PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

BIOLOGY



EXAM QUESTION PACK

TOPIC 4: EXCHANGE AND TRANSPORT

CIRCULATION

SCORE	PERCENTAGE
/179	%

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Q1.

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

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

(4)

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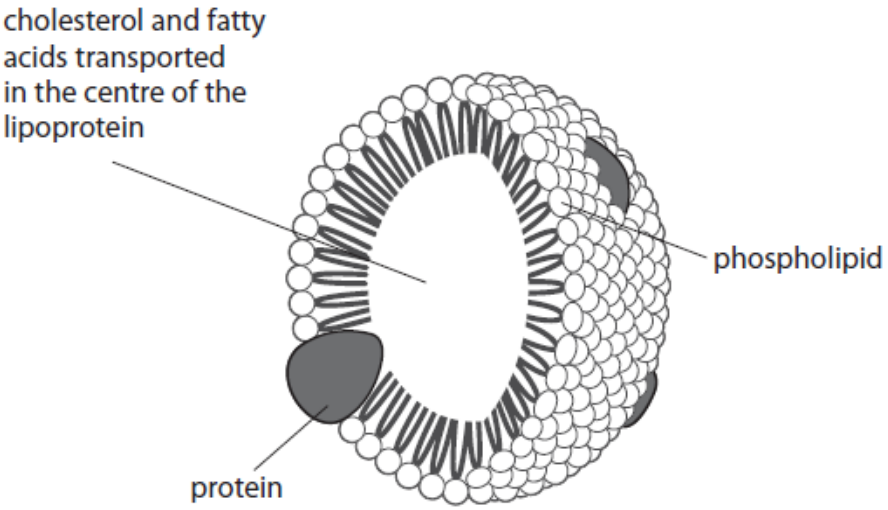
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Q2.

High density and low density lipoproteins are spherical structures that transport cholesterol and fatty acids in the bloodstream.

The diagram shows a lipoprotein.



Explain why the properties of lipoproteins enable cholesterol and fatty acids to be transported in the bloodstream.

(3)

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(Total for question = 3 marks)

Q3.

Scientists are developing ways of using stem cells to replace heart cells that have been damaged as a result of heart disease.

The table shows the results of a survey of the incidence of heart disease.

Age / years	Incidence of heart disease per 1000 population	
	In women	In men
18 to 44	3	5
45 to 64	118	138
65 to 74	220	305
75 and older	358	422

Analyse the data to explain the factors affecting the incidence of heart disease.

(2)

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(Total for question = 2 marks)

Q4.

Scientists are developing ways of using stem cells to replace heart cells that have been damaged as a result of heart disease.

Explain why heart cells are damaged as a result of heart disease.

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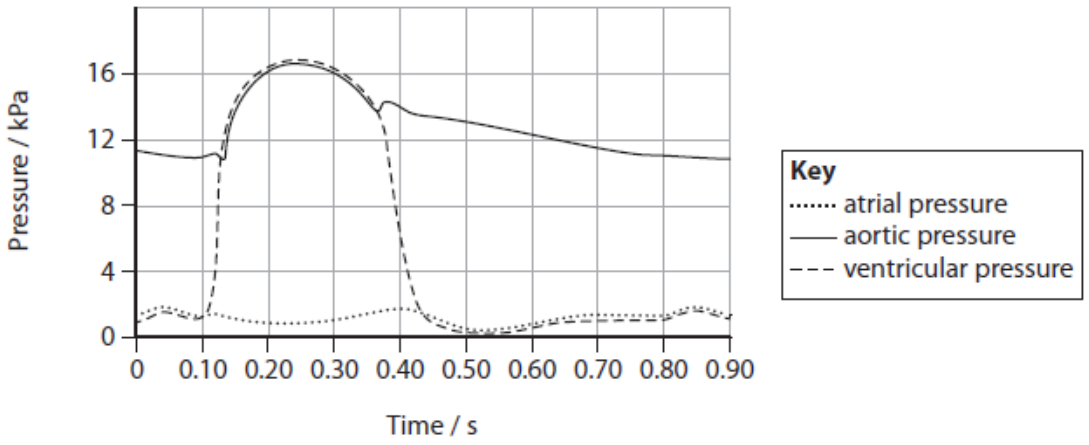
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(Total for question = 2 marks)

Q5.

The graph shows the pressure changes in the left side of the heart during one cardiac cycle.



(i) Calculate the heart rate.

(1)

Answer .....

(ii) During which time period does blood leave the left ventricle?

(1)

☒ **A** 0.10 s to 0.13 s

☒ **B** 0.10 s to 0.37 s

☒ **C** 0.13 s to 0.37 s

☒ **D** 0.13 s to 0.43 s

(iii) At which time does the valve between the atrium and the ventricle close?

(1)

☒ **A** 0.10 s

☒ **B** 0.13 s

☒ **C** 0.37 s

☒ **C** 0.43 s

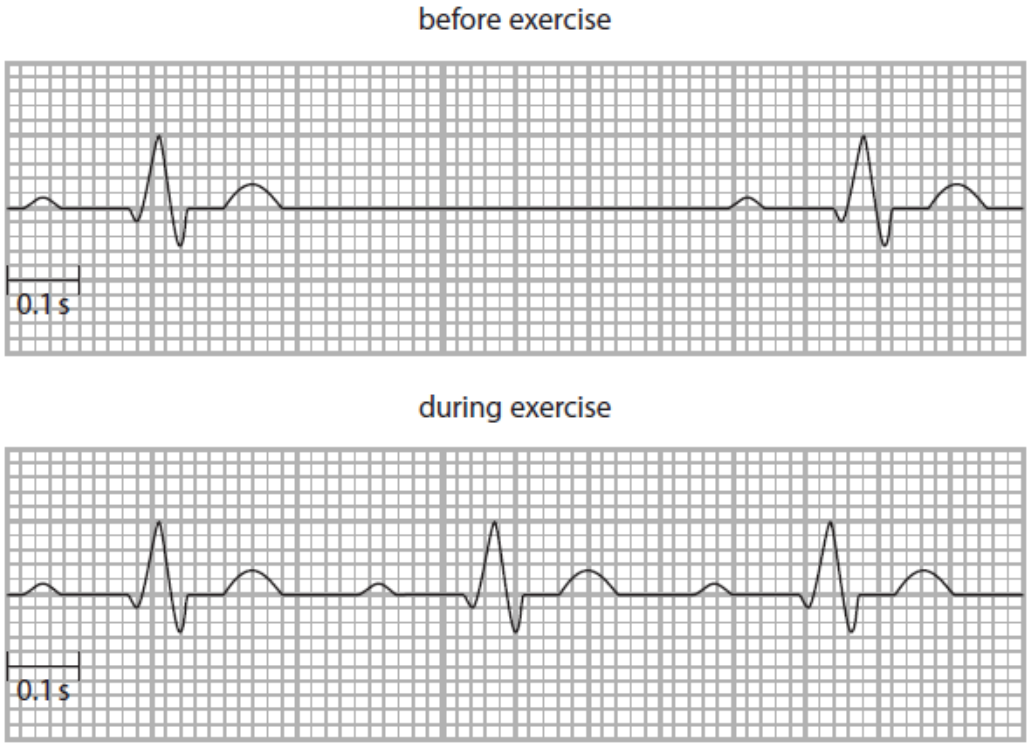
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Q6.

The brain is involved in many homeostatic mechanisms.

The autonomic nervous system plays a role in regulating heart rate.

The diagram shows an ECG trace from a student before and during exercise.



(i) Calculate the heart rate of this student during exercise.

(1)

Answer .....

(ii) Describe how exercise results in an increased heart rate.

(4)

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(Total for question = 5 marks)

Q7.

Hypoxia is an inadequate supply of oxygen to tissues and cells that restricts their function.

The normal partial pressures of oxygen vary from tissue to tissue.

The table shows the normal partial pressure of oxygen in two tissues.

Tissue	Partial pressure of oxygen / kPa
Pulmonary arterial blood	5.3
Other arterial blood	13.3

(i) Calculate the ratio of the partial pressures of oxygen in these two tissues.
Give your answer to one decimal place.

(1)

Answer .....

(ii) Explain why the partial pressures of oxygen in these two tissues are different.

(2)

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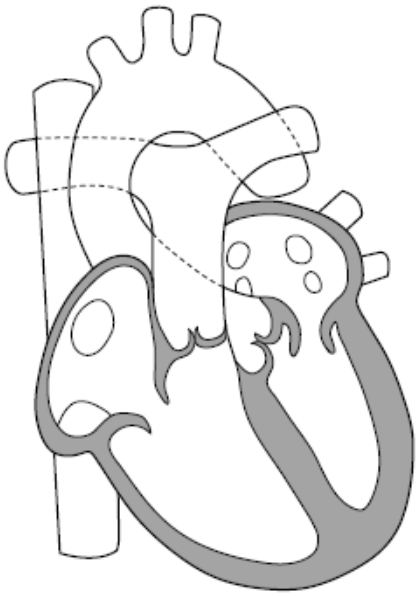
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(Total for question = 3 marks)

Q8.

