

1. The table shows the percentage of various gases in atmospheric air, exhaled air and in air samples collected from the alveoli and the trachea of a healthy human.

Gas	Atmospheric air(inhaled air)	Exhaled air	Sample of air collected from alveoli	Sample of air collected from trachea
Oxygen	20.9	15.7	13.7	19.6
Carbon dioxide	0.04	3.6	5.2	1.1
Water vapour	0.5	6.2	6.2	6.2
Nitrogen	78.5	74.4	74.9	73.1

Use the table to suggest an explanation for the difference between:

- (a) the percentage of carbon dioxide in the air sample collected from the alveoli and that in exhaled air;

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(1)

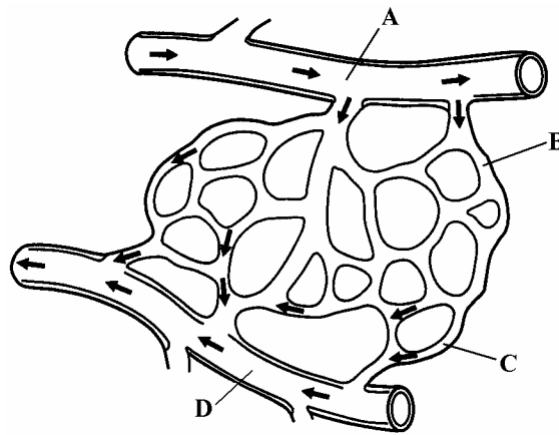
- (b) the percentage of nitrogen in atmospheric air and that in exhaled air.

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(2)

(Total 3 marks)

2. The diagram shows some blood vessels in a muscle.



(a) (i) Name **two** substances which are at a higher concentration in the blood at point **A** than in the blood at point **D**.

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2

(1)

(ii) The more active a muscle, the greater the blood flow through its capillaries. Explain the advantage of this.

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(2)

(b) (i) Explain why the amount of protein in the blood plasma does not fall when tissue fluid is formed at point **B**.

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(1)

(ii) Explain the role of the proteins in the blood plasma in returning fluid to the capillary at point C.

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(2)
(Total 6 marks)

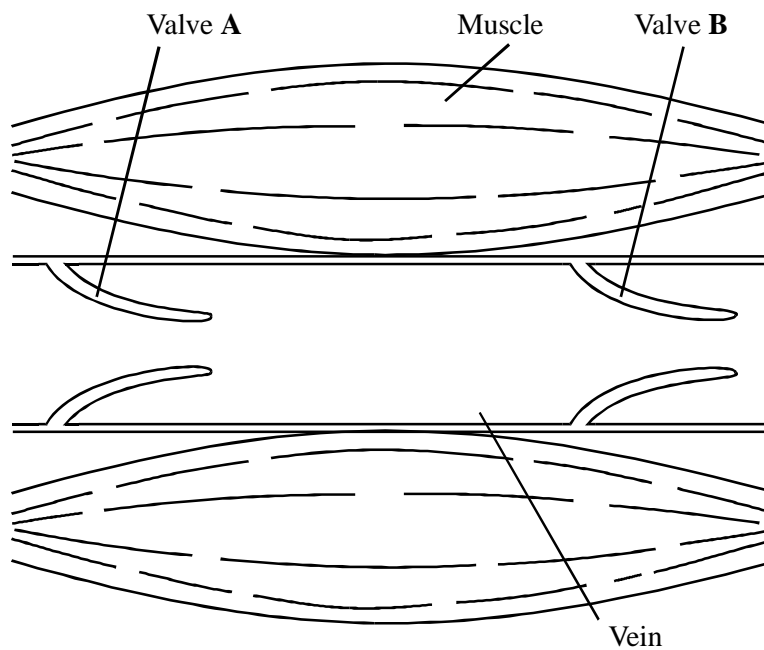
3. (a) Explain why a vein is described as an organ.

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(1)

(b) The diagram shows a vein passing between two muscles.



