

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 4: EXCHANGE AND TRANSPORT CIRCULATION

SCORE

/179

PERCENTAGE

%

STEMUP

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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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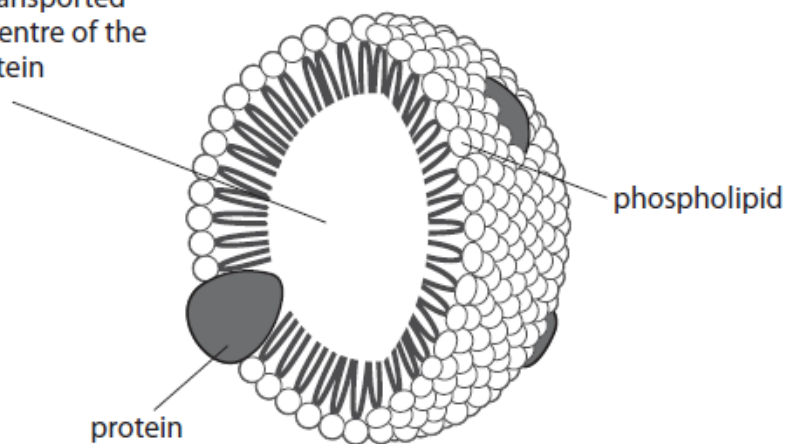
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Q2.

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

The diagram shows a lipoprotein.

cholesterol and fatty acids transported in the centre of the 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)

(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.

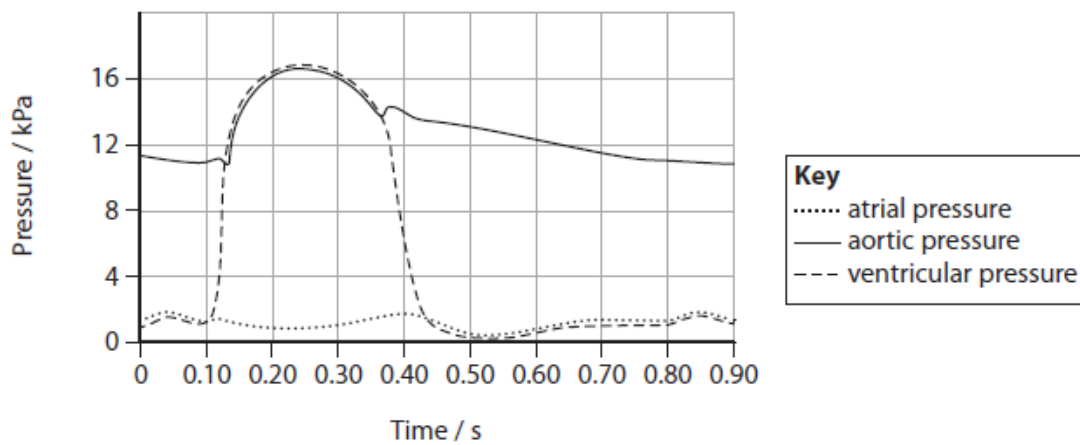
Explain why heart cells are damaged as a result of heart disease.

(2)

(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

(Total for question = 3 marks)

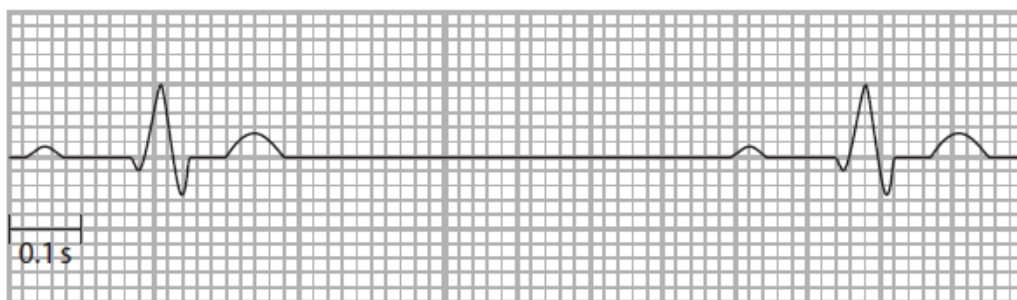
Q6.

The brain is involved in many homeostatic mechanisms.

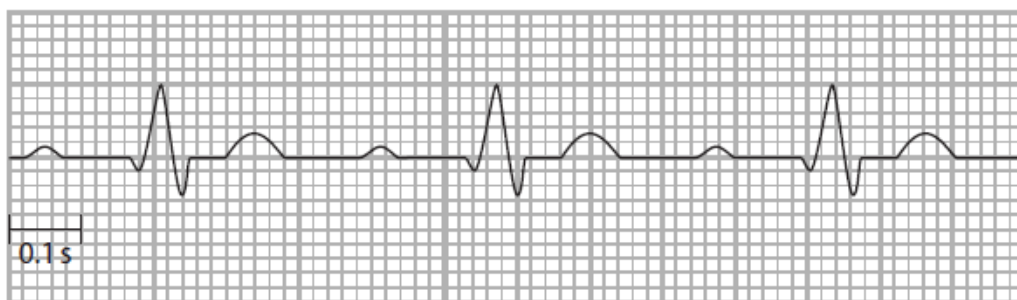
The autonomic nervous system plays a role in regulating heart rate.

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

before exercise



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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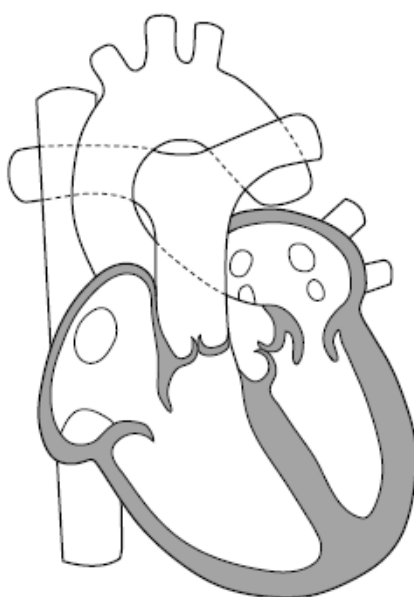
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(Total for question = 3 marks)

Q8.

The diagram below shows the structure of a mammalian heart.

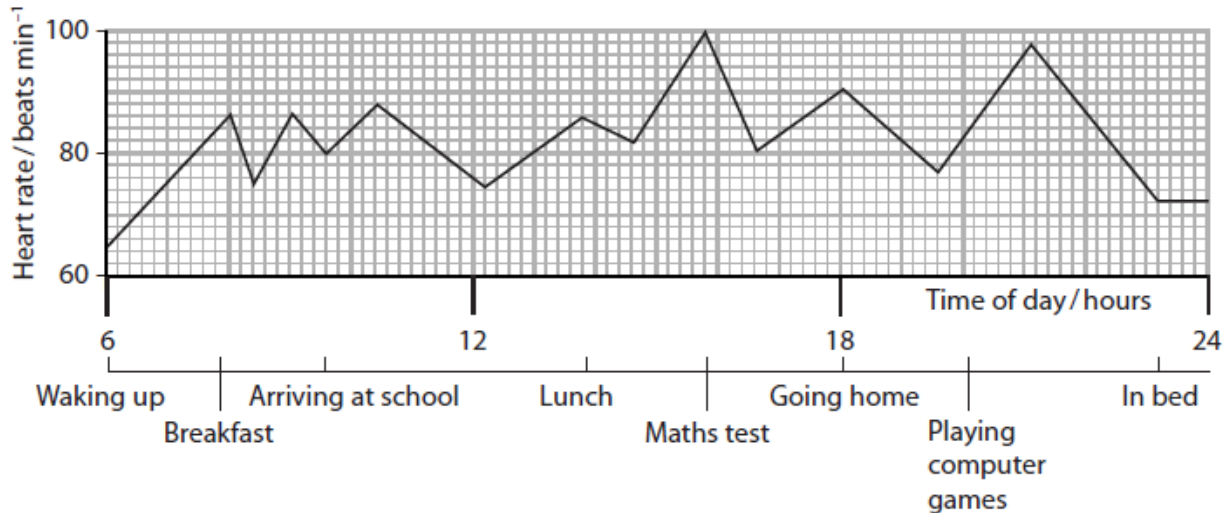


Which stage of the cardiac cycle is shown by this heart?

- ☒ **A** atrial systole and ventricular systole
- ☒ **B** atrial systole and ventricular diastole
- ☒ **C** atrial diastole and ventricular systole
- ☒ **D** atrial diastole and ventricular diastole

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.