The diagram below shows the structure of a mammalian heart.



Which stage of the cardiac cycle is shown by this heart?

☒ **A** atrial systole and ventricular systole

☒ **B** atrial systole and ventricular diastole

☒ **C** atrial diastole and ventricular systole

☒ **D** atrial diastole and ventricular diastole

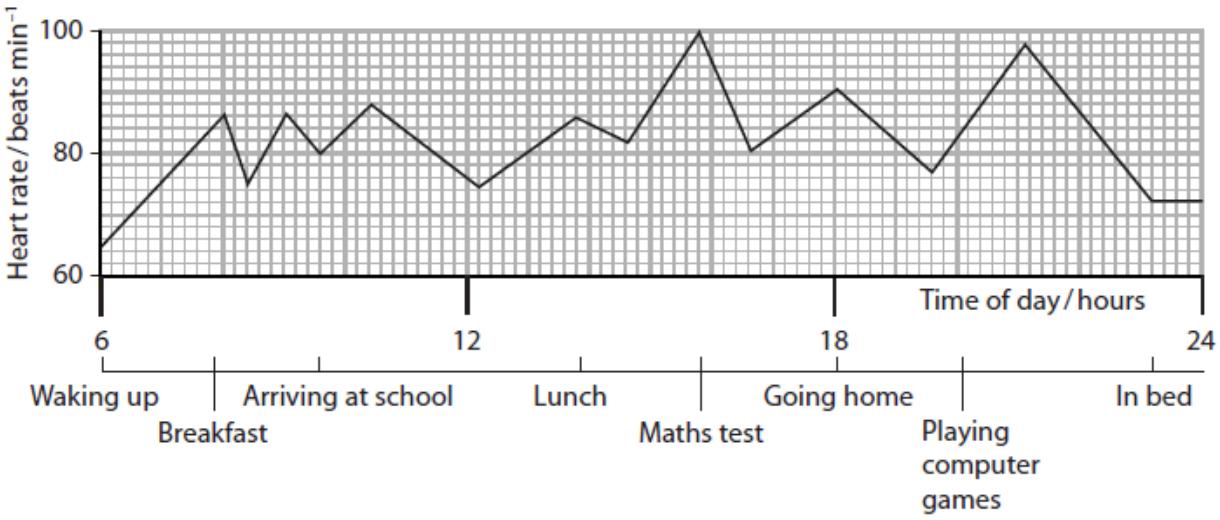
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Q9.

A student was interested to find out how his heart rate would vary throughout the day.

He wore a heart rate monitor from the time he woke up until the time he went to bed.

The graph shows the data collected and some of the student's activities during the day.



The student noticed that the graph showed a change in his heart rate while he was playing computer games.

He designed an investigation to find out how different computer games affect heart rate.

The student played one computer game and recorded the increase in his heart rate.

He then played four other different computer games and again recorded the increase in his heart rate.

He repeated this on six different occasions throughout the week.

(i) Explain how the design of the student's investigation could be improved.

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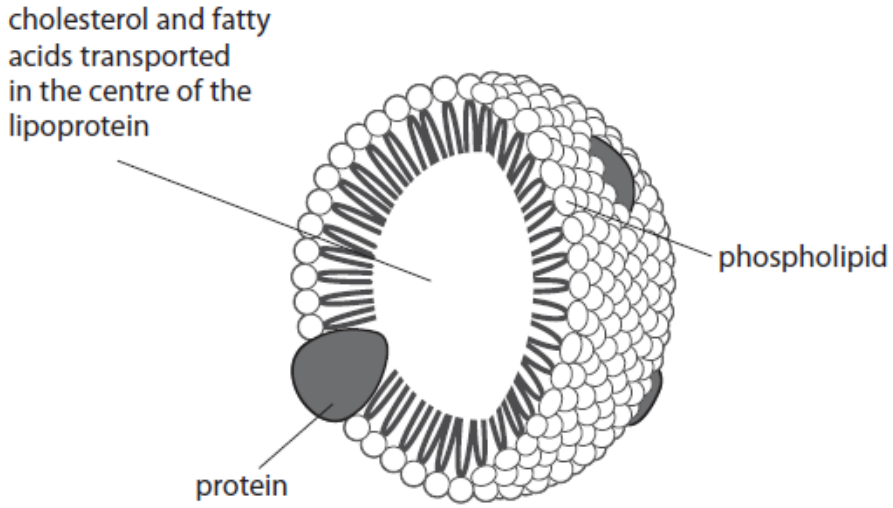
(ii) Sketch a suitable graph that the student could use to present the results of his investigation.

(2)

Q10.

High density and low density lipoproteins are spherical structures that transport cholesterol and fatty acids in the bloodstream.

The diagram shows a lipoprotein.



The table shows some information about two types of lipoprotein, high density lipoprotein (HDL) and low density lipoprotein (LDL).

Information about lipoproteins	HDL	LDL
density range / g cm^{-3}	1.063 to 1.210	1.019 to 1.063
typical diameter / nm	8	22
typical volume / nm^3	268	
percentage of protein (%)	50	20

(i) Complete the table to show the volume of a typical LDL using the formula:

$$\frac{4}{3}\pi r^3 \quad \text{where } \pi = 3.14$$

(2)

(ii) Analyse the information to explain why LDLs have a lower density range than HDLs.

(2)

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(iii) Explain why raised levels of LDLs may increase the risk of heart disease.

(4)

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(Total for question = 8 marks)

Q11.

A student investigated the effect of adrenaline and acetylcholine on the heart rate of water fleas using the
following method:

- place a water flea in pond water on a microscope slide
- count the number of heart beats in one minute
- repeat with two other water fleas
- repeat this procedure using three water fleas placed in adrenaline solution and three water fleas placed in acetylcholine solution.

The table shows the results of this investigation.

Treatment	Heart rate / beats min^{-1}				Standard deviation (SD)
	Water flea 1	Water flea 2	Water flea 3	Mean	
Pond water	195	185	190	190	
Adrenaline solution	240	236	238	238	±2.0
Acetylcholine solution	116	120	118	118	±2.0

(i) Calculate the standard deviation for the mean heart rate in the pond water.

Use the formula

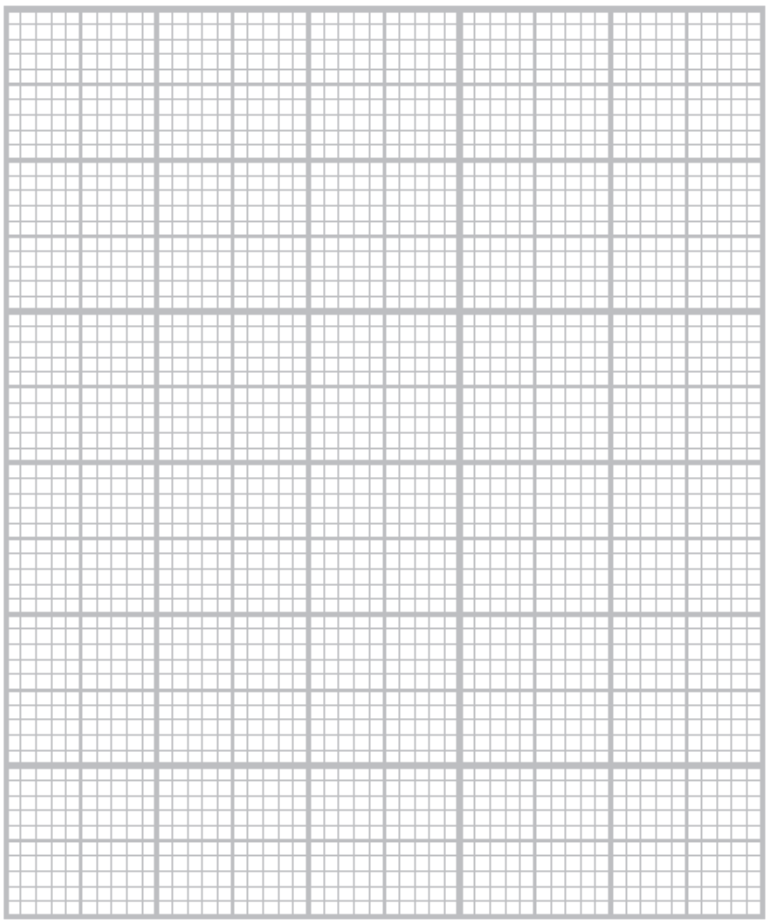
$$SD = \sqrt{\frac{\sum (X - \bar{X})^2}{n - 1}}$$

(2)

Answer .....

(ii) Plot a graph to show the data for the mean heart rate and SD in each treatment.