- (i) When the muscles contract, the pressure of the blood in the part of the vein between valves **A** and **B** changes. Explain how this change in pressure, together with the action of the valves, helps the blood to flow to the heart

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(3)

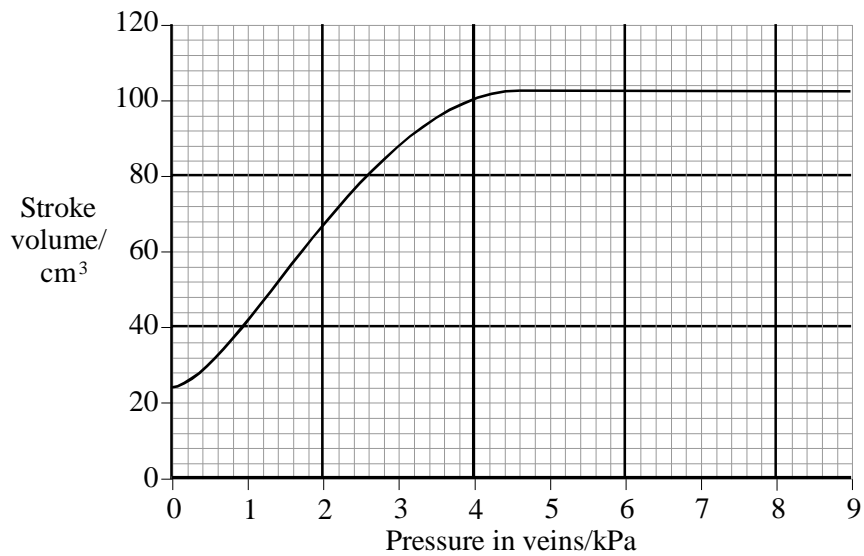
- (ii) Suggest how blood is returned to the heart when the muscles are not contracting

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(1)

- (c) The graph shows the relationship between the pressure in the veins returning blood into the heart and stroke volume.



(i) Describe the relationship between stroke volume and pressure in the veins.

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(1)

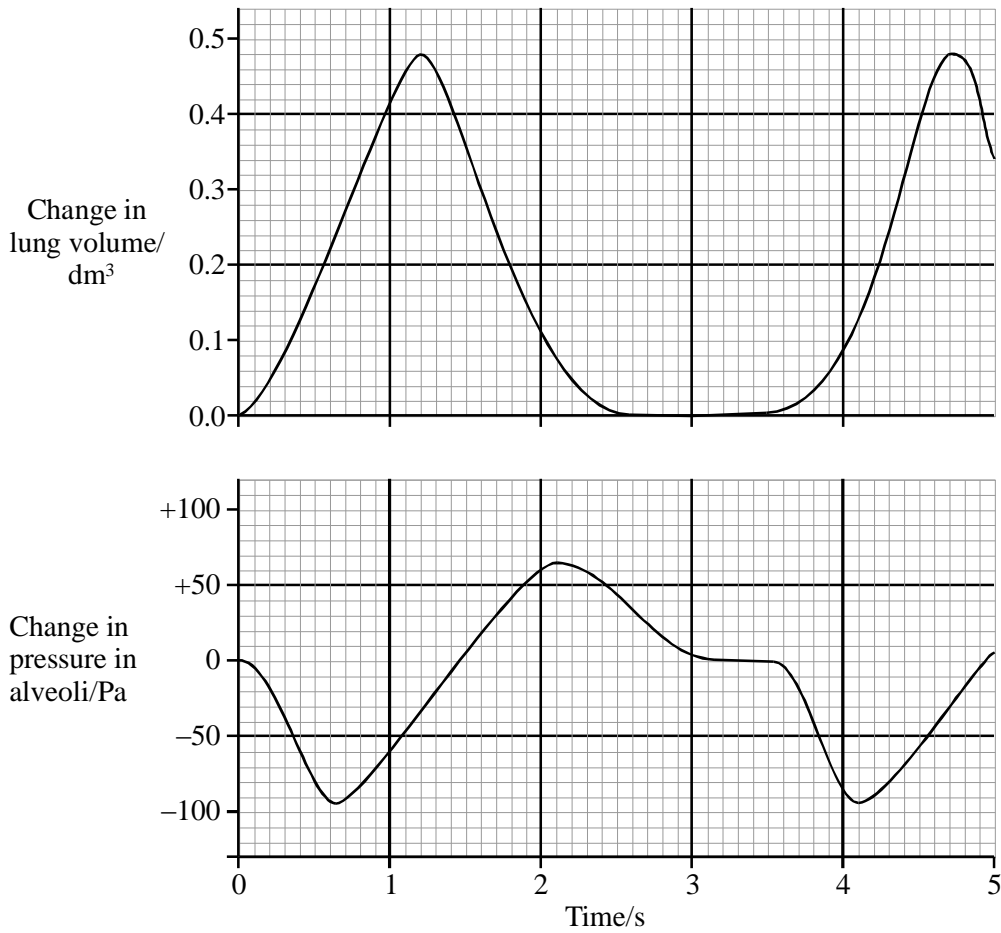
(ii) What information would you need, other than that in the graph, to calculate this person's cardiac output

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(1)

(Total 7 marks)

4. The graph shows some of the changes which take place in a man during breathing.



- (a) (i) Use the information in the graph to calculate this man's rate of breathing in breaths per minute. Show your working.

