorded at rest.

(i) This person had a resting heart rate of 74 beats per minute.

Calculate the time taken for this ECG. Show your working.

(2)

Answer .....

(ii) Suggest suitable units for the vertical axis (*y*-axis) of this ECG.

(1)

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(Total for Question 4 = 13 marks)