(2)



(iii) Explain why abiotic variables should be controlled in this investigation.

(2)

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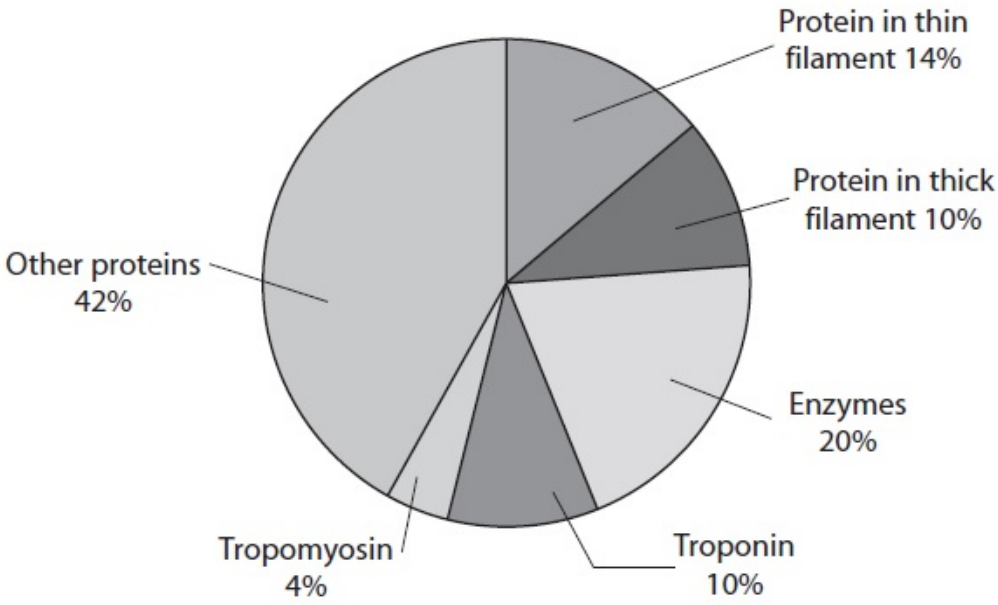
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(Total for question = 6 marks)

Q12. Skeletal muscle and cardiac muscle have some of the same proteins.

(a) Some of these proteins found in cardiac muscle are shown in the chart below.



(i) Using the chart, name the protein that makes up each of the two types of filament.

(2)

Protein in thin filament

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Protein in thick filament

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(ii) Describe the interaction between troponin and tropomyosin when a skeletal muscle fibre contracts.

(2)

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(iii) In the chart, some of the other proteins are neurotransmitter receptors. These are found on the cell surface membrane of cardiac muscle cells in the sinoatrial node (SAN).

Suggest **one** neurotransmitter substance that might bind to these receptors.

(1)

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(b) Troponin T is found in cardiac muscle cells. It can leak into the blood if the heart is damaged as a result of cardiovascular disease.

Testing for troponin T in blood can be used to study patients with damaged hearts.

The table below shows the concentration of troponin T in the blood of patients. The table also shows the mean number of days in hospital and the range of stay.

Concentration of troponin T in the blood / arbitrary units	Mean number of days of stay in hospital and the range
6.0 +	9 ± 2.0
4.0 – 5.9	6 ± 1.0
1.0 – 3.9	3 ± 0.5

Using the information in the table suggest what prediction a doctor could make and comment on the reliability of this prediction for patients with damaged hearts.

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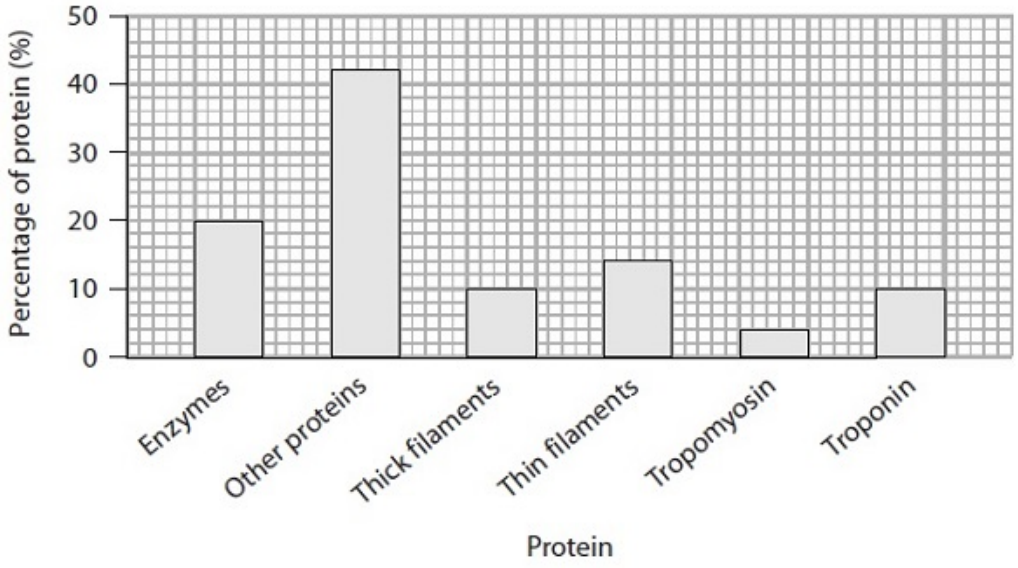
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(Total for Question = 8 marks)

Q13. Skeletal muscle and cardiac muscle have some of the same proteins.

(a) The percentage of the proteins found in cardiac muscle are shown in the bar chart below.



(i) Using the information in the bar chart, give the percentage of protein that is actin and the percentage that is myosin.

(2)

Actin:
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%

Myosin:
.....%

(ii) Describe how calcium ions affect troponin as a skeletal muscle fibre contracts.

(2)

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(iii) Some of the 'other proteins' shown in the bar chart are found in the sinoatrial node (SAN).

State the location of the SAN in the heart.

(1)

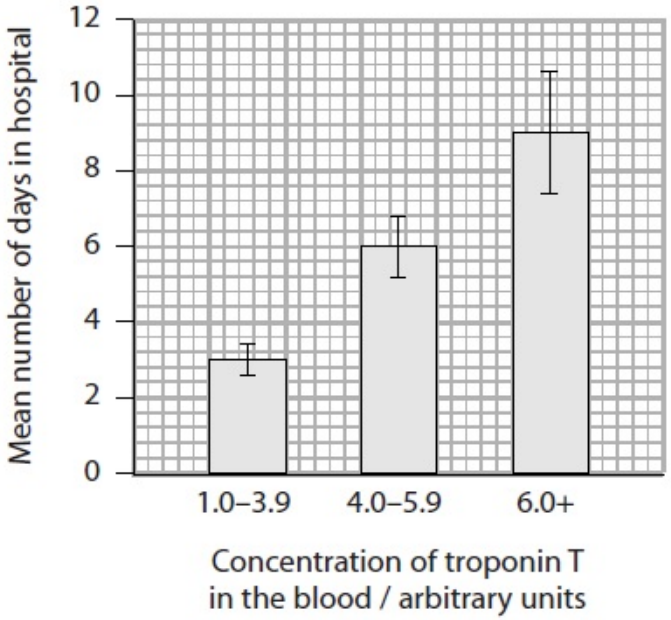
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(b) Troponin T is found in cardiac muscle cells. It can leak into the blood if the heart is damaged as a result of cardiovascular disease (CVD).

Testing for troponin T in blood can be used to study patients with CVD.

The graph below shows the concentration of troponin T in the blood of patients with CVD.

The graph also shows the mean number of days and the range of time spent in hospital.



(i) Suggest a conclusion that a doctor could draw from these data.

(1)

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(ii) Comment on the validity of the doctor's conclusion.

(2)

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(Total for Question = 8 marks)

Q14.

A mutation of the *F*2 gene causes thrombophilia, a condition that results in the production of excess prothrombin.

In this gene mutation, guanine is replaced with adenine.

(i) Name this type of mutation.

(1)

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(ii) People without this mutation have a 1 in 1000 risk of producing a blood clot in an artery.

The mutation increases this risk by 20 times.

State the probability of producing a blood clot for people with this mutation.

(1)

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(iii) Explain why thrombophilia increases the risk of producing a blood clot in an artery.