Answer.....breaths per minute

(2)

- (ii) The volume of air in the man's lungs after he had exhaled was 2400 cm^3 . What is the volume of air in his lungs immediately after he had inhaled

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(1)

- (b) Explain how muscles cause the change in alveolar pressure between 0 and 0.5 s.

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(2)

The table shows the composition of atmospheric air and gas samples obtained while this man was breathing normally.

Sample	Percentage of total volume	
	Oxygen	Carbon dioxide
Atmospheric air	21.0	0.0
Air from alveoli	13.8	5.5
Exhaled air	16.9	4.1

- (c) Explain why the percentage of carbon dioxide in atmospheric air is given in the table as zero.

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(1)

(d) (i) Not all the air that a person breathes out has been in the alveoli. Explain why.

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(1)

(ii) Use your answer to part (i) to explain the difference in carbon dioxide concentration between exhaled air and air from alveoli

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(2)

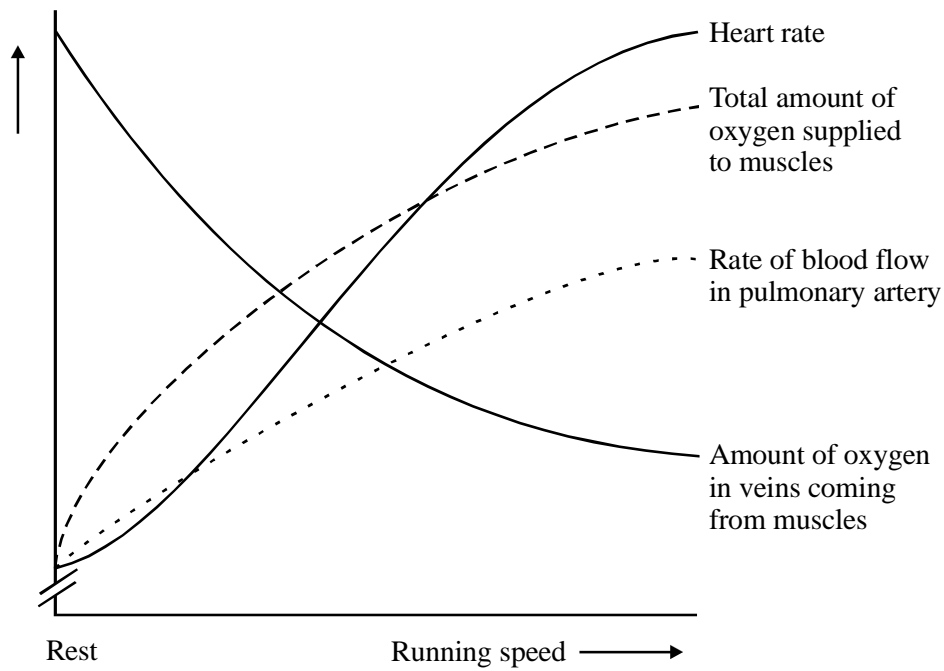
(e) Describe how the structure of the lungs and the red blood cells enable efficient diffusion and transport of oxygen.

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(6)

(Total 15 marks)

5. An athlete ran at different speeds on a treadmill. The graph shows some of the changes which occurred as running speed increased.



- (a) (i) Give suitable units for the rate of blood flow in the pulmonary artery.

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(1)

- (ii) Explain why the rate of blood flow in the pulmonary artery changes when the heart rate changes.

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(1)

- (b) During exercise, red blood cells give up more of the oxygen they are transporting. Give **one** piece of evidence from the graph which supports this statement.

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(1)

- (c) Suggest how an increase in the rate of blood flow in the pulmonary artery helps to supply more oxygen to muscles.

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(2)
(Total 5 marks)

6. The table shows some information about blood vessels in a dog.

Blood vessels	Mean diameter/cm	Total number	Mean length/cm	Total cross-sectional area/cm ²	Total volume/cm ³
Main arteries	0.1	600	10.0	5	50
Arterioles	0.002	4×10^7	0.2	125	25
Capillaries	0.0008	1.2×10^9	0.1	600	60
Main veins	0.24	600	10.0	27	270
Other blood vessels					525

- (a) Use your knowledge of the pattern of blood circulation in a mammal to explain why

- (i) the total number of arterioles is more than the total number of main arteries;

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(1)

- (ii) the total number of main arteries is the same as the total number of main veins.

