Q1.

(a) Give the pathway a red blood cell takes when travelling in the human circulatory system from a kidney to the lungs.

Do **not** include descriptions of pressure changes in the heart or the role of heart valves in your answer.

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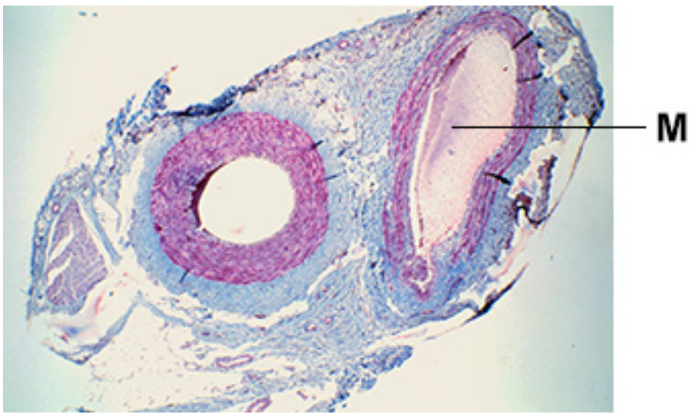
(3)

The figure below shows a section through two types of blood vessels observed using an optical microscope.



(b) Identify the type of blood vessel labelled **M** in the figure above.

Explain your answer.

Type of blood vessel ____

Explanation ____

____

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(2)

(c) Tissue fluid is formed from blood at the arteriole end of a capillary bed.

Explain how water from tissue fluid is returned to the circulatory system.

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(4)
(Total 9 marks)

Q2.

A student dissected an organ from a mammal to observe blood vessels.

He dissected a slice of the organ and identified two blood vessels.

Figure 1 shows a photograph of his dissection.

Figure 1

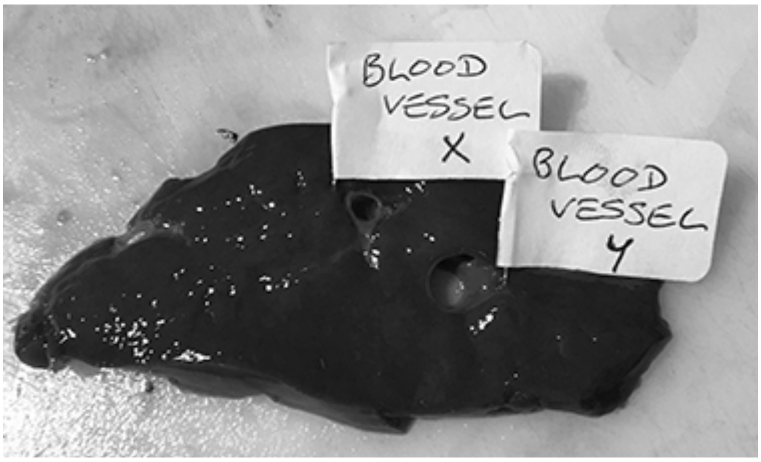
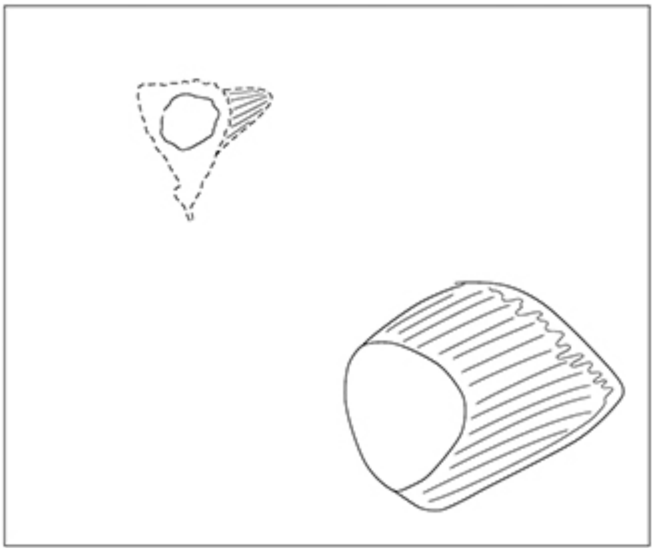


Figure 2 shows a drawing of the blood vessels from his dissection.