(3)

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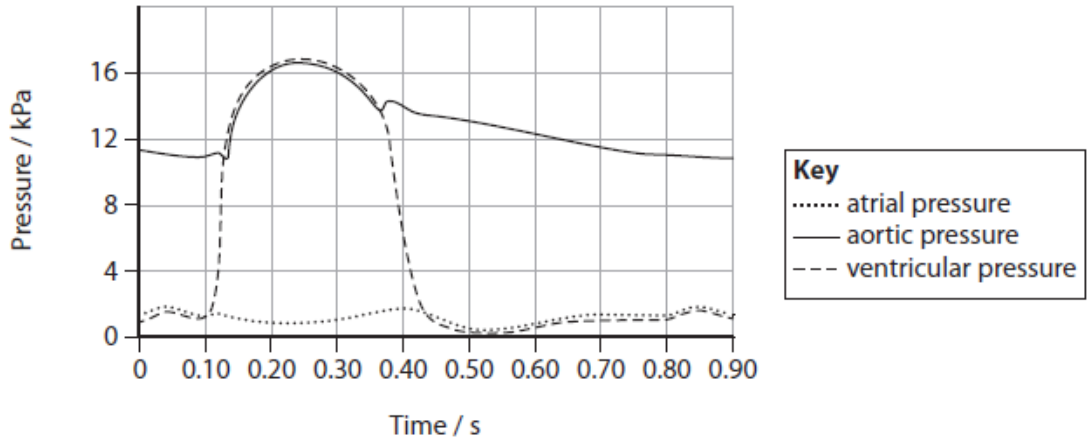
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(Total for question = 5 marks)

Q15.

The graph shows the pressure changes in the left side of the heart during one cardiac cycle.



Describe how myogenic stimulation brings about contraction of the atria and the ventricles.

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(Total for question = 5 marks)

Q16.

The venom from some species of snake contains enzymes that affect the blood clotting process.

State the role of platelets in the blood clotting process.

(1)

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(Total for question = 1 mark)

Q17.

A student investigating the factors affecting the heart rate of humans carried out a trial to find out the most reliable method of counting the number of heartbeats in one minute.

She counted the number of pulses in one minute of a single subject in identical conditions using two different methods.

Method A – she counted the number of pulses for 15 seconds and multiplied the result by 4.

Method B – she counted the number of pulses continuously for one minute.

The table below shows the results of six trials for each method.

Method	Pulse rate / beats min^{-1}						Mean pulse rate / beats min^{-1}	Standard deviation
A	64	60	68	76	64	72	67.3	5.9
B	63	59	69	58	71	74	65.7	

(a) The student calculated the standard deviation for method A using the following formula:

$$\sigma = \sqrt{\frac{\Sigma[x - \bar{x}]^2}{n - 1}}$$

Calculate the standard deviation for method B.

(3)

Answer .....

(b) Explain why standard deviation is used for analysing the data.

(3)

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(c) Explain why both methods **A** and **B** can lead to inaccuracies.

(3)

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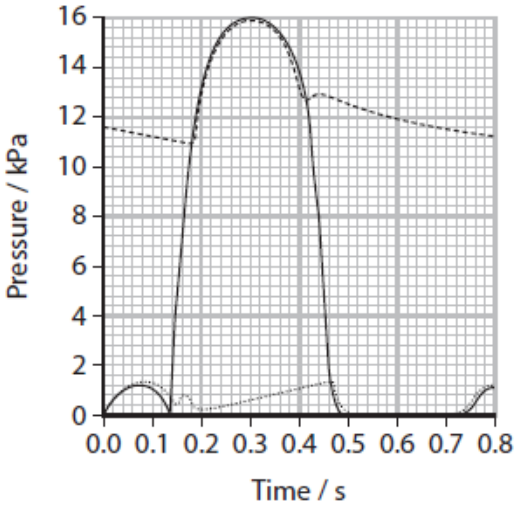
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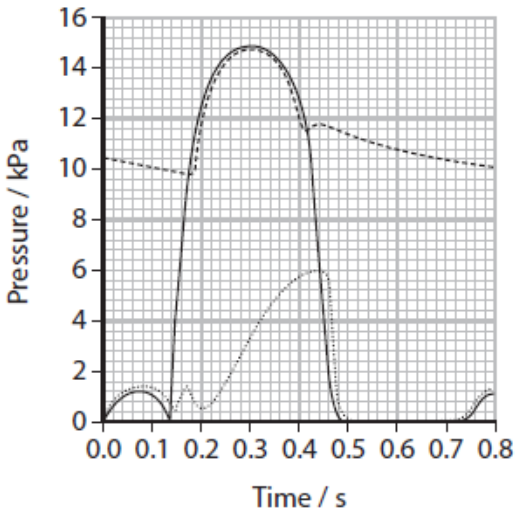
(Total for question = 9 marks)

Q18.

The graphs show the pressure changes that occur in a healthy heart and the pressure changes that occur in a heart with an atrioventricular valve that leaks.



Healthy heart



Heart with an atrioventricular valve that leaks

Key

—— left ventricle

----- aorta

..... left atrium

(i) An atrioventricular valve in the healthy heart has a surface area of 3.5 cm^2.

Determine the force that is applied to this atrioventricular valve when it closes.

Use the formula

$$\text{Pressure in kPa} = \frac{\text{Force in newtons}}{\text{Area in m}^2}$$

(3)

Answer ..... newtons

(ii) Explain why people with an atrioventricular valve that leaks find exercise difficult.

(4)

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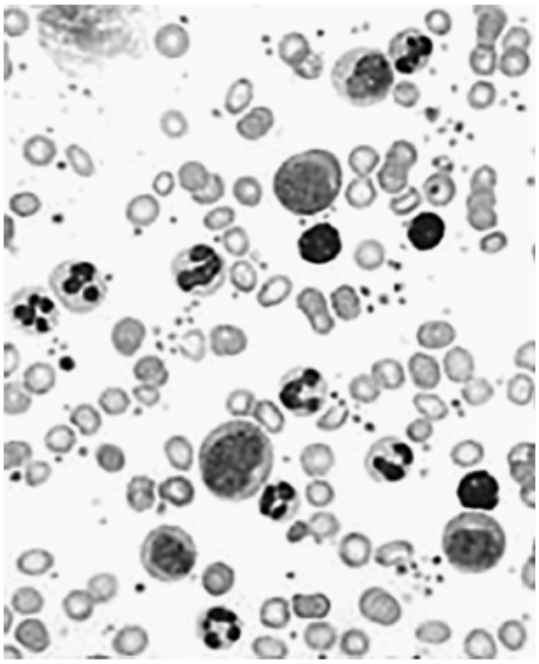
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(Total for question = 7 marks)

Q19.

The photograph shows a blood smear.



Which row of the table gives the correct number of each type of white blood cell in this photograph?

(1)

	Number of lymphocytes	Number of monocytes	Number of neutrophils
☒ **A**	3	5	8
☒ **B**	3	8	5
☒ **C**	5	3	8
☒ **D**	8	5	3

(Total for question = 1 mark)

Q20.

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 .....

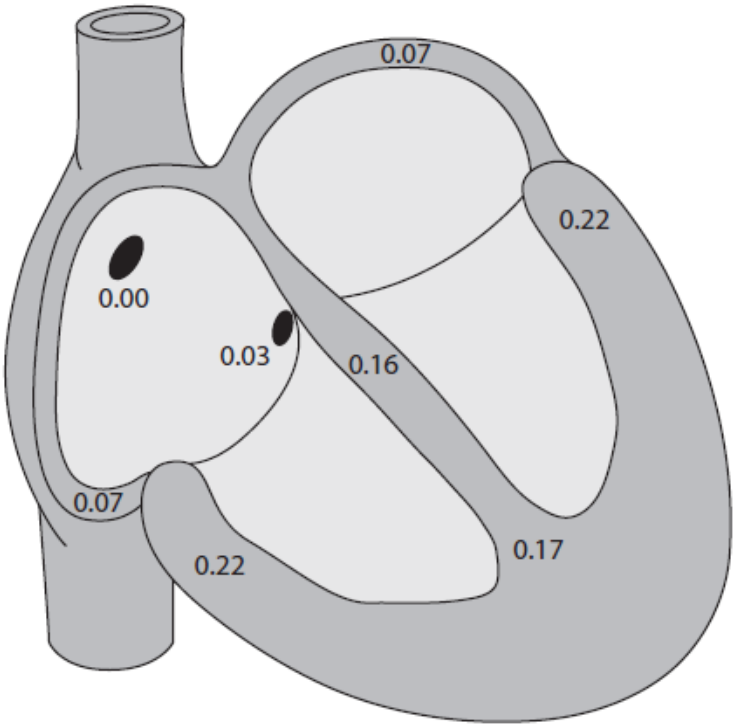
(ii) Suggest suitable units for the vertical axis (*y*-axis) of this ECG.

(1)

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Q1.

The diagram shows the time taken in seconds for an impulse to travel through the human heart.



Analyse the information to explain how the times shown in the diagram relate to the cardiac cycle.

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(Total for question = 5 marks)

Q2.

Water is the major component of tissue fluid in mammals.

In humans, left side heart failure can cause symptoms such as breathlessness, palpitations and a rapid pulse.

The table shows the mean blood pressure in the lung capillaries of patients with left side heart failure compared with healthy individuals.