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(1)

(b) (i) Explain how the total volume of blood in the arterioles was calculated.

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(1)

(ii) Calculate the percentage of blood in the blood vessels which is in the capillaries. Show your working.

Answer %

(2)

(c) (i) Name **one** tissue or organ in which the volume of blood in the capillaries increases during exercise.

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(1)

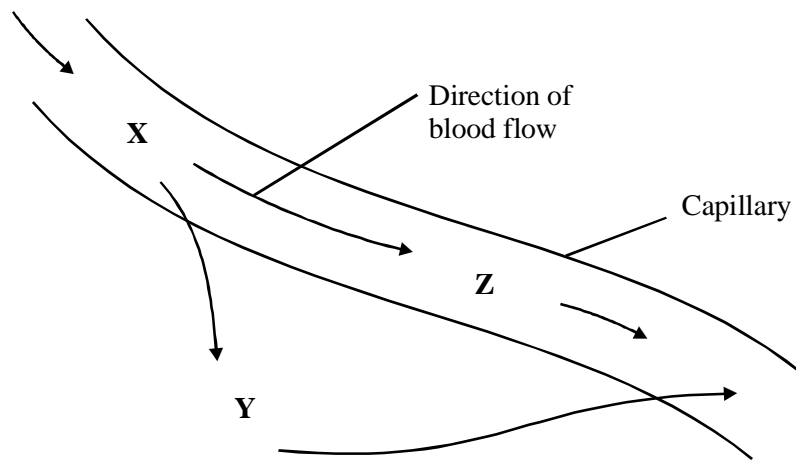
(ii) Describe the part played by the arteriole walls in reducing blood flow to the capillaries in the intestines during exercise.

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(3)

(Total 9 marks)

7. The diagram shows the formation of tissue fluid and its return to a capillary.



(a) (i) Describe how the concentration of protein in the tissue fluid at **Y** differs from that in the plasma at **X**. Explain what causes this difference.

Difference

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Explanation

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(2)

(ii) Describe how the concentration of protein in the plasma at **Z** differs from that in the plasma at **X**. Explain what causes this difference.

Difference

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Explanation

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(2)

(b) Describe the part played by proteins in the plasma in returning tissue fluid to the capillary.

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(3)

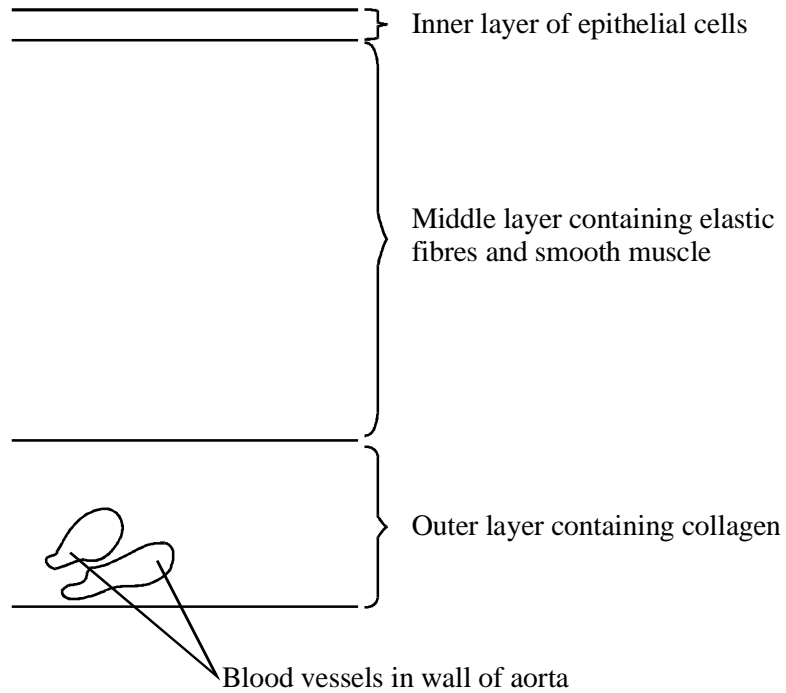
(c) The tissues of people who are starving often swell because of the accumulation of tissue fluid. Explain what causes this accumulation of tissue fluid.