(4)

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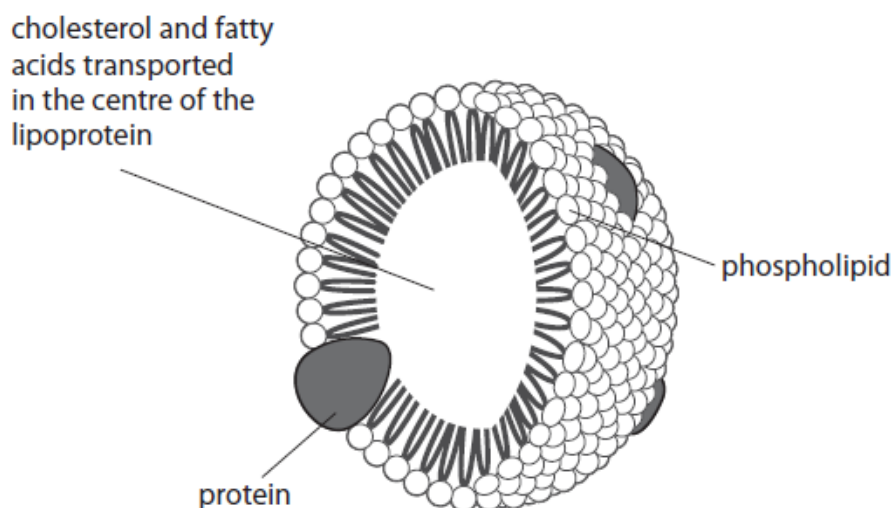
(ii) Sketch a suitable graph that the student could use to present the results of his investigation.

(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:

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

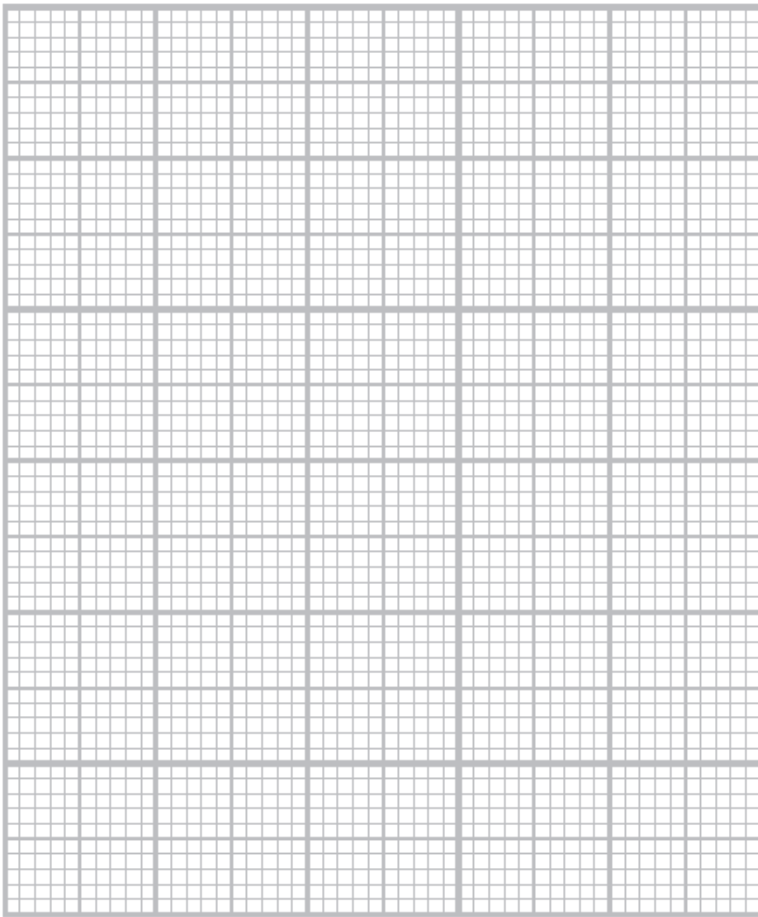
$$SD = \sqrt{\frac{\sum (X - \bar{X})^2}{n - 1}}$$

(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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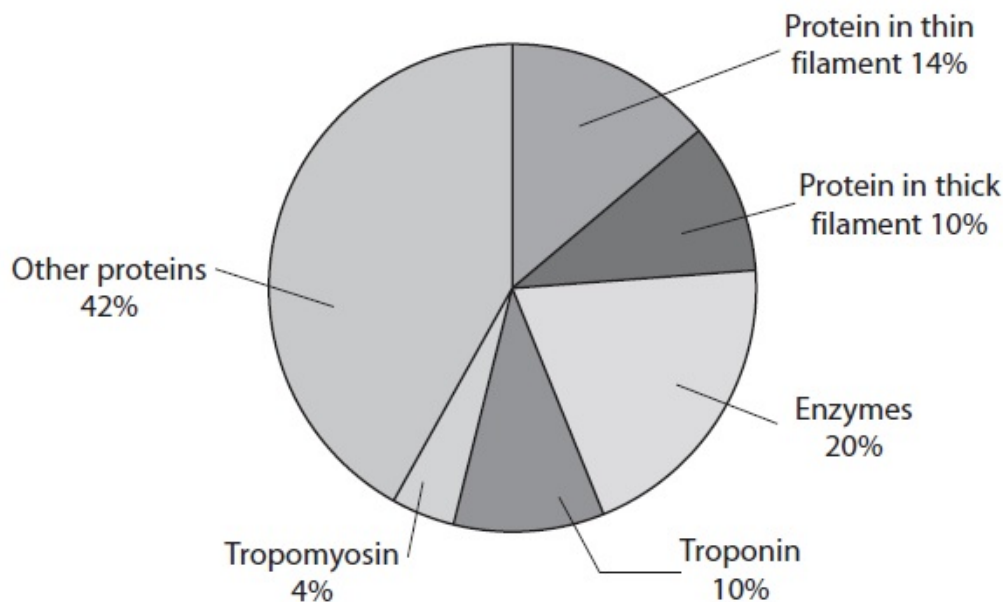
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(Total for question = 6 marks)

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.

(3)

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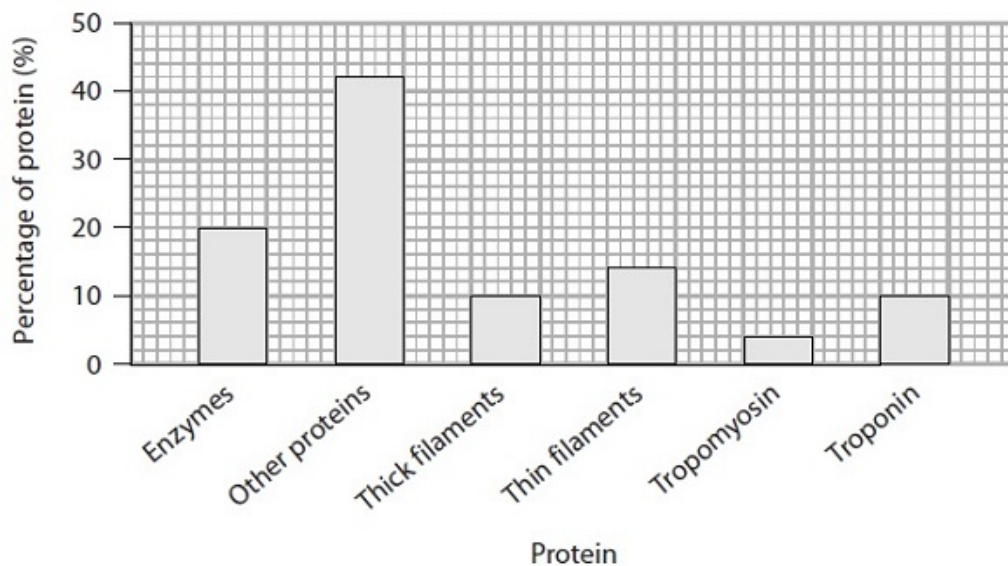
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(Total for Question = 8 marks)

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:
%

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)

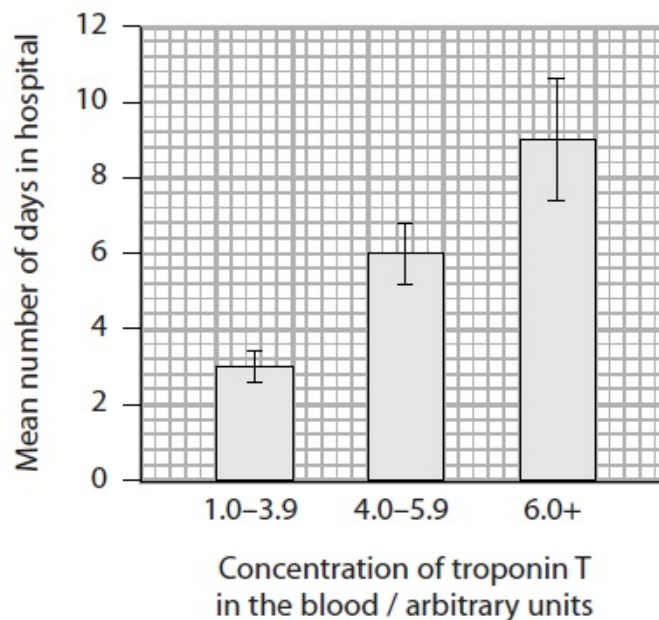
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(b) Troponin T is found in cardiac muscle cells. It can leak into the blood if the heart is damaged as a result of cardiovascular disease (CVD).