Group	Mean blood pressure in the lung capillaries / arbitrary units
Healthy individuals	0.90
Left side heart failure	2.75

(i) Calculate the percentage increase in the mean blood pressure in the lung capillaries due to left side heart failure.

(1)

Answer ..... %

(ii) This increased blood pressure in the capillary will cause more tissue fluid to be formed.

Analyse this information to explain the symptom of breathlessness.

(2)

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(iii) In healthy individuals, only 80% of excess tissue fluid is reabsorbed directly into the blood

stream.

Describe how the remaining 20% is reabsorbed.

(2)

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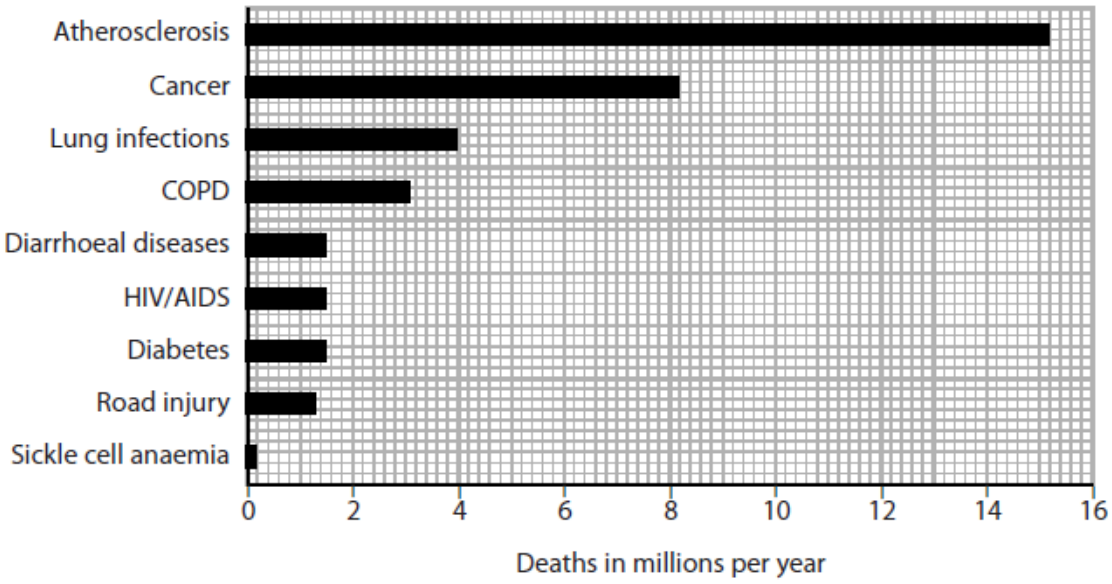
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Q3.

There are many disorders that affect the health of people.

The graph shows the number of people in the world who die each year from different health disorders.



The graph shows that atherosclerosis kills more people than any of the other disorders.

This is mainly due to its development in the coronary arteries.

(i) State the number of deaths caused by atherosclerosis.

Give your answer in standard form.

(1)

Answer .....

(ii) Describe how atherosclerosis develops in the coronary arteries.

(3)

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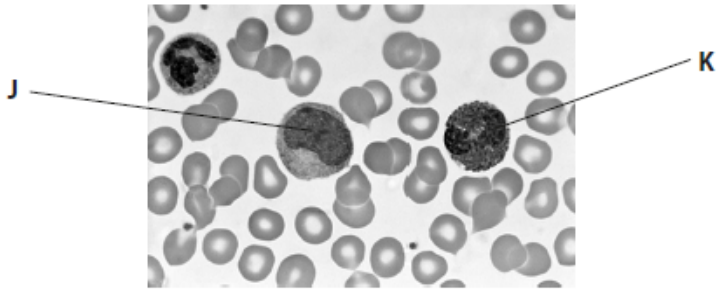
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(Total for question = 4 marks)

Q4.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The photograph shows a blood smear from a healthy person, as seen using a light microscope.



(i) Which row of the table identifies the cells labelled **J** and **K**?

(1)

	Cell J	Cell K
☒ **A**	eosinophil	lymphocyte
☒ **B**	lymphocyte	neutrophil
☒ **C**	monocyte	eosinophil
☒ **D**	neutrophil	monocyte

(ii) Which is the approximate ratio of erythrocytes to leucocytes in this blood smear?

(1)

☒ **A** 1 : 50

☒ **B** 3 : 50

☒ **C** 50 : 1

☒ **D** 50 : 3

(Total for question = 2 marks)

Q5.

Which row of the table gives the correct role of each of the blood components?

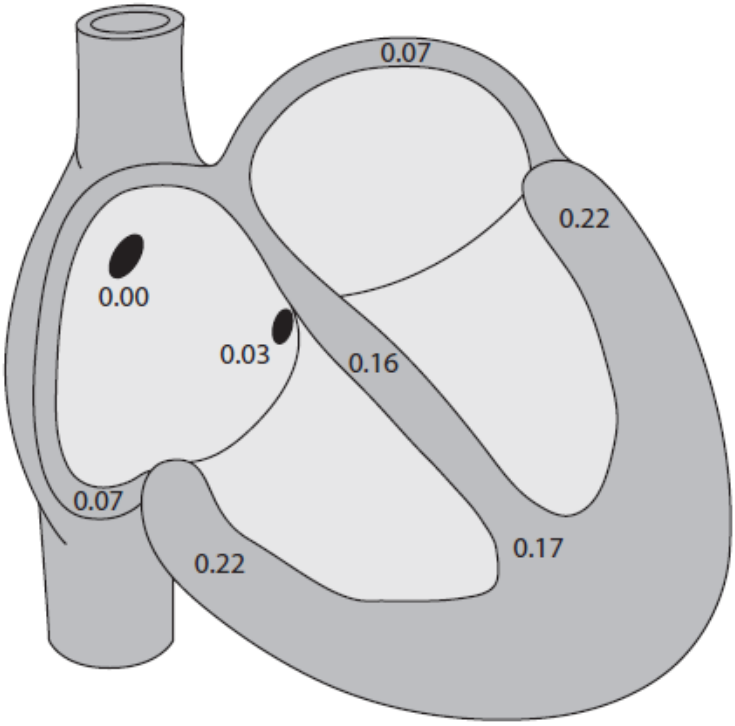
(1)

	Erythrocytes	Leucocytes	Platelets
☒ **A**	defence	transport	defence
☒ **B**	defence	defence	transport
☒ **C**	transport	defence	defence
☒ **D**	transport	transport	defence

(Total for question = 1 mark)

Q6.

The diagram shows the time taken in seconds for an impulse to travel through the human heart.



The mean heart rate of this heart was 72 beats per minute.

Calculate how long the ventricles are relaxed during one cardiac cycle.

(2)

Answer ..... s

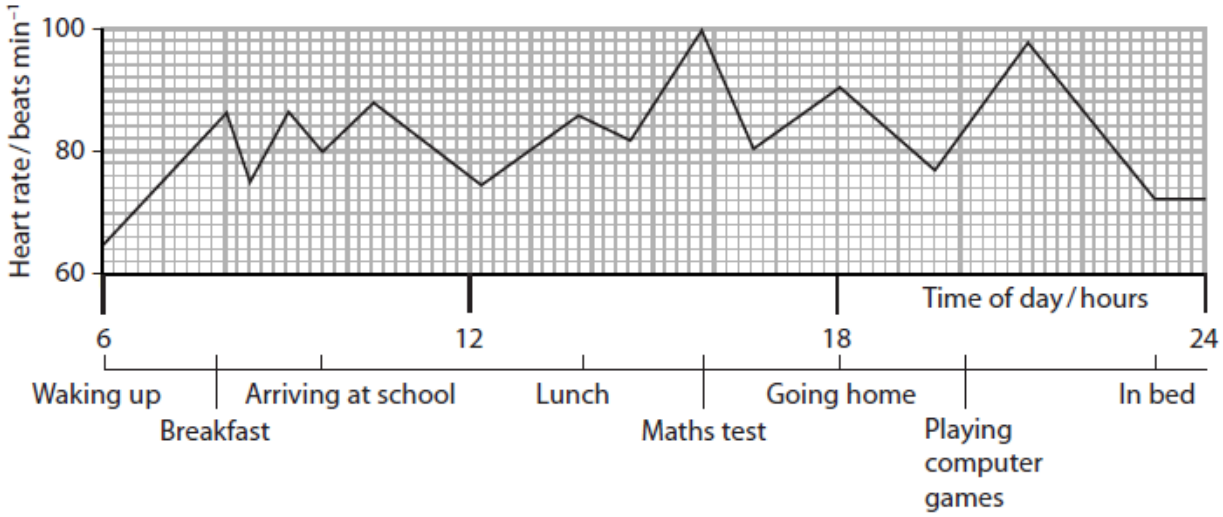
(Total for question = 2 marks)

Q7.

A student was interested to find out how his heart rate would vary throughout the day.