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(2)

(Total 9 marks)

8. The diagram shows a section through the wall of the aorta.



(a) Explain why the aorta is an organ.

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(1)

(b) Explain how cells in the outer layer of the wall of the aorta get oxygen for respiration.

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(2)

(c) (i) The wall of the aorta helps to smooth out blood pressure in the aorta. Explain how.

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(2)

(ii) The changes in the pressure of blood in the aorta can be measured. Explain why this information would enable you to measure the heart rate.

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(1)

(Total 6 marks)

9. The pressure of the blood in an artery was measured during a cardiac cycle. The minimum pressure was 9.6 kPa and the maximum pressure was 13.4 kPa.

(a) Describe how the increase in pressure of the blood in the artery results from the events in the cardiac cycle.

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(2)

(b) The elastin fibres in the wall of the artery help to smooth out the flow of blood. What happens to these fibres as the pressure of the blood in the artery changes?

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(2)

- (c) Give **one** way in which the structure of the wall of an artery is similar to the structure of the wall of a capillary.

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(1)
(Total 5 marks)

10. (a) Explain why both the heart and arteries are described as organs.

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(1)

The table shows changes in the volume of blood in the left ventricle over a period of one second.

Time / s	Volume of blood as percentage of maximum
0	70
0.1	100
0.2	70
0.3	30
0.4	0
0.5	35
0.6	60
0.7	70
0.8	70
0.9	100
1.0	70

Use information in the table to answer the following questions.

(b) What is the approximate length of one cardiac cycle?

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(c) At what time is there least blood in the *right* ventricle? Explain your answer.

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..... (1)

(d) (i) Between which times are the muscles in the wall of the left atrium contracting? Give the reason for your answer.

Times
Reason
..... (1)

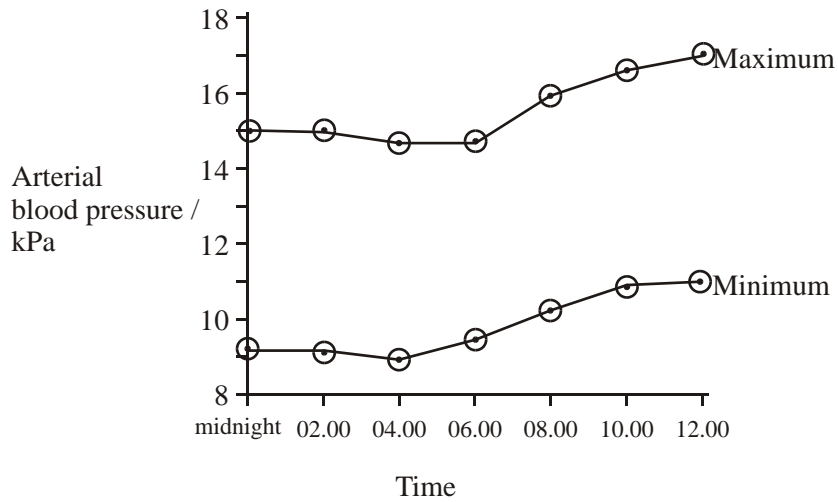
(ii) Between which times are the semilunar valves in the arteries open? Give the reason for your answer.

Times
Reason (1)

(e) The maximum volume of blood in the left ventricle is 45 cm^3 . Calculate the volume of blood in the left ventricle at 0.5 s. Show your working.

Volume of blood = cm^3 (2)
(Total 7 marks)

11. (a) The graph shows hourly blood pressure recordings from a group of 65 people.



(i) Describe how the mean maximum arterial blood pressure changes over the period shown in the graph.

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(1)

(ii) In each cardiac cycle, the arterial pressure has a maximum value. Explain the link between this maximum value and the events of the cardiac cycle.

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(1)

(iii) The recordings shown in this graph were taken from an artery. Describe **two** ways in which you would expect blood pressure in a vein to differ from that in an artery.

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(2)

- (b) Molecules of different substances differ in size. The relative molecular mass of a substance gives an indication of the size of its molecules. The table shows the relative permeability of the wall of a capillary to different molecules.

Substance	Relative molecular mass	Relative permeability of capillary wall
Water	18	1.00
Urea	60	0.96
Glucose	180	0.60
Haemoglobin	68 000	0.01
Albumin (plasma protein)	69 000	0
Globulin (plasma protein)	140 000	0

- (i) Describe the relationship between molecule size and the permeability of the capillary wall.