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 *F2* 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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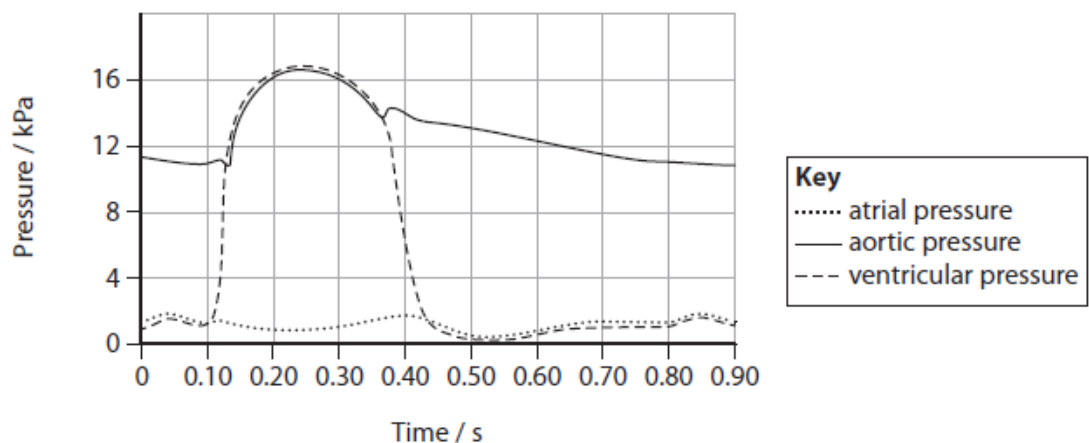
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(Total for question = 5 marks)

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:

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

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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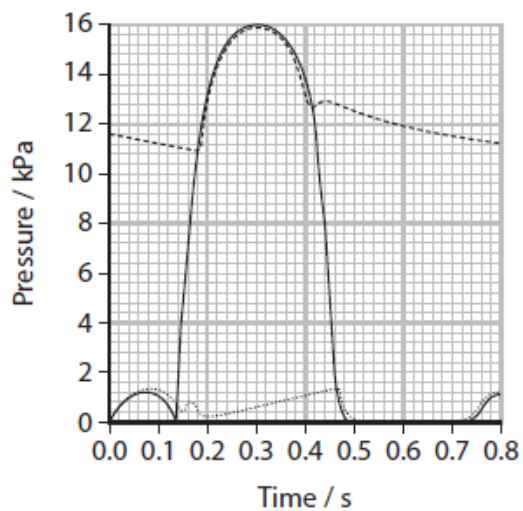
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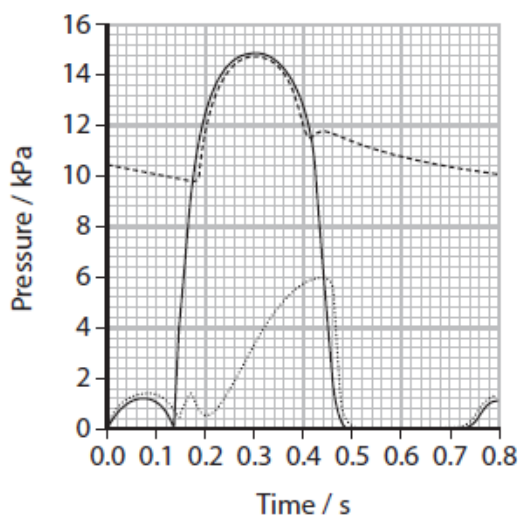
(Total for question = 9 marks)

Q18.

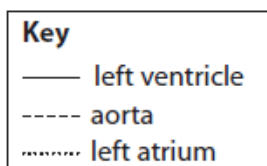
The graphs show the pressure changes that occur in a healthy heart and the pressure changes that occur in a heart with an atrioventricular valve that leaks.



Healthy heart



Heart with an atrioventricular valve that leaks



(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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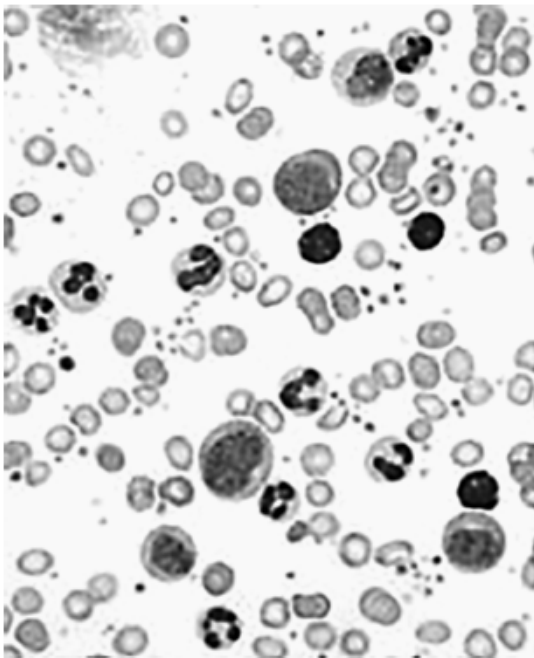
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(Total for question = 7 marks)

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

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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Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	- idea that initiates electrical activity over atria ; - causes atria to contract / eq ; {forcing / eq} the (oxygenated) blood into the left ventricle / eq ; - electrical activity from SAN {received by AVN / travels through {bundle of His / Purkyne fibres / eq }} ; - causing left ventricle to contract (forcing blood into aorta) / eq ;	ACCEPT initiates impulse / initiates depolarisation ACCEPT systole for contract ACCEPT Purkinje for Purkyne ACCEPT systole for contract NOT left and right	(4)

Q2.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: - because {cholesterol / fatty acids} are hydrophobic (so cannot be carried in bloodstream) (1) - phospholipid tails are hydrophobic so {cholesterol / fatty acids} can be carried inside lipoprotein (1) {protein / phospholipid heads} in lipoprotein are hydrophilic (enabling transport in bloodstream) (1)	ACCEPT non-polar ACCEPT non-polar ACCEPT polar	

Q3.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: - more men than women are affected and heart disease increases with age (1) - gender because {presence of oestrogen in women / more men than women smoke} (1) - age because {more time to develop atherosclerosis / less active lifestyle / higher blood pressure / less elastic arteries} (1)	Accept pieced together answer	(2)

Q4.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: - the { atheroma / plaque / (blood) clot} blocks the (coronary) artery (1) - therefore the heart {cells / muscle} are deprived of {oxygen / glucose} (1) - therefore respiration cannot take place (1)	Accept atherosclerosis results in the (coronary) artery being blocked Accept they (heart cells) are deprived of oxygen / less oxygen {reaches / transported to} the cells / ischaemia / reduction in flow of oxygenated blood	(2)

Q5.

Question Number	Answer	Additional Guidance	Mark
(i)	time of cardiac cycle read from graph and divided into 60	$60 \div 0.8 = 75$ (beats per minute)	(1)

Question Number	Answer	Mark
(ii)	The only correct answer is C <i>A is not correct because the aortic pressure is higher than the ventricular pressure</i> <i>B is not correct because the aortic pressure is higher than the ventricular pressure between 0.10 s to 0.13 s</i> <i>D is not correct because the aortic pressure is higher than the ventricular pressure between 0.37 s and 0.43 s</i>	(1)

Question Number	Answer	Mark
(iii)	The only correct answer is A <i>B is not correct because 0.13 s is when the semi-lunar valve opens</i> <i>C is not correct because 0.37 s is when the semi-lunar valve closes</i> <i>D is not correct because 0.43 s is when the atrio-ventricular valve opens</i>	(1)

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	127.6 – 130.4 beats per minute / bpm	Accept any number between and including 127.6 and 130.4 beats per minute / bpm	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	A description that makes reference to four of the following: • exercise {increases carbon dioxide / lowers pH / increases H⁺ / increases lactate} in blood (1) • detected by chemoreceptors in the {carotid artery / aorta / aortic body / carotid body} (1) • impulses sent to {medulla / cardio acceleratory centre / cardiac control centre} (1) • impulses along sympathetic {nervous system / nerve / neurone} (1) • noradrenaline {is released onto / stimulates} SA node (1)	Do not accept signal / message Do not accept signal / message Accept adrenaline stimulates SA node	(4)

Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	• (other : pulmonary) 2.5 : 1 / 2.5 / 1 : 0.4 / 0.4 • (pulmonary : other) 1 : 2.5 / 2.5 / 0.4 : 1 / 0.4	DO NOT ACCEPT with units	(1) GRAD

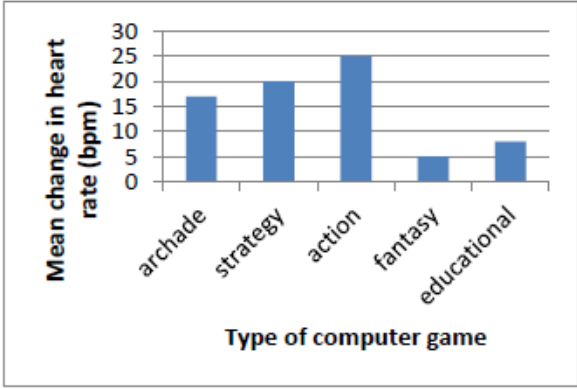
Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • (partial pressure of oxygen is low in) pulmonary artery is carrying deoxygenated blood to lungs (1) • (partial pressure of oxygen is high in) arterial blood is carrying oxygenated blood to the {body / cells / tissues} (1)	NB piece together ACCEPT deoxygenated as it has come back from the body ACCEPT oxygenated as it has been through lungs	(2) EXP

Q8.