Figure 2



(a) Suggest **two** ways the student could improve the quality of his scientific drawing of the blood vessels in this dissection.

1 ____

____

2 ____

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(2)

(b) Identify the type of blood vessel labelled as **X** and the type of blood vessel labelled as **Y** in **Figure 1**.

Describe **one** feature that allowed you to identify the blood vessels.

Blood vessel **X** ____

Blood vessel **Y** ____

Feature ____

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(2)

(c) Describe **two** precautions the student should take when clearing away after the dissection.

1 ____

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2 ____

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(2)

(Total 6 marks)

Q3.

(a) Explain how an arteriole can reduce the blood flow into capillaries.

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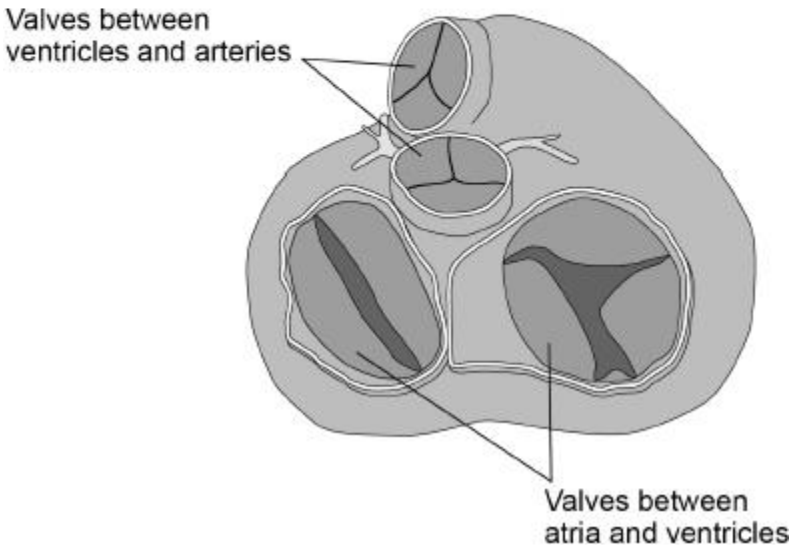
(2)

The image below shows heart valves during one stage of a cardiac cycle.

Ventricles are visible through the open valves.



(b) What can you conclude from the appearance of valves in the image above about heart muscle activity and blood movement between:

1. ventricles and arteries?

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(2)

2. atria and ventricles?

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(2)

(c) Tick (✓) **one** box next to the blood vessel carrying blood at the lowest blood pressure.

Capillary ☐

Pulmonary vein ☐

Renal vein ☐

Vena cava ☐

(1)

(d) A scientist measured the heart rate and the volume of blood pumped in a single heart beat (stroke volume) of an athlete before exercise and calculated the cardiac output.

Cardiac output is calculated using this equation.

cardiac output = heart rate × stroke volume

Her results are shown in the table below.

Heart rate / beats minute^{-1}	**Stroke volume / cm^3**	**Cardiac output / cm^3 minute^{-1}**
62	80	4960

After exercise, the athlete's stroke volume increased by 30% and the cardiac output was 13 832 cm^3 minute^{-1}

Calculate the athlete's heart rate after exercise.

Give the answer to 2 significant figures. Show your working.