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(2)

- (ii) The water potential of the plasma at the venule end of the capillary is more negative than the water potential at the arteriole end. Use the table to explain why.

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(2)

- (iii) Although the capillary walls are slightly permeable to haemoglobin molecules, there is no haemoglobin in the tissue fluid. Explain what causes the absence of haemoglobin in tissue fluid.

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(1)
 (Total 9 marks)

12. The table shows the relative thickness of layers in the walls of an artery and a vein.

Layer in wall	Thickness / μm	
	Artery	Vein
Endothelium	20	20
Smooth muscle	490	240
Elastic tissue	370	240
Connective tissue	120	120

- (a) Explain why a vein may be described as an organ.

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(1)

- (b) (i) Use information from the table to suggest the thickness of a capillary wall. Give the reason for your answer.

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(1)

- (ii) The diameter of the artery was 4 mm. Calculate the diameter of the lumen of this artery. Show your working.

Answer

(2)

- (c) Explain how the elastic tissue in the wall helps to even out the pressure of blood flowing through the artery.

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(2)

(Total 6 marks)

13. S The table shows factors which affect oxygen transport to the body tissues in different groups of animals.

Animal group	Mean rate of blood flow to body tissues/ $\text{cm}^3 \text{ kg}^{-1} \text{ minute}^{-1}$	Mean haemoglobin concentration in blood/ g cm^{-3}
Reptiles	45	0.072
Fish	17	0.038
Amphibians	25	0.070
Mammals	75	0.132

- (a) Suggest why values for mean rate of blood flow to the tissues are expressed per kilogram of body mass.

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(2)

- (b) Describe the relationship between the mean rate of blood flow and haemoglobin concentration.

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(1)

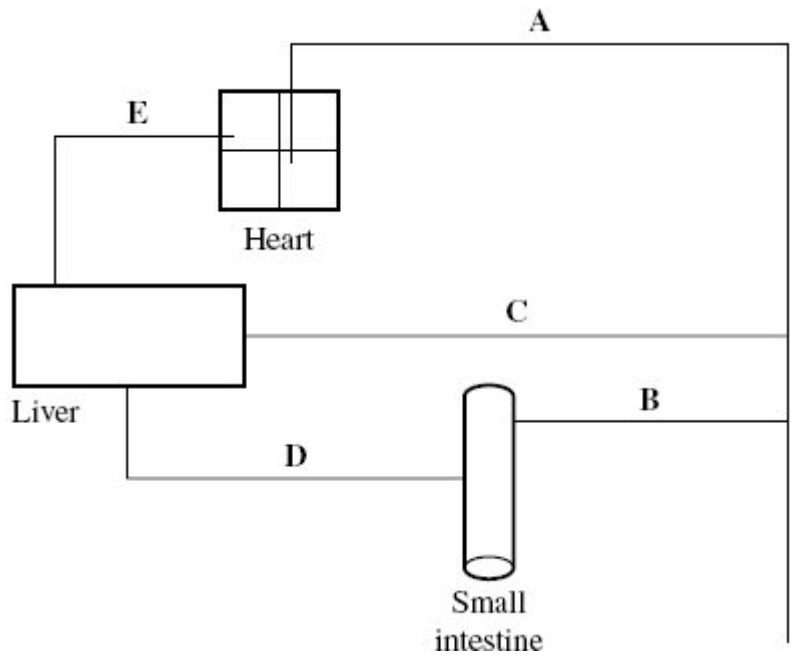
- (c) Each gram of haemoglobin can transport up to 1.38 cm^3 of oxygen. Calculate the difference between mammals and fish in the maximum amount of oxygen that can be transported per cm^3 of blood. Show your working,

Answer cm^3

(2)

(Total 5 marks)

14. The diagram shows some of the large blood vessels in a mammal.



(a) Add arrows to the diagram to show the direction of blood flow in each of the blood vessels **A** to **E**.

(1)

(b) (i) Which of blood vessels **A** to **E** is the hepatic portal vein?

(1)

(ii) Which of blood vessels **A** to **E** contains blood at the lowest pressure?

(1)

- (c) Complete the table to show **two** differences between the structure of vessel **C** and the structure of vessel **E**.

Structural feature	Vessel C	Vessel E

(2)

- (d) Blood vessel **B** contains smooth muscle in its walls. Explain how this muscle may reduce the blood flow to the small intestine.

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(2)

- (e) Elastic tissue in the walls of blood vessel **A** helps to even out the pressure of blood through this vessel. Explain how.

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(2)

(Total 9 marks)