Question Number	Correct Answer	Additional guidance	Mark
	B		(1)

Q9.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to four of the following: • all games must be played for the same length of time to make a valid comparison (1) • a recovery period is needed for the heart rate to return to normal before each subsequent game (1) • repeats should be { at the same time of day / under the same conditions } to avoid effect of other variables (1) • games should be tested in a different sequence each time, to account for effects of fatigue (1) • more individuals should be tested, other than the student himself, to obtain valid results (1)		(4)

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	- bar chart (1) - x-axis: type of computer game and y-axis: mean change in heart rate (1)	 Mean change in heart rate (bpm) Type of computer game	(2)

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	- substitution of values into equation - answer given to 3 or 4 sig figs	$\frac{4}{3} \times \pi \times 11 \times 11 \times 11 /$ 5572.453 $5570 / 5572$ ACCEPT 5580 / 5575 for 1 mark	

Question Number	Answer		Mark
(ii)	An explanation that makes reference to two of the following: because (in the LDL) there is less protein (contained in a larger volume) (1)	ACCEPT converse statements for HDL	
	- because the protein is denser than the phospholipid (in the LDL) (1) (the LDL has) {a larger hole in the middle / fewer molecules in relation to its size} (1)	ACCEPT types of protein in HDL are denser than the types in LDL	

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to four of the following: - because cholesterol is a risk factor (1) (because of raised LDLs) more cholesterol in the blood (1) {cholesterol / plaque / atheroma} builds up in (walls of) artery (1) - reducing the flow of blood to the heart {tissue / cells} (1) - therefore lack of oxygen for (aerobic) respiration (in heart cells) (1)		

Q11.

Question Number	Answer	Additional Guidance	Mark
(i)	- calculate sum of d^2 and divide (1) - calculate square root (1)	$50 \div 2 = 25$ 5.0 Correct answer gains full marks, with no working shown.	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: - one axis labelled mean heart rate with units, linear scale starting at 0 (not broken scale), bars labelled and covers at least half the grid (1) - accurate plot and standard deviations (1)		(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to two of the following: - for valid comparison / to get a valid result (1) and any one from the following: - temperature because {water fleas are ectotherms / affects heart rate} (1) {carbon dioxide / pH} affects heart rate (1) - time of measuring because water fleas may fatigue (1) - acclimatisation to allow equal time for substances to take effect (1)	Accept to ensure the treatment is the only factor affecting heartrate	(2)

Q12.

Question Number	Answer	Additional guidance	Mark
(a)(i)	(protein in thin filament) - actin / G actin ; (protein in thick filament) - myosin ;		(2)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	{Ca²⁺ / calcium ions} bind to troponin ; - troponin {changes shape / moves / eq} ; - this displaces tropomyosin (away from myosin) / eq ;	ACCEPT 3 – pulls/shifts/moves tropomyosin	(2)

Question Number	Answer	Additional guidance	Mark
(a)(iii)	acetylcholine / {noradrenaline / eq} ;	ACCEPT – ACh, noradrenalin, norepinephrine	(1)

Question Number	Answer	Additional guidance	Mark
(b)	1. the higher troponin T, the longer the stay / eq ; 2. reliability of prediction decreases as troponin T concentration increases ; 3. because {range / eq} increases ; 4. least reliable for 6.0+ as range is largest ; 5. one range stated e.g. for 6.0+ it is 7 to 11 days ; 6. reference to range overlapping between 4.0-5.9 and 6.0+ ; 7. idea that 6.0+ is too wide a category for conc. of troponin T ; 8. idea that the higher the troponin T, the greater the damage to the heart ;	ACCEPT 1 - converse ACCEPT 2 - converse, less reliable at high troponin T ACCEPT 3 - range of the length of stay, range of data ACCEPT 4 - converse for 1.0-3.9 / 4.0-5.9	(3)

Q13.

Question Number	Answer	Additional Comments	Mark
(a)(i)	Actin = 14 (%) _{...%} Myosin = 10 (%) _{...%}	For Actin Accept 28 (%)	(2)

Question Number	Answer	Additional Comments	Mark
(a)(ii)	1. {Ca²⁺ / eq} bind to troponin ; 2. troponin molecules {changes shape / moves / eq} ; 3. idea that this displaces tropomyosin ;	3. Ignore comments on exposing myosin binding sites	(2)

Question Number	Answer	Additional Comments	Mark
(a)(iii)	{right/ R} atrium ;		(1)

Question Number	Answer	Additional Comments	Mark
(b)(i)	The higher the concentration of troponin T in the blood, the higher the mean number of days in hospital / eq ;	Accept the longer the stay in hospital Accept the higher the concentration of troponin T in the blood, the more severe the CVD is T1 (1)	

Question Number	Answer	Additional Comments	Mark
(b)(ii)	1. idea that the conclusion is valid ; 2. as there is no overlap between the range of data for each concentration of troponin T / eq ; 3. the validity (of the conclusion) becomes less the higher the concentration of troponin T / eq ; 4. (because) the data becomes less reliable at higher concentrations of troponin T / eq ; 5. idea that the range of data becomes greater ;	Accept comments relating to spread of data or standard deviations	(2)

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	substitution	Accept point mutation	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	1 in 50	Accept other correct probabilities e.g. 2% or 0.02	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: (excess prothrombin means) more thrombin (1) - therefore increased {conversion / catalysis} of fibrinogen to fibrin (1) - fibrin {is insoluble / traps blood cells / forms mesh / forms net} (1)	Accept if there is more fibrin it is more likely to clot	(3)

Q15.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to five of the following: • (myogenic means) no external nerve impulses / doesn't require nerve impulse / no stimulation from brain / generated from within heart (1) • (contraction initiated by) SAN (1) • {depolarisation / wave of excitation} causes {atria to contract / atrial systole} (1) • delay at the AVN (1) • (depolarisation) through the {bundle of His / Purkyne fibres} (1) • (depolarisation) causing {ventricle to contract / ventricular systole} from base/apex of heart (1)	ACCEPT no outside stimulation (needed to contract heart) ACCEPT impulses	(5)

Q16.

Question Number	Answer	Additional Guidance	Mark
	form a {plug / mesh / scab / barrier / thrombus} to seal the {blood vessel / wound} / release {clotting factors / thromboplastin}	ACCEPT to stop bleeding / to prevent {infection / microorganisms entering} DO NOT ACCEPT prothrombin / thrombin / fibrinogen / fibrin	(1)

Q17.

Question Number	Correct Answer	Additional guidance	Mark
(a)	Numerator = 219.34 (1) Denominator = 5 (1) Standard deviation = 6.6 (1)	Correct answer gains full marks	(3)

Question Number	Correct Answer	Additional guidance	Mark
(b)	An explanation that makes reference to the following: • S.D. shows variation from the mean (1) • a larger S.D. means greater spread, smaller S.D. is more reliable representation of the data (1) • therefore although ranges of A and B are the same, the S.D. shows there is more variation in the data for method B (1)	S.D. indicates spread of data	(3)

Question Number	Correct Answer	Additional guidance	Mark
(c)	An explanation that makes reference to the following: • for method A if there is an error made it is multiplied by four, when calculating pulse rate per minute (1) • for method B counting for one minute may lead to inaccuracy due to loss of concentration (1) • both methods are measuring pulse rate rather than heart rate (1)		(3)

Q18.