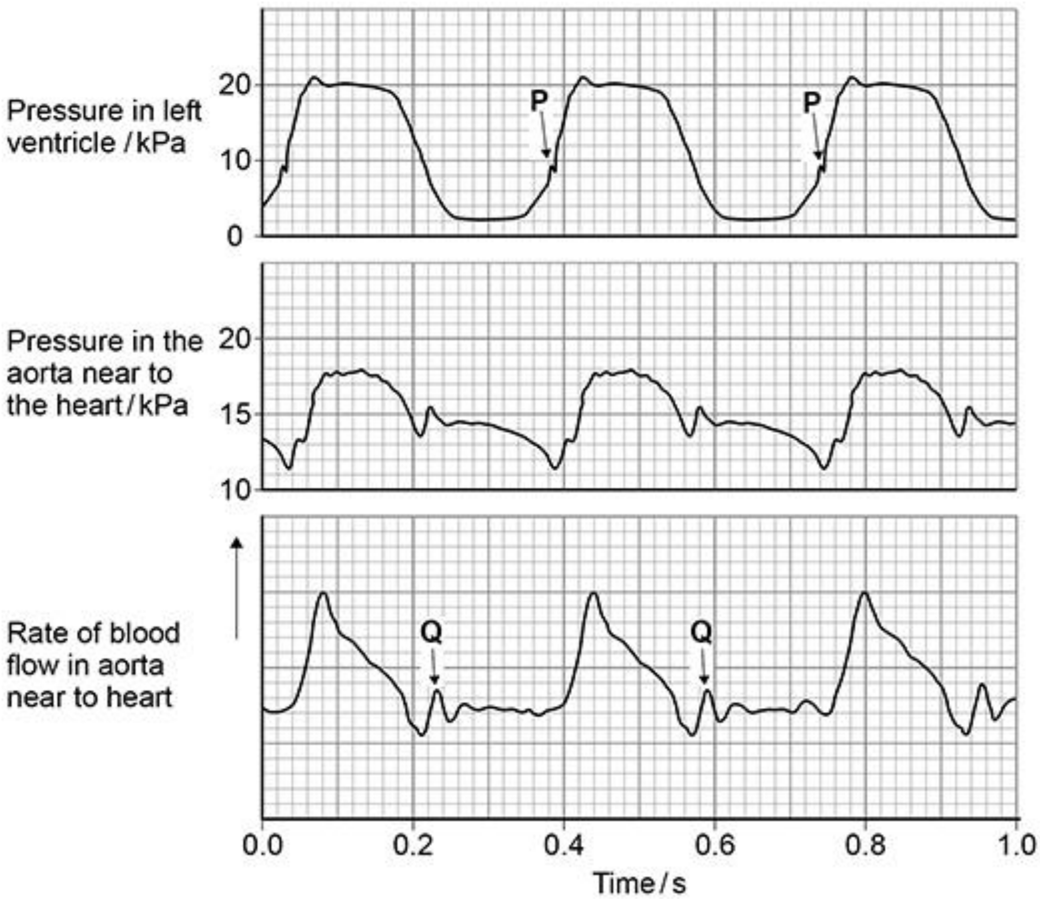
Heart rate ________________ beats minute^{-1}

(2)

(Total 9 marks)

Q4.

The diagram below shows pressure and blood flow during the cardiac cycle in a dog.



(a) At **P** on the diagram above, the pressure in the left ventricle is increasing. At this time, the rate of blood flow has not yet started to increase in the aorta.

Use evidence from diagram above to explain why.

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(2)

(b) At **Q** on the diagram above there is a small increase in pressure **and** in rate of blood flow in the aorta.

Explain how this happens **and** its importance.

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(2)

(c) A student correctly plotted the right ventricle pressure on the same grid as the left ventricle pressure in diagram above.

Describe **one** way in which the student's curve would be similar to and **one** way it would be different from the curve shown in the diagram above.

Similarity ____

____

____

____

Difference ____

____

____

____

(2)

(d) Use information from the diagram above to calculate the heart rate of this dog.

Heart rate ________________ beats minute^{-1}

(1)

(Total 7 marks)

Q5.

(a) Describe the advantage of the Bohr effect during intense exercise.