He wore a heart rate monitor from the time he woke up until the time he went to bed.

The graph shows the data collected and some of the student's activities during the day.



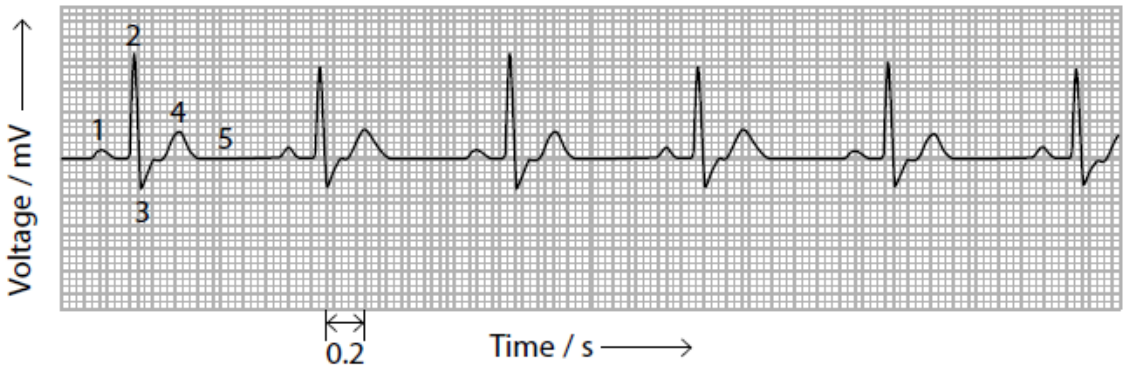
Calculate the rate of increase in the student's heart rate between 6 am and 8 am.

(2)

Answer .....

Q8.

(a) The diagram below shows an ECG trace for a person with a healthy heart.



(i) Which label identifies depolarisation of the sinoatrial node (SAN) in the cardiac cycle?

(1)

☒ **A** label 1

☒ **B** label 3

☒ **C** label 4

☒ **D** label 5

(ii) Which label identifies repolarisation of the ventricles in the cardiac cycle?

(1)

☒ **A** label 2

☒ **B** label 3

☒ **C** label 4

☒ **D** label 5

(b) Calculate the heart rate for this person.

(2)

Answer .....

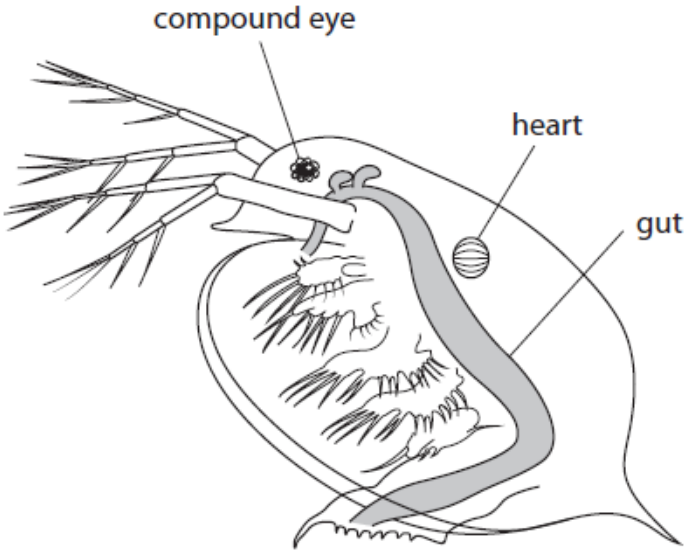
(Total for question = 4 marks)

Q9.

Water fleas are small animals that live in pond water.

A student observed a water flea using a light microscope.

The diagram shows the student's drawing of the water flea.



The water flea has a spherical heart with a diameter of 0.2 mm.

Cardiac output is the volume of blood pumped out of a heart in one minute.

The resting heart rate of a water flea is 200 beats min^{-1}.

The volume of a sphere is calculated using the formula

$$\frac{4}{3}\pi r^3$$

where $\pi = 3.142$

(i) Calculate the cardiac output of a water flea at rest using the formula

cardiac output = stroke volume × heart rate

(3)

Answer ..... $dm^3\ min^{-1}$

(ii) The cardiac output of a human heart at rest is 5.0 $dm^3\ min^{-1}$.

Give one reason why the cardiac output of a human heart at rest needs to be greater than the cardiac output of a water flea at rest.

(1)

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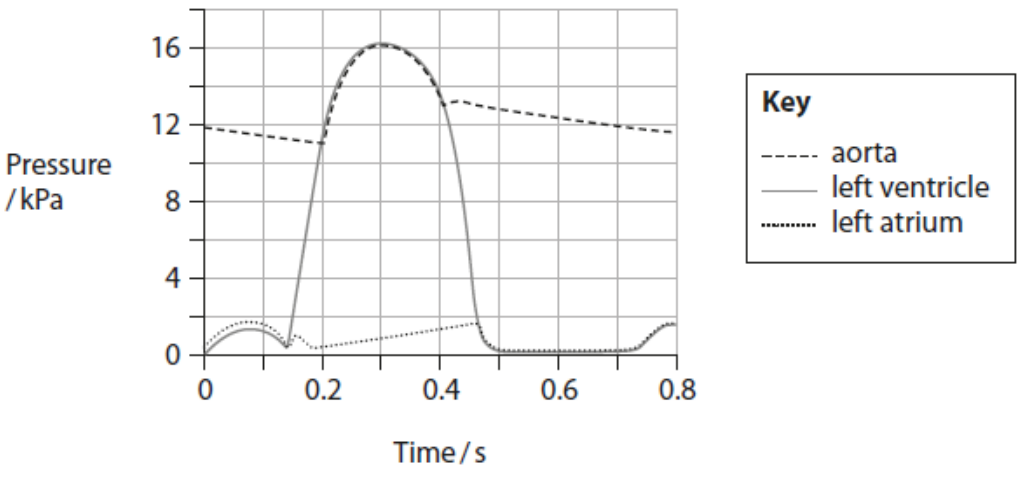
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(Total for question = 4 marks)

Q10.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The graph shows the pressure changes in the left side of the heart during one contraction.



(i) At what time does the atrioventricular (bicuspid) valve close?

(1)

☒ **A** 0.14 s

☒ **B** 0.20 s

☒ **C** 0.45 s

☒ **D** 0.40 s

(ii) Which is the sequence of structures that an impulse passes through during one heart contraction?

(1)

☒ **A** atrioventricular node, bundle of His, sinoatrial node

☒ **B** atrioventricular node, sinoatrial node, bundle of His

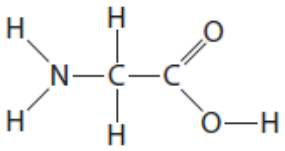
☒ **C** sinoatrial node, bundle of His, atrioventricular node

☒ **D** sinoatrial node, atrioventricular node, bundle of His

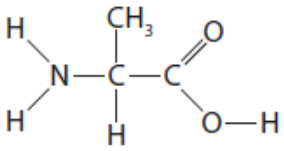
(Total for question = 2 marks)

Q11.

The diagram shows two amino acids found in the primary sequence of collagen.



glycine



alanine

Ehlers-Danlos syndrome is a human condition caused by a mutation in a collagen gene.

This causes changes to the elasticity and strength of arteries.

Mice were genetically modified to have this mutation.

The elastic constant and force required to break arteries from genetically modified mice and unmodified mice were measured.

The elastic constant is calculated by using the formula:

$$\text{elastic constant} = \frac{\text{force applied}}{\text{increase in length of artery}}$$

The results are shown in the table.

Artery	Elastic constant / N mm^{-1}	Force required to break artery / N
unmodified mice	0.26	2.0
genetically modified mice	0.12	1.6

(i) Calculate the force required to produce an increase in length of 0.5 cm for an artery taken from an unmodified mouse.

(1)

Answer .....

(ii) People with Ehlers-Danlos syndrome are at risk of developing aneurysms.

An aneurysm is an area of artery wall that weakens and can burst.

Explain why people with Ehlers-Danlos syndrome have a high risk of aneurysms.

(3)

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(Total for question = 4 marks)

Q12.

Kidney dialysis machines are used to remove urea from the blood of patients who are suffering from kidney disease.

Anti-clotting drugs are given to patients to reduce the risk of blood clot formation whilst undergoing kidney dialysis.