Question Number	Answer	Additional Guidance	Mark
(i)	- correct identification of pressure when the valve closes (1) - conversion of cm^2 into m^2 (1) - correct calculation of force (1)	Example of calculation: 0.8 kPa Accept reading between 0.6 – 0.8 (one mark) 0.00035 m^2 or 3.5×10^{-4} (one mark) 0.00028 N (three marks) Accept final answer between 0.00021 – 0.00028 Accept correct standard form 2.1×10^{-4} to 2.8×10^{-4} Correct answer with no working gains full marks ECF for mp 3 if either or both wrong graph reading / wrong area conversion	3 exp

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to four of the following points: - pressure rises in the atrium during contraction (of ventricle) (1) (because) blood is flowing back into the atrium (1) - lower pressure in aorta / lower pressure in ventricle / lower pressure in systemic (circulatory system) (1) - therefore less oxygenated blood flows to muscles / slower flow of oxygen to muscles (1) - so there is less respiration (in muscles) (1)	Accept pressure in atrium rises during systole Accept valve prevents backflow into atrium Accept less / slower (deoxygenated) blood to lungs Accept less ATP produced / more anaerobic respiration	4 expert

Q19.

Question Number	Answer	Mark
	The only correct answer is A <i>B is not correct because there are 5 monocytes and 8 neutrophils</i> <i>C is not correct because there are 3 lymphocytes, 5 monocytes and 8 neutrophils</i> <i>D is not correct because there are 3 lymphocytes</i>	(1)

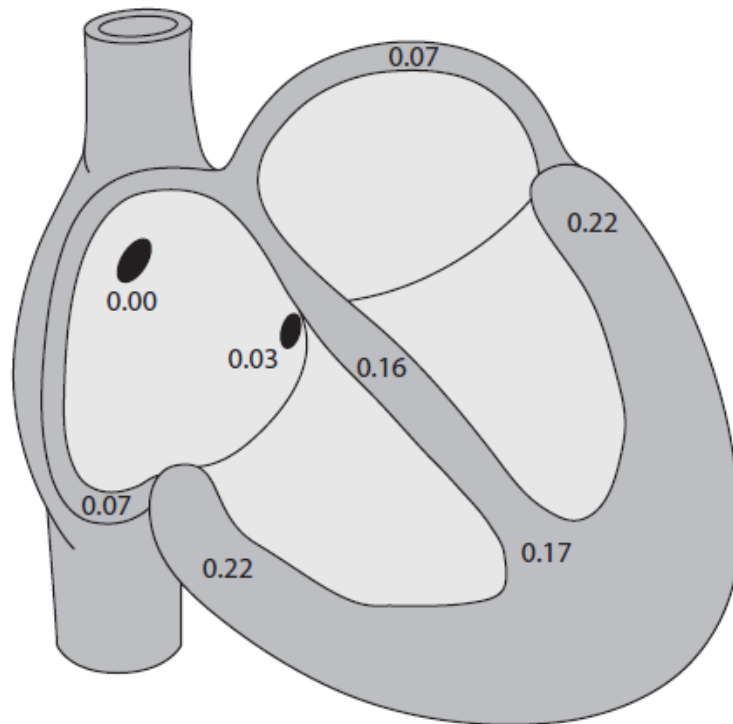
Q20.

Question Number	Answer	Additional Guidance	Mark
(i)	Correct answer with units gains 2 marks 1 beat = 0.81 sec / 60 ÷ 74 / eq ; 8.1 seconds ;	ACCEPT 8.11 seconds	(2)

Question Number	Answer	Mark
(ii)	mV / millivolts / eq ;	(1)

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.

(5)

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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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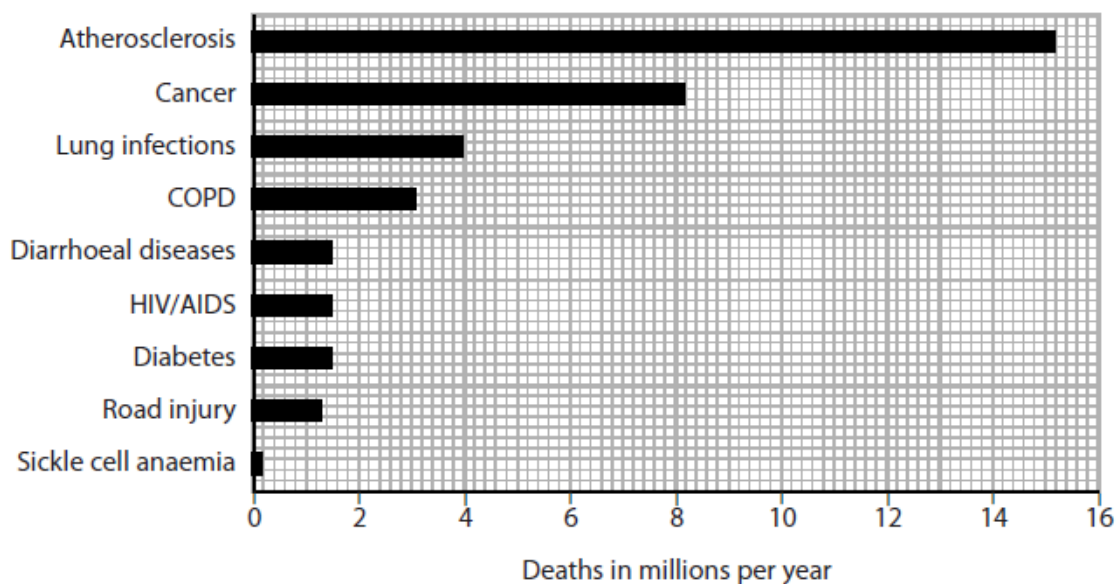
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Q3.

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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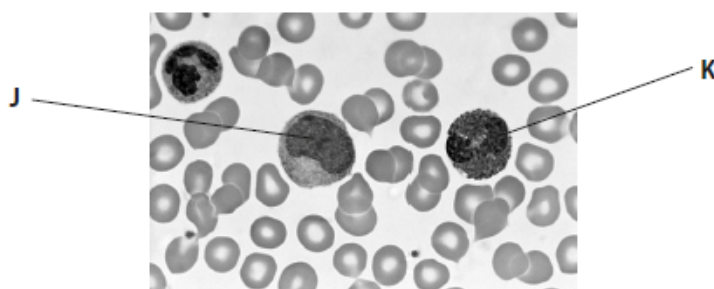
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(Total for question = 4 marks)

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?

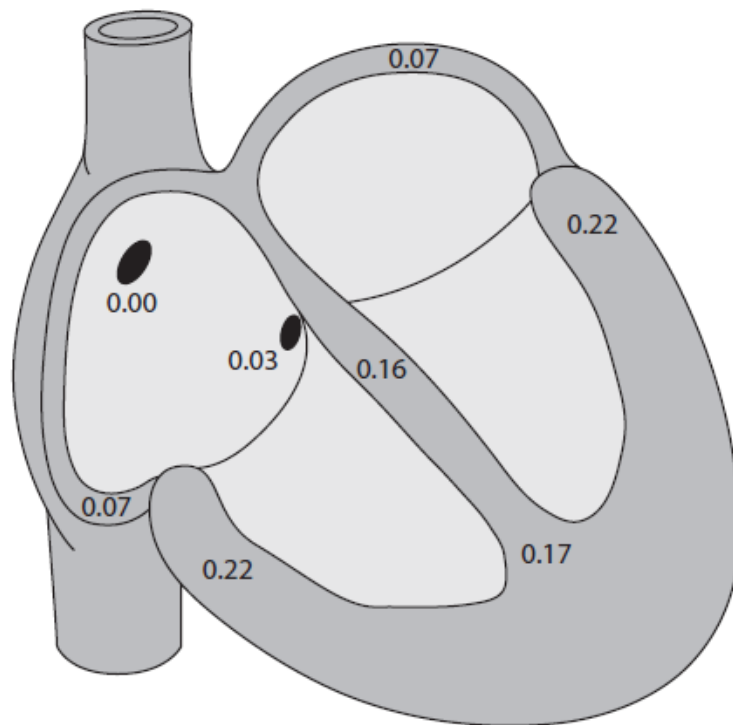
(1)

	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

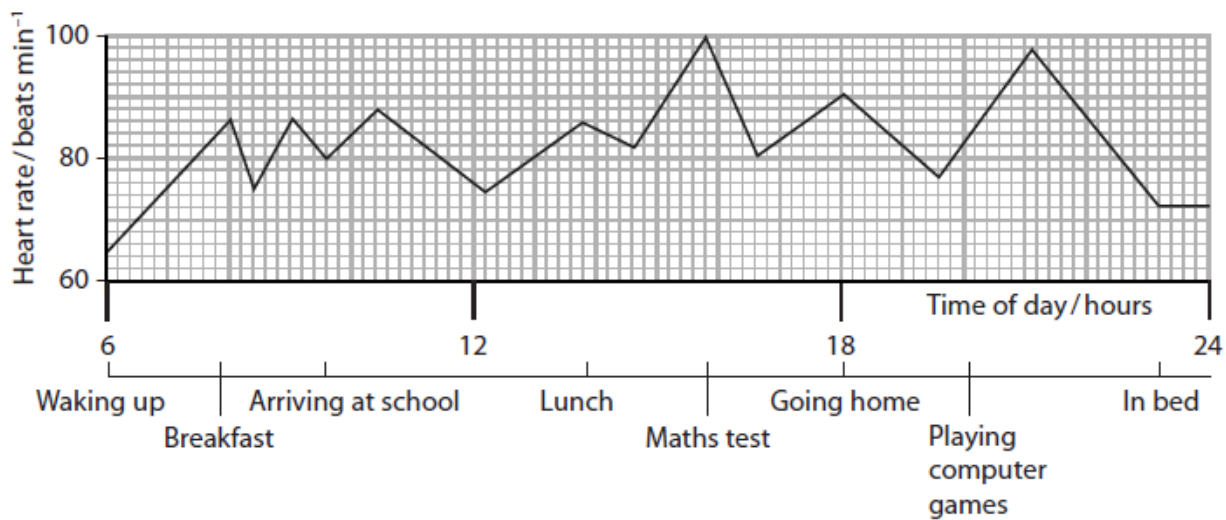
(Total for question = 2 marks)

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.