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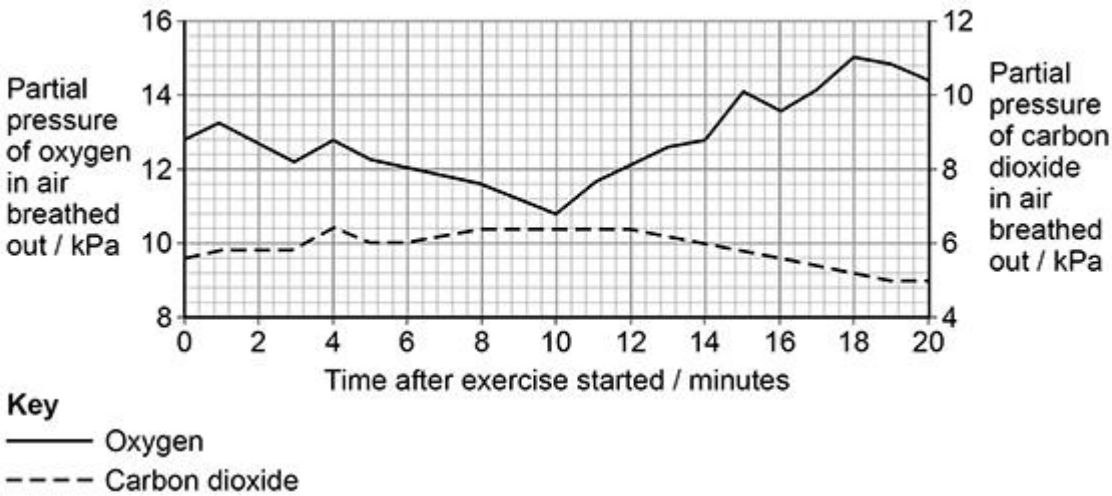
(2)

A cyclist completed a fitness test on an exercise bike. The intensity of the exercise was increased every 10 seconds. The test finished when he was unable to cycle any further. The partial pressure of oxygen (pO_2) and of carbon dioxide (pCO_2) in air breathed out was measured.

The graph below shows the results of the cyclist's fitness test.



Ventilatory threshold (VT) is a measure of the point when anaerobic respiration increases because aerobic respiration alone can no longer maintain muscle contraction.

(b) VT can be identified as the **first** point when there is an increase in pO_2 breathed out, without an equivalent increase in pCO_2 breathed out.

Use the graph above to determine the **time** after the exercise started when the cyclist reached VT.

Calculate the **ratio** of pO_2 to pCO_2 in breathed-out air at this time.

Show your working.

Time when the cyclist reached VT = ___________ min

Ratio of pO_2 to pCO_2 at VT = ______ :1

(2)

(c) An increase in the intensity of exercise produces an increase in the volume of carbon dioxide produced.

However, the graph above shows that the pCO_2 in air breathed out did **not** show a large increase during the exercise.

Suggest **one** physiological change that would cause this result. Explain how the physiological change would allow for the removal of the increase in the volume of carbon dioxide produced.

Physiological change ____

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Explanation ____

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(2)

EPO is another performance-enhancing drug. It can increase the haematocrit (the percentage of red blood cells in blood).

(f) A heart attack is caused by a lack of glucose and oxygen being delivered to cardiac muscle via the coronary arteries. The overuse of EPO can increase the risk of a heart attack.

Suggest how.

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(2)

(g) The normal haematocrit for human males is 47(±5)%. For professional male cyclists, the maximum haematocrit allowed is 50%.

A student suggested that professional male cyclists should be allowed to use EPO until their haematocrit is 50%.

Give **two** reasons why this suggestion is **not** valid.

1 ____

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2 ____

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(2)

Q6.

(a) Describe and explain the effect of increasing carbon dioxide concentration on the dissociation of oxyhaemoglobin.