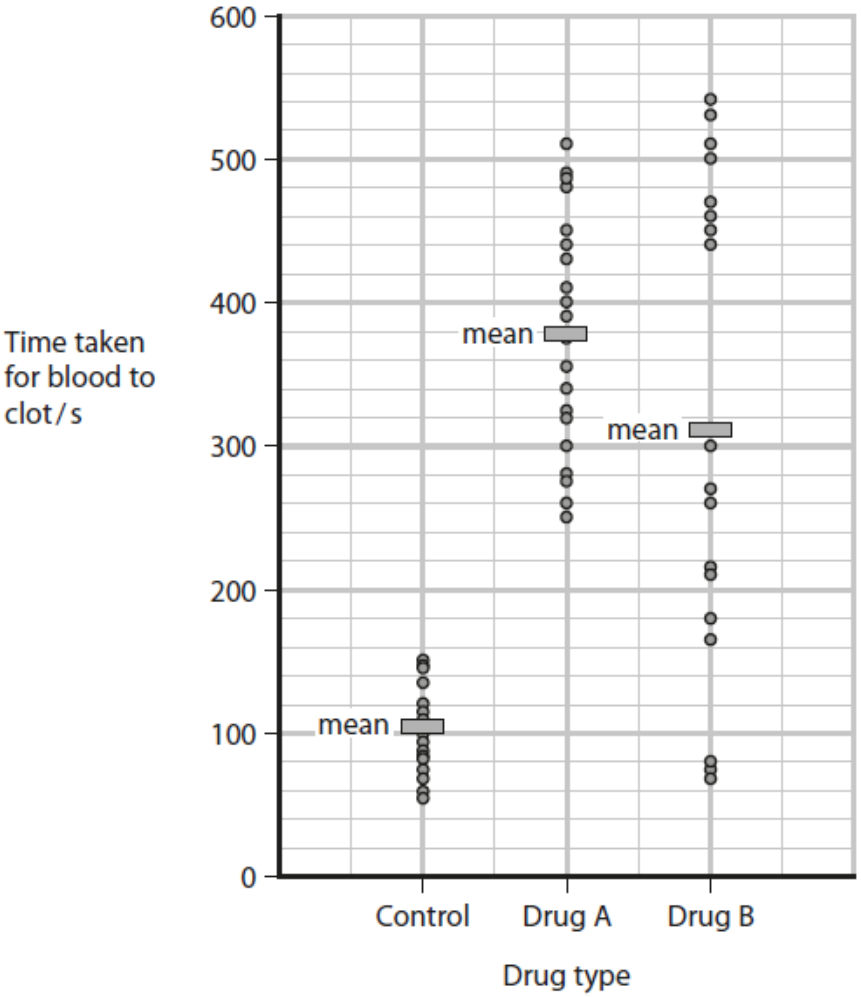
The potential use of two anti-clotting drugs, Drug A and Drug B, was investigated.

Blood samples were taken from 20 healthy adults and placed into test tubes.

The times taken for the blood samples to clot after addition of 2 mg dm^{-3} of Drug A were recorded.

This was repeated with Drug B and again with a control.

The results are shown in the graph.



It takes 40 minutes for Drug A to become inactive in a person and 110 minutes for Drug B to become inactive.

Analyse the data to discuss the use of Drug A and Drug B to prevent the formation of blood clots.

(5)

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(Total for question = 5 marks)

Q13.

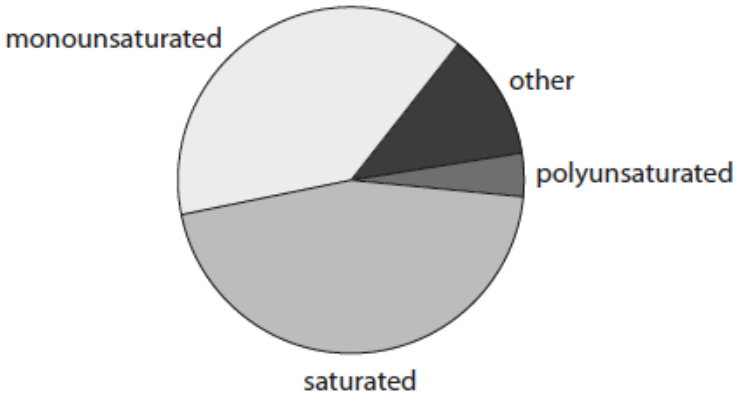
The structure of a lipid relates to its role in living organisms.

The type of lipid in the diet of a person can affect their risk of developing atherosclerosis.

The table shows the percentage content of different lipids in some products used to cook food.

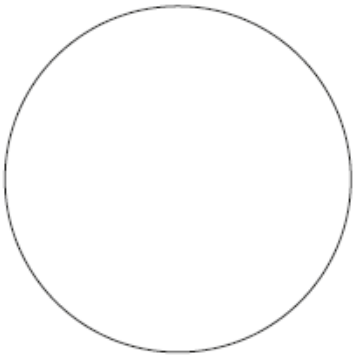
Product	Source of product	Saturated lipids	Monounsaturated lipids	Polyunsaturated lipids		Other lipids
				Omega-6	Omega-3	
Beef fat	animal	45	39	3	1	12
Butter	animal	52	24	2	1	21
Rapeseed oil	plant	7	59	20	9	5
Safflower oil	plant	10	15	75	0	0

(i) The pie chart shows the approximate ratio of the lipids in beef fat.



Complete the pie chart to show the approximate ratio of the lipids in safflower oil.

(1)



(ii) Calculate the difference in mass of polyunsaturated lipid in 500 g of safflower oil and 500 g of beef fat.

(2)

Answer ..... g

(iii) Explain why cooking food using plant products rather than animal products could lower the risk of developing atherosclerosis.

(2)

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(Total for question = 5 marks)

Q14.

The venom from some species of snake contains enzymes that affect the blood clotting process.

Factor Xa is a clotting factor present in human blood.

The table shows the effect of different masses of Factor Xa and snake venom on the time taken for blood to clot.

Mass added / μg	Time taken for blood to clot / s	
	Factor Xa added	Snake venom added
0.002	150	104
0.004	44	50
0.020	40	38
0.040	39	37

Describe the effect of snake venom on the time taken for the blood to clot.

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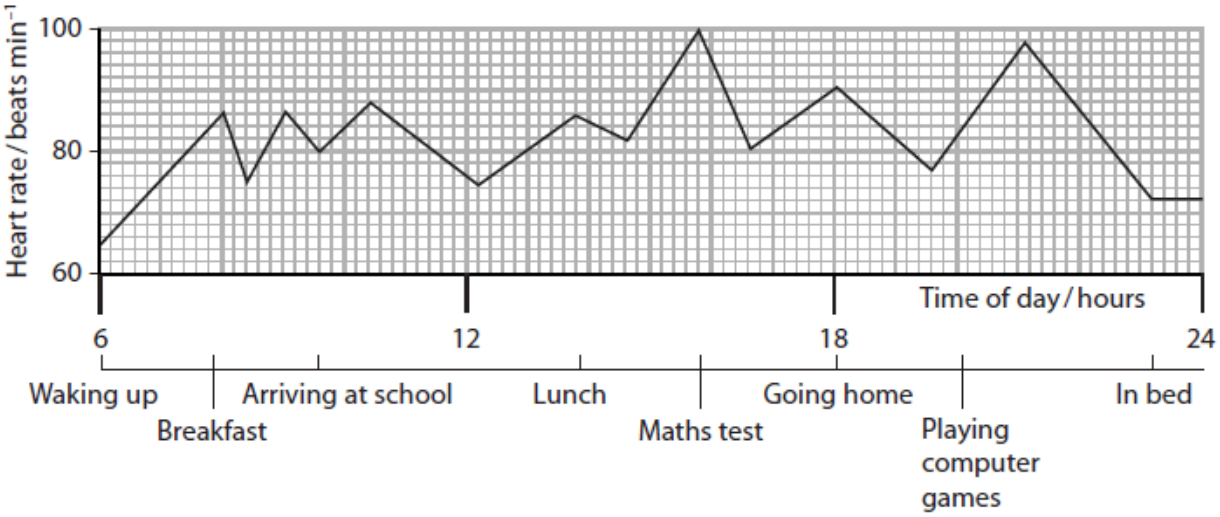
(Total for question = 2 marks)

Q15.

A student was interested to find out how his heart rate would vary throughout the day.

He wore a heart rate monitor from the time he woke up until the time he went to bed.

The graph shows the data collected and some of the student's activities during the day.



Explain why the student's heart rate changed at the time of his maths test.