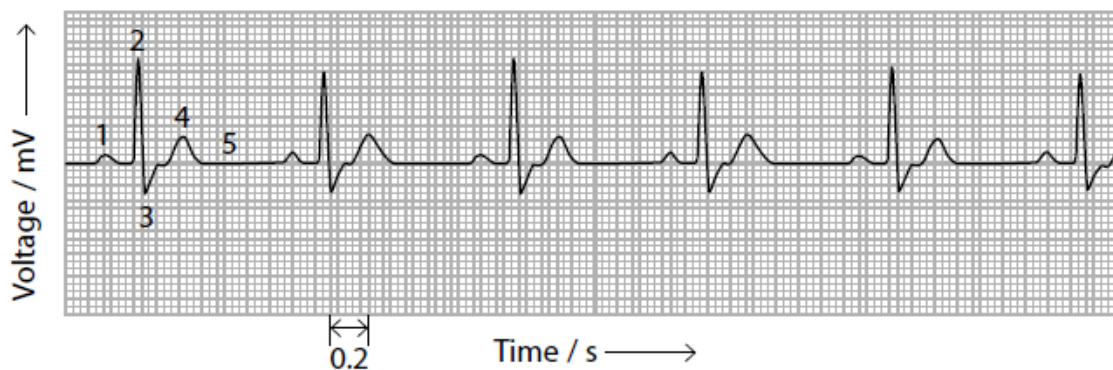
Calculate the rate of increase in the student's heart rate between 6 am and 8 am.

(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

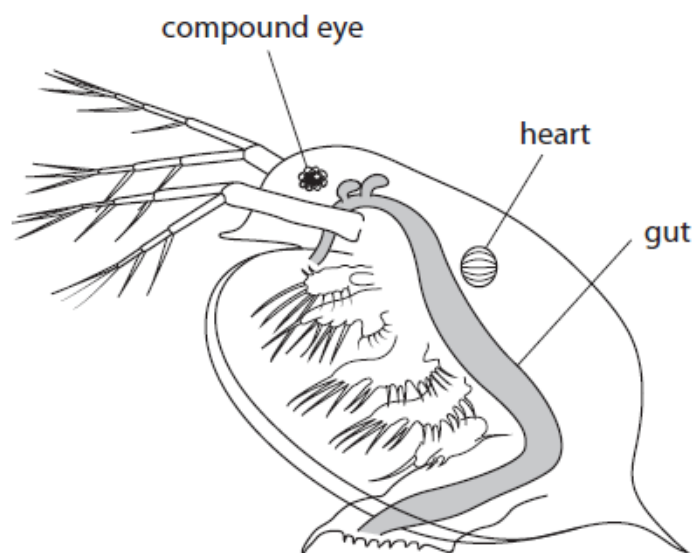
(Total for question = 4 marks)

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

$$\text{cardiac output} = \text{stroke volume} \times \text{heart rate}$$

(3)

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

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

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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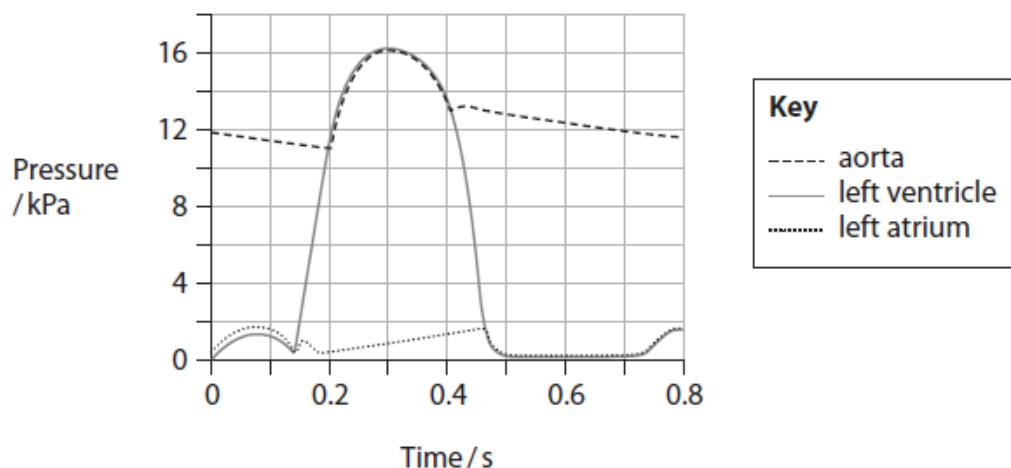
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(Total for question = 4 marks)

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?

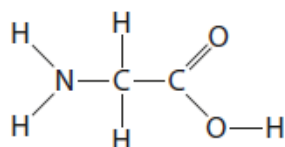
(1)

- ☐ **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

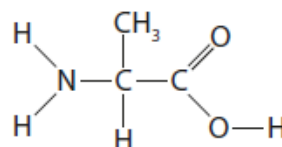
(Total for question = 2 marks)

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)

(Total for question = 4 marks)

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.

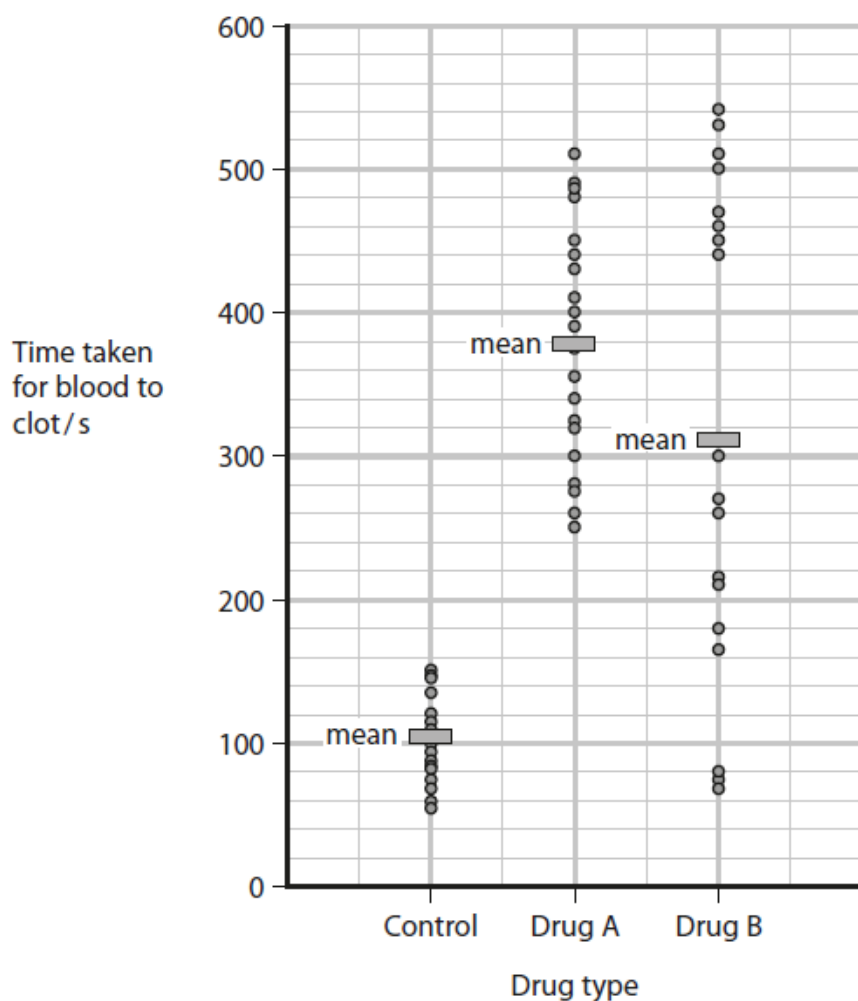
The potential use of two anti-clotting drugs, Drug A and Drug B, was investigated.

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.