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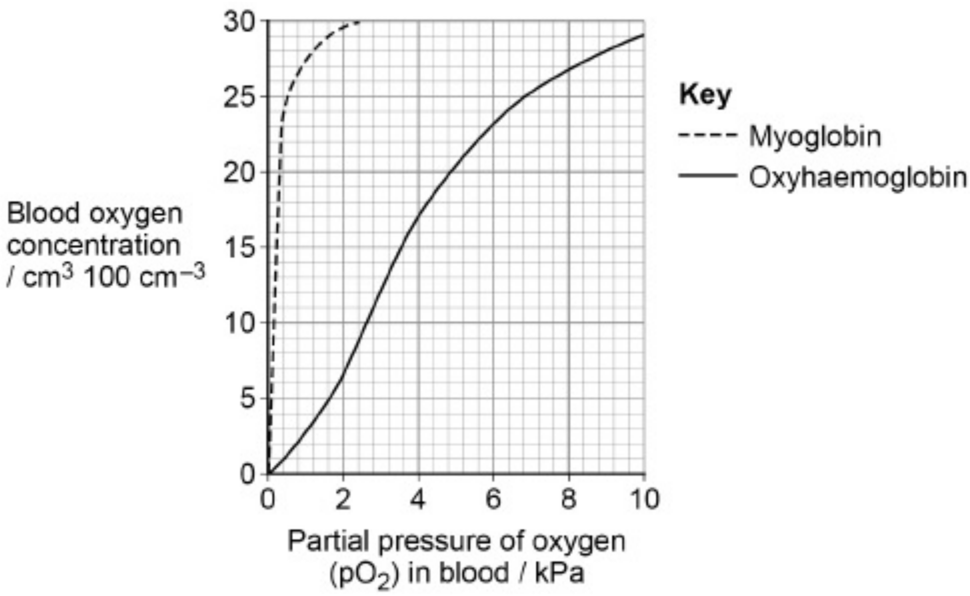
(2)

Seals are diving mammals. They fill their lungs with air before they dive and hold their breath during the dive.

The graph shows the dissociation curves for seal oxyhaemoglobin and seal myoglobin. Myoglobin is an oxygen-carrying protein found in muscles.



(b) Use information in the graph to explain how the seal's myoglobin dissociation curve shows the seal is adapted for diving.

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(2)

(c) Scientists measured the oxygen carrying capacity of seal blood.
They found the haemoglobin in a 190 kg seal contained 1.07×104 cm^3 oxygen.
When the seal dived, it used 5.2 cm^3 oxygen per minute per kg of body mass.

Use this information to calculate the maximum number of minutes the seal can remain under water. Assume that all of the oxygen attached to the haemoglobin is released during the dive.

Answer = ____________________________ minutes

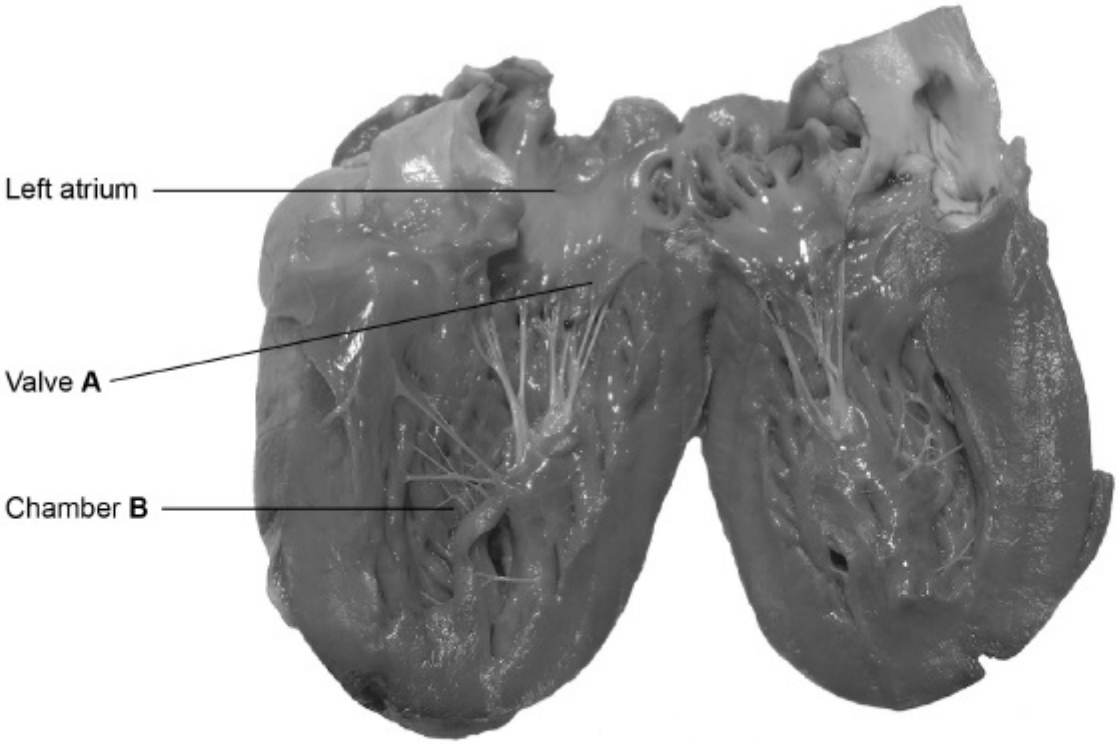
(2)