(5)

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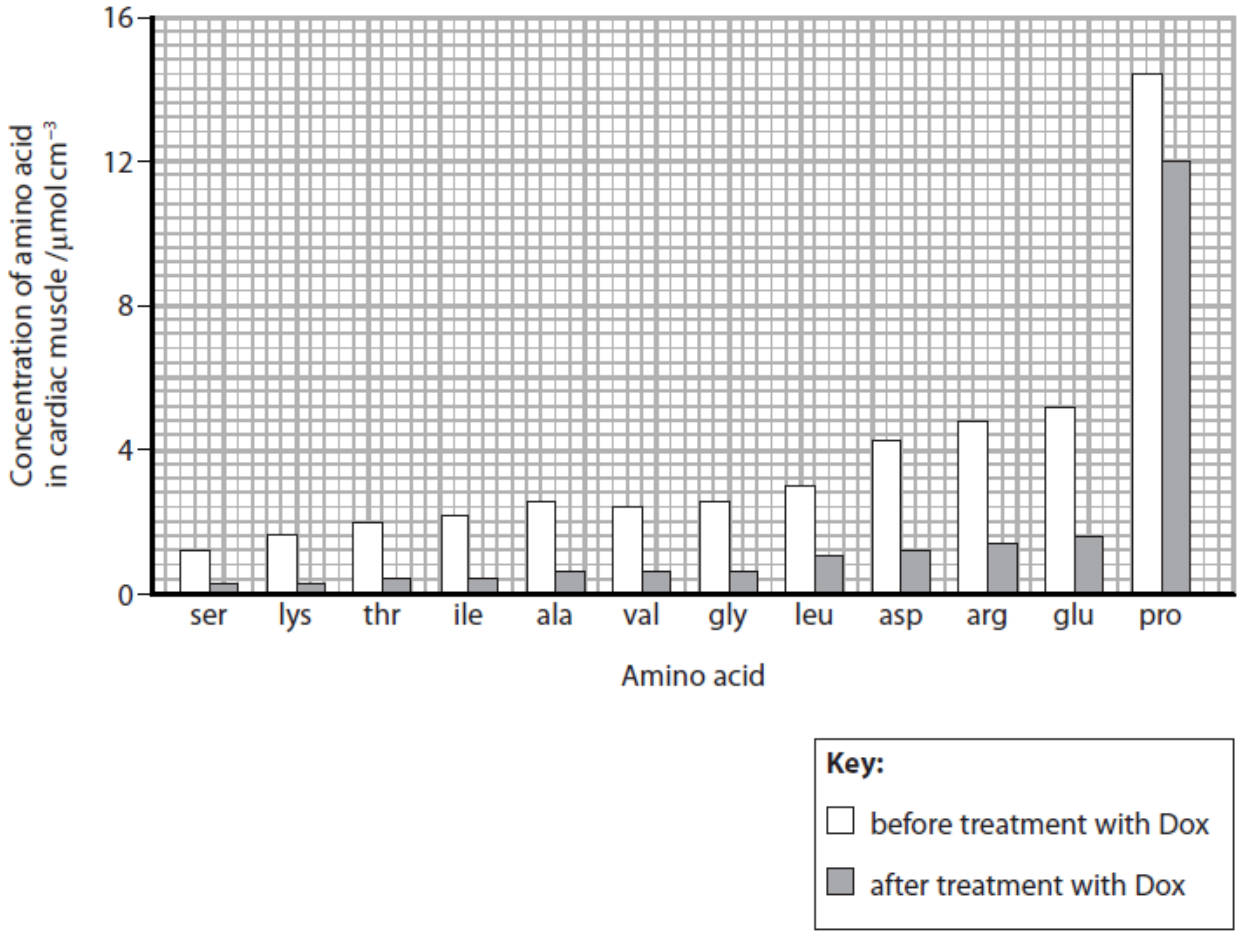
Q16.

Doxorubicin (Dox) is a drug used to treat cancer.

Weakening of the cardiac muscle is one side effect of using Dox.

The effect of Dox on the concentration of several amino acids in cardiac muscle was investigated.

The graph shows the results of this investigation.



The table shows some non-polar and polar amino acids.

Type	Amino acids
non-polar	ala, gly, ile, leu, pro, val
polar	arg, asp, glu, lys, ser, thr

* (i) Analyse the information to determine the effect of Dox on the concentration

of these types of amino acid in cardiac muscle.

(6)

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(ii) Explain why a change in the concentration of amino acids results in the weakening of cardiac muscle.

(2)

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(iii) Explain how weakening of the cardiac muscle could affect a person.

(3)

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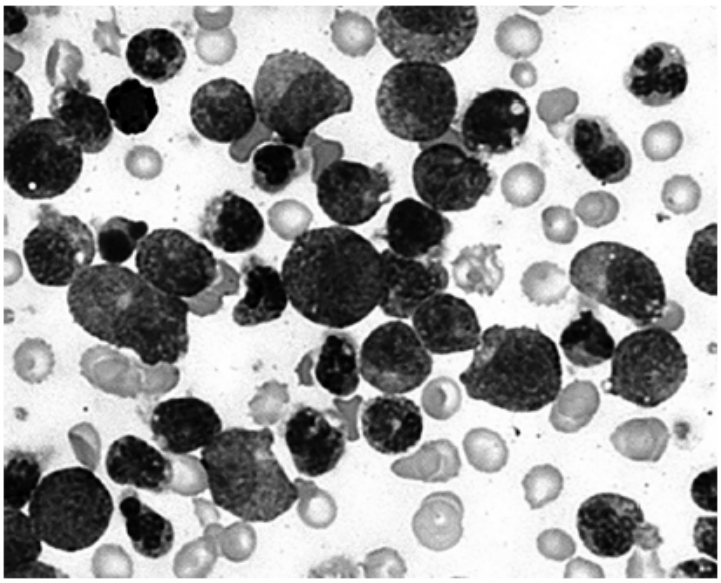
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(Total for question = 11 marks)

Q17.

Chronic myelogenous leukaemia (CML) is a blood disorder.

The photograph shows a blood smear from a person with CML, as seen using a light microscope.



Explain why a blood smear can be used to diagnose CML.

(2)

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(Total for question = 2 marks)

Q18.

A person visited their doctor with symptoms of fatigue, dizziness and mental confusion.

The doctor suspected a heart condition and carried out an electrocardiogram (ECG).

The chart shows this ECG trace.



(i) Which wave of a normal ECG trace is missing?

(1)

☒ **A** P

☒ **B** QRS

☒ **C** ST

☒ **D** T

(ii) The doctor diagnosed a heart condition called 'Sick Sinus Syndrome' (SSS).

Use the information in the trace to explain the electrical activity in this person's heart

(3)

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(iii) The diagram shows a normal ECG trace.



Calculate the difference between the heart rates of this normal ECG trace and that of the person with Sick Sinus Syndrome.

(2)

Answer ..... beats min^{-1}

(iv) Analyse the data to explain the symptoms of Sick Sinus Syndrome.

(2)

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(Total for question = 8 marks)

Q19.

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.

One physiological change will be an increase in cardiac output.

(4)

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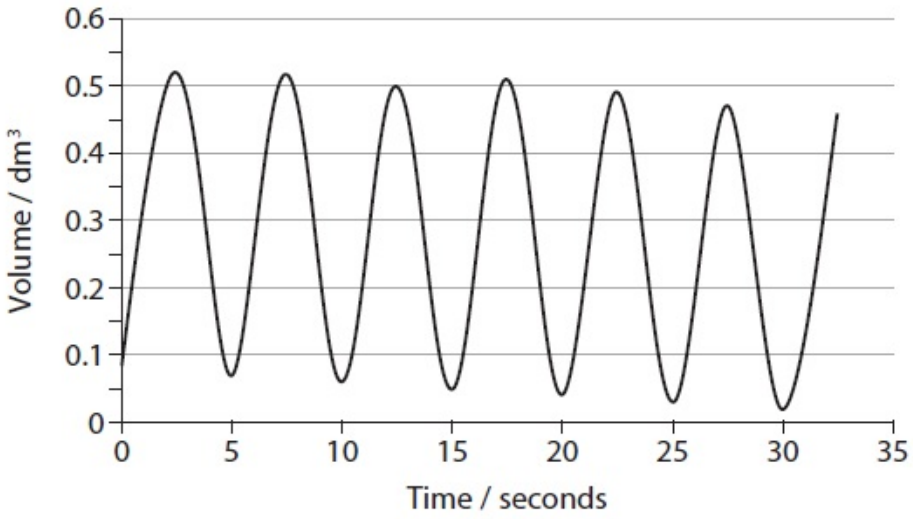
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(b) The respiratory system will also undergo physiological changes during a period of exercise.

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) The light conditions experienced by group B were similar to those found near ground level in woodland.

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 = 10 marks)

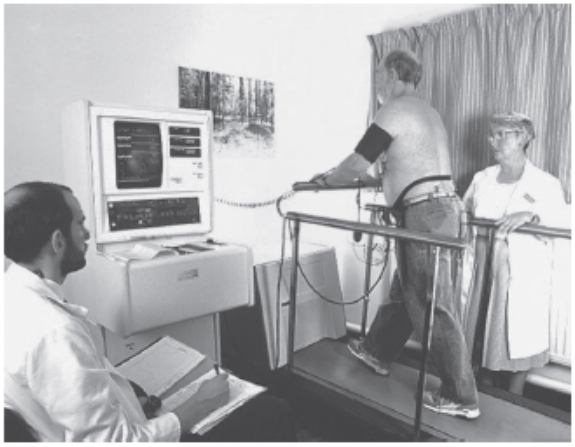
Q20.

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

* 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)

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