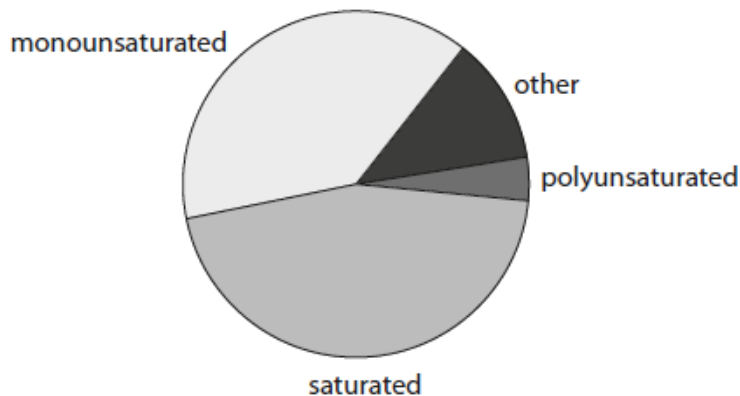
The structure of a lipid relates to its role in living organisms.

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.

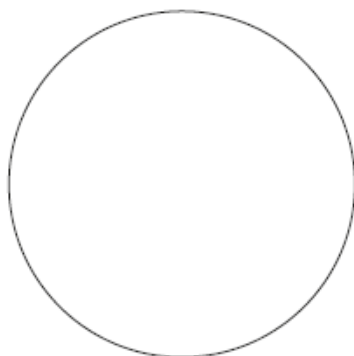
Product	Source of product	Saturated lipids	Monounsaturated lipids	Polyunsaturated lipids		Other lipids
				Omega-6	Omega-3	
Beef fat	animal	45	39	3	1	12
Butter	animal	52	24	2	1	21
Rapeseed oil	plant	7	59	20	9	5
Safflower oil	plant	10	15	75	0	0

(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.

(2)

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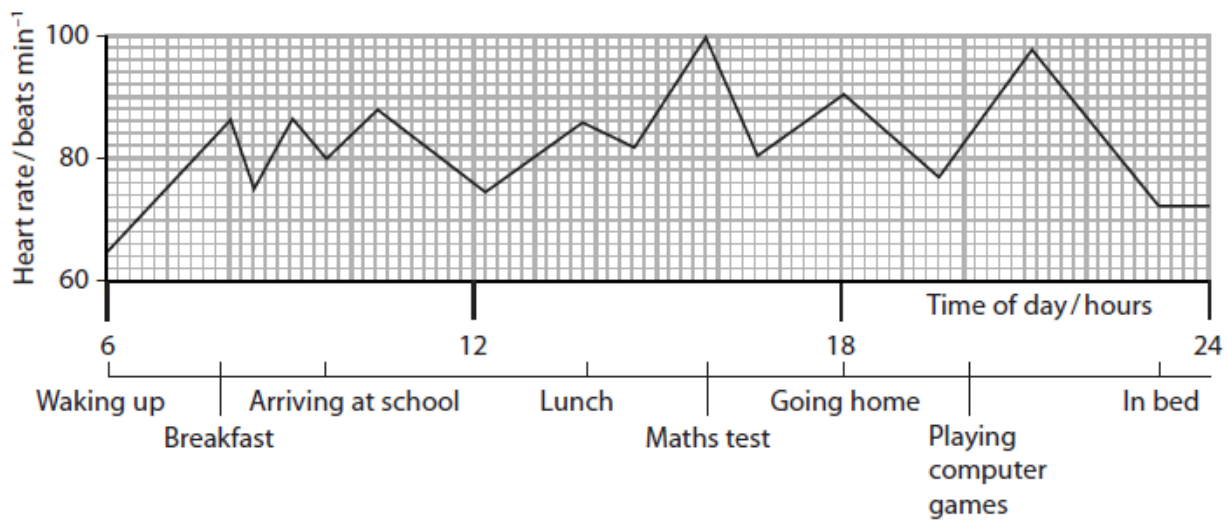
(Total for question = 2 marks)

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)

[illegible]

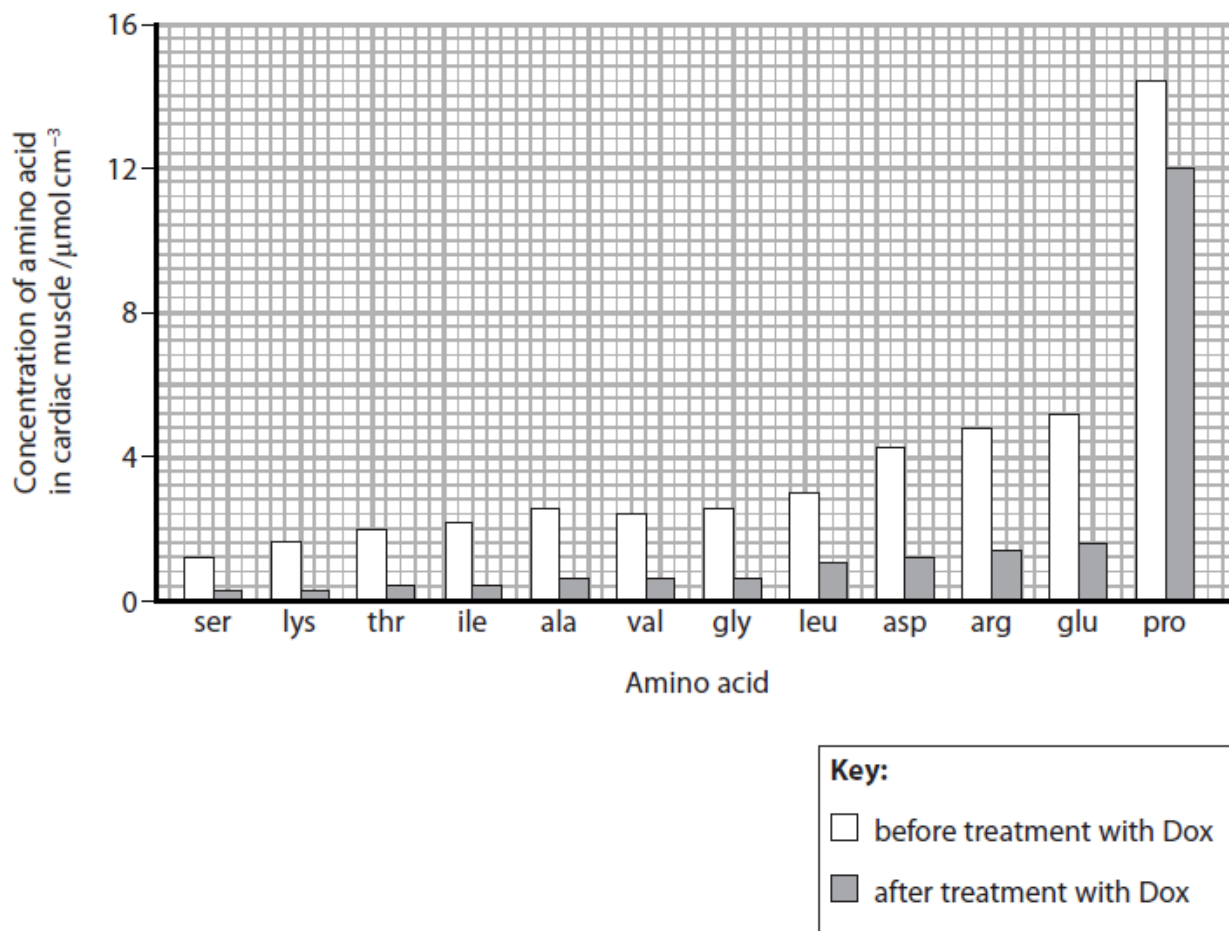
Q16.