(Total 6 marks)

Q7.

Figure 1 shows a photograph of a dissected heart.

Figure 1



(a) Name valve **A** and chamber **B**.

Valve **A** ______________________________

Chamber **B** ______________________________

(1)

(b) Give **two** safety precautions that should be followed when dissecting a heart.

1 ______________________________

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2 ______________________________

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(1)

(c) Explain how valve **A** in **Figure 1** maintains a unidirectional flow of blood.

(2)

A research scientist investigated the effect of caffeine on heart rate in human volunteers.

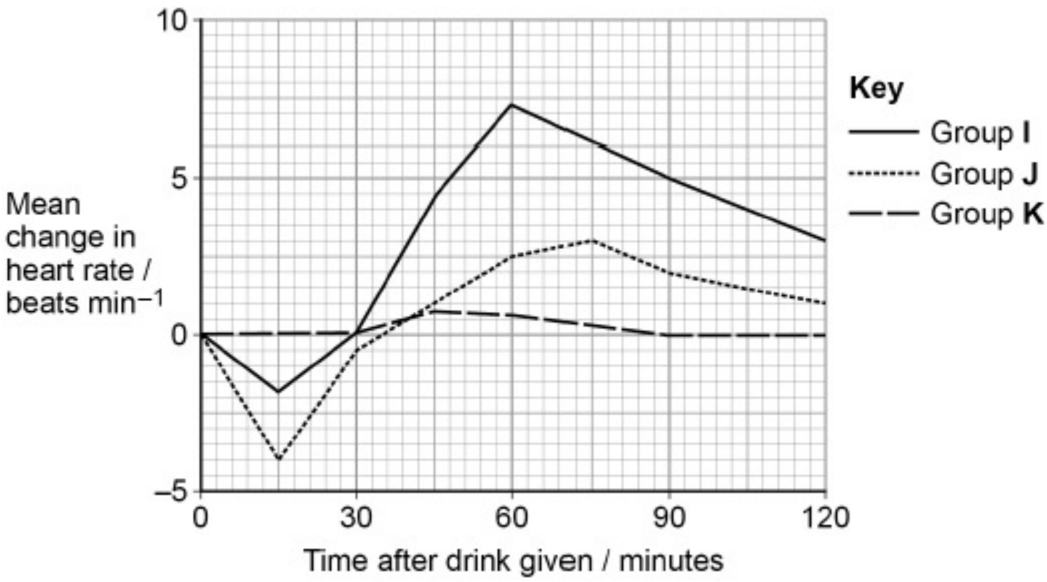
The scientist divided volunteers into three groups. Each group was given the same volume of fluid.

- Each member of Group **I** was given a sports drink containing caffeine and sugar.
- Each member of Group **J** was given a sports drink containing caffeine and no sugar.
- Each member of Group **K** was given water.