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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[illegible]

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

(2)

[illegible]

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

(3)

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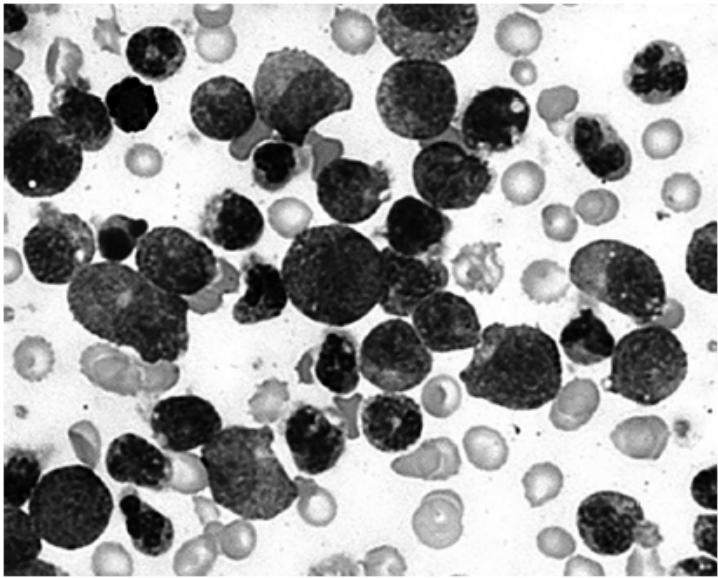
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(Total for question = 11 marks)

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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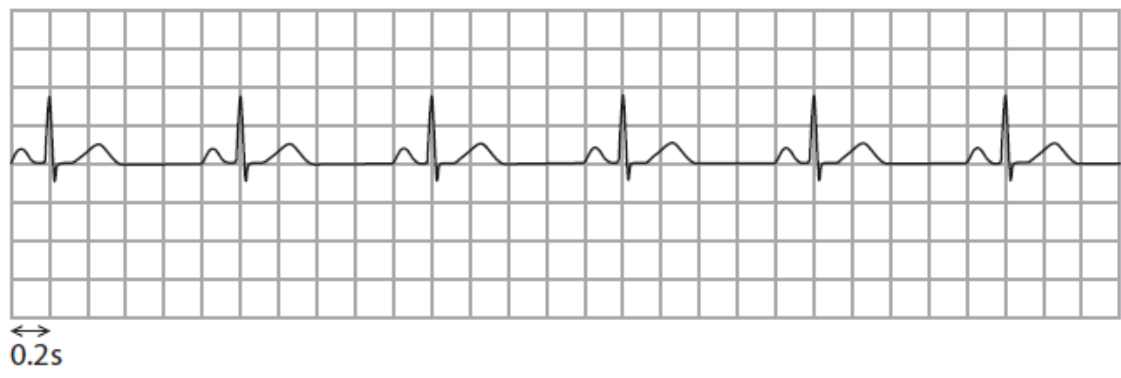
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(iii) The diagram shows a normal ECG trace.



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.

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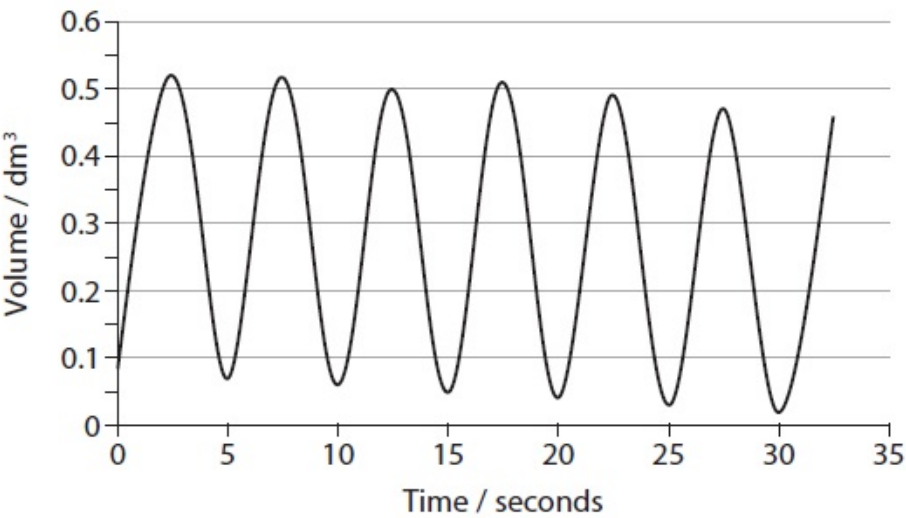
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(b) The respiratory system will also undergo physiological changes during a period of exercise.

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.

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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Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to five of the following: • {impulse / depolarisation / wave of excitation} starts at SAN / pacemaker (1) • takes 0.03s to travel to AVN (1) • atrial systole takes 0.07s / takes 0.07s for atria to contract (1) • delay at AVN (1) • {0.16s / 0.17s at septum / Bundle of His} / {0.17s / 0.22s at Purkyne fibres (1) • ventricular systole ends at 0.22s / ventricles {contract / depolarise} from base / upwards (1) • atrioventricular valves {open during atrial systole / atrial contraction} / {close during ventricular systole / ventricular contraction} (1)	DO NOT ACCEPT signal / message	(5)

Q2.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	An answer that makes reference to the following: percentage increase calculated (1)	<u>Example of calculation</u> % increase = $1.85 \times 100 / 0.9$ = 205.555% = 206%	(1)

Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following: - because tissue fluid accumulates and prevents gas exchange (1) - therefore less oxygen uptake and carbon dioxide removal makes patient feel breathless (1)		(2)

Question Number	Acceptable Answer	Additional guidance	Mark
(iii)	A description that makes reference to the following: - excess tissue fluid is absorbed by the lymphatic system (1) - lymphatic system drains into the veins (1)		(2)

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	1.52×10^7		(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	A description that makes reference to three of the following: • damage to {endothelium} caused by {high blood pressure / toxins / smoking} (1) • inflammatory response and arrival of {macrophages / white blood cells} (1) • deposits of {cholesterol / calcium} (1) • formation of {atheroma / plaque} (1)	DO NOT ACCEPT fat / lipid	(3)

Q4.

Question Number	Answer	Additional Guidance	Mark		
(i)	C <table><tr><td>monocyte</td><td>eosinophil</td></tr></table>	monocyte	eosinophil	A is incorrect because cell J is not an eosinophil and cell K is not a lymphocyte B is incorrect because cell J is not a lymphocyte and cell K is not a neutrophil D is incorrect because cell J is not a neutrophil and cell K is not a monocyte	(1)
monocyte	eosinophil				

Question Number	Answer	Additional Guidance	Mark
(ii)	D 50 : 3	A is incorrect because there are about 50 erythrocytes and 3 leukocytes B is incorrect because there are about 50 erythrocytes and 3 leukocytes ie the ratio is the wrong way round C is incorrect because there are 3 leukocytes	(1)

Q5.

Question Number	Answer	Mark
	The only correct answer is C <i>A is not correct because erythrocytes transport oxygen and platelets prevent entry of bacteria</i> <i>B is not correct because erythrocytes transport oxygen and platelets prevent entry of bacteria</i> <i>D is not correct because leucocytes are involved in defence</i>	(1)

Q6.

Question Number	Answer	Additional Guidance	Mark
	• obtain duration of one heart beat by dividing number of seconds in one minute by heart rate (1) • subtract duration of ventricular systole (1)	<u>Example of calculation</u> $60 \div 72 = 0.83 / 0.833$ $0.83 - 0.06 = 0.77 / 0.773$ $0.83 - 0.05 = 0.78 / 0.783$ Correct answer gains full marks, with no working shown	(2)

Q7.

Question Number	Acceptable Answer	Additional Guidance	Mark
	• correct numerical calculation (1) • correct units (1)	<u>Example of Calculation:</u> $22 \div 120 = 0.183$ beats per minute per minute / beats minutes⁻²	(2)

Q8.

Question Number	Correct Answer	Additional guidance	Mark
(b)(i)	A		(1)

Question Number	Correct Answer	Additional guidance	Mark
(b)(ii)	C		(1)

Question Number	Correct Answer	Additional guidance	Mark
(c)	5 squares = 1 beat 1 beat per second x 60 (1) 60 beats per minute (1)	Correct answer gains full mark	(2)

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	- calculation of volume (1) - calculation of cardiac output (1) - conversion to $\text{dm}^3 \text{ min}^{-1}$ (1) OR - change units for radius (1) - calculation of volume (1) - calculation of cardiac output (1)	$= \frac{4}{3} \times 3.142 \times 0.001$ $= 0.004189 \times 200$ $= 0.0000008379 \text{ (dm}^3 \text{ min}^{-1}\text{)}$ Accept $8 \times 10^{-7} / 8.4 \times 10^{-7} / 8.38 \times 10^{-7} / 8.379 \times 10^{-7} / 0.0000008 / 0.00000084 / 0.000000838$ Correct answer gains full marks, with no working shown. $8 / 8.4 / 8.38 / 8.379$ to wrong power of 10 gets 2 marks Ecf if diameter used instead of radius $0.1\text{mm} = 0.001 \text{ dm}$ $= \frac{4}{3} \times 3.142 \times 0.001$ $= 4.189 \times 10^{-9} \times 200 \text{ (dm}^3 \text{ min}^{-1}\text{)} = 8.38 \times 10^{-7}$ Accept $8 \times 10^{-7} / 8.4 \times 10^{-7} / 8.379 \times 10^{-7} / 0.0000008 / 0.00000084 / 0.000000838 / 0.0000008379$	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	more cells that need supply of {glucose / oxygen} (1)		(1)

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	A 0.14 s <i>B is incorrect as the valve has already closed</i> <i>C is incorrect as the valve is open</i> <i>D is incorrect as the valve is open</i>		1
(ii)	D sinoatrial node, atrioventricular node, bundle of His <i>A is incorrect as the impulse starts at the sinoatrial node</i> <i>B is incorrect as the impulse starts at the sinoatrial node</