The scientist recorded the volunteers' heart rate before the drink was given and for 120 minutes after the drink was given.

Her results can be seen in **Figure 2**.

Figure 2



(d) Caffeine affects the autonomic nervous system.

Suggest how caffeine could account for the results of Group **I** in **Figure 2** at 60 minutes.

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(2)

(e) Before taking the drink, the mean heart rate of Group **J** was 68 beats per minute.

Fifteen minutes after taking the drink, the mean volume of blood leaving the hearts of Group **J** was 4700 cm^3 per minute.

Calculate the mean volume of blood leaving the heart at each beat fifteen minutes after taking the drink.

Answer = ____________________________ cm^3

(1)

(f) The increase seen in Group **I** could be due to the combination of caffeine and sugar.

Suggest **one** drink to be given to an **additional** group that should be investigated to find out if this is true.

Give a reason for your answer.

Group to be given ____

____

____

Reason ____

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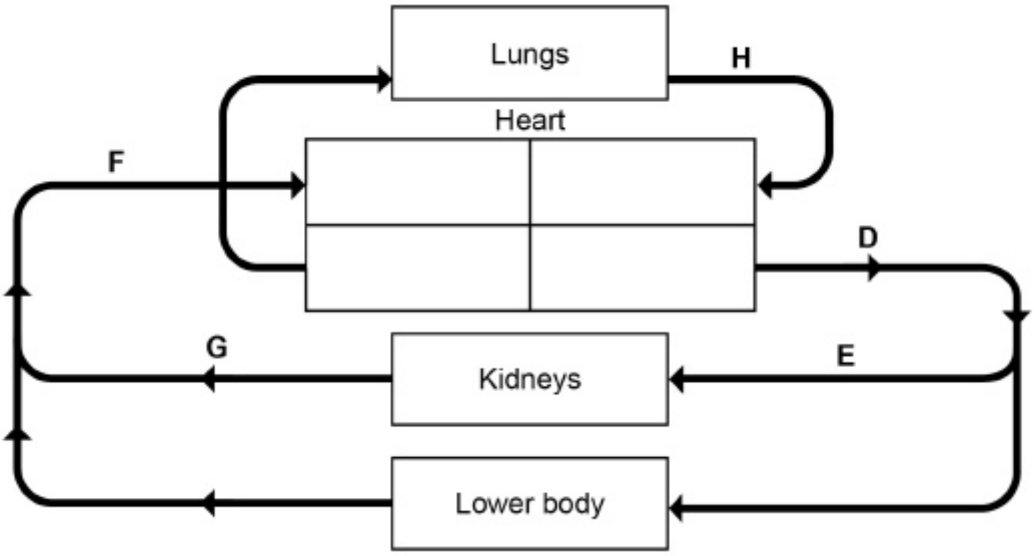
(2)

(Total 9 marks)

Q8.

(a) **Figure 1** shows part of the blood circulation in a mammal.

Figure 1



Use **Figure 1** to give the letter that represents each of these blood vessels.

Aorta ☐

Renal vein ☐

Vena cava ☐

(3)

(b) Name the blood vessels that carry blood to the heart **muscle**.

____

(1)

Q9.

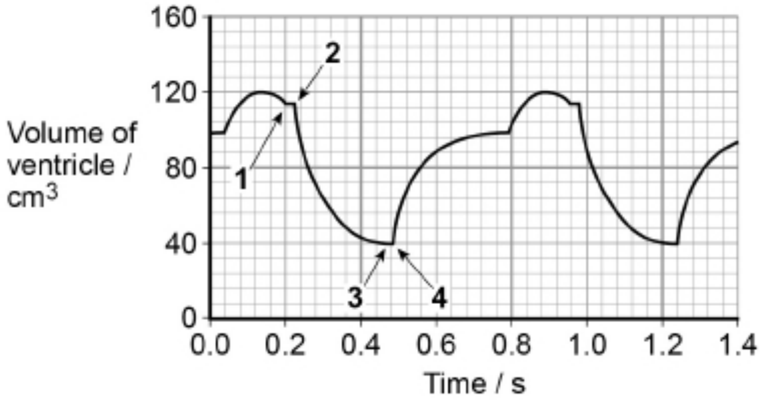
(a) Binding of one molecule of oxygen to haemoglobin makes it easier for a second oxygen molecule to bind.

Explain why.

(2)

Q10.

The graph shows the volume changes in the left ventricle of a human heart during two cardiac cycles. The numbers **1**, **2**, **3** and **4** represent times when heart valves open or close.



(a) Use information from the graph to complete the table in part (a). Place the number **1**, **2**, **3** or **4** in the appropriate box.

	Valve opens	**Valve closes**
Semi-lunar valve		
Atrioventricular valve		

(2)

(b) Use the diagram above to calculate the volume of blood pumped per minute by the left ventricle.

Answer = ____________________ $cm^3\ min^{-1}$

(2)

(c) Explain the role of the heart in the formation of tissue fluid.

(2)

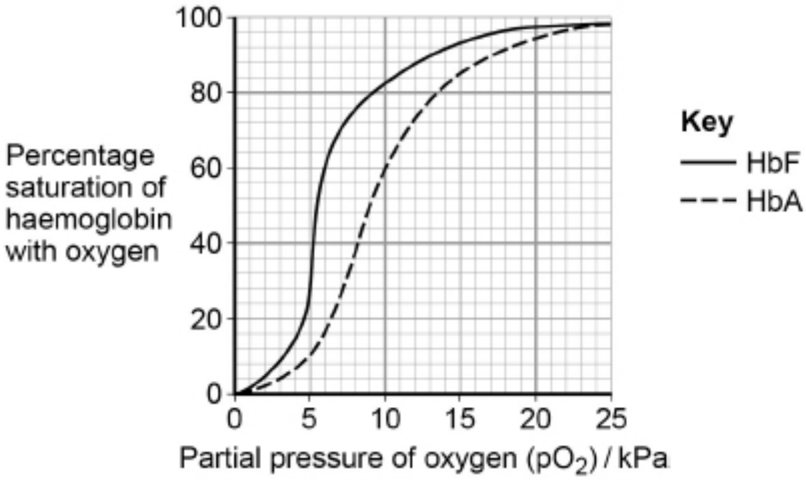
(d) Lymphoedema is a swelling in the legs which may be caused by a blockage in the lymphatic system.

Suggest how a blockage in the lymphatic system could cause lymphoedema.

(1)
(Total 7 marks)

Q11.

The graph shows the oxyhaemoglobin dissociation curves for fetal haemoglobin (HbF) and adult haemoglobin (HbA).



(a) Explain how changes in the shape of haemoglobin result in the S-shaped (sigmoid) oxyhaemoglobin dissociation curve for HbA.

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(2)

(b) At birth 98% of the haemoglobin is HbF. By the age of 6 months, the HbF has usually completely disappeared from the baby's blood and been replaced by HbA.

Use the graph above to explain why this change is an advantage for the baby.

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(2)

(c) Sickle cell disease (SCD) is caused by production of faulty HbA. This results in a reduced ability to transport oxygen to tissues. Scientists investigated the use of a substance called hydroxyurea to treat babies with SCD. Hydroxyurea changes the concentration of HbF in the blood.

The scientists carried out an investigation with 122 babies who had SCD. Each baby was given hydroxyurea for 41 months. The scientists then found the mean change in the concentration of HbF in the babies' blood.

Their results are shown in the table.

Mean concentration of HbF in the babies' blood / arbitrary units	
Before treatment with hydroxyurea (± 1 standard deviation)	**After treatment with hydroxyurea (± 1 standard deviation)**
7.6 (± 4.5)	19.1 (± 6.5)

The scientists concluded that treatment with hydroxyurea would increase the concentration of oxygen in the blood of babies with SCD.

Suggest how the graph and table above support this conclusion.

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(3)

(Total 7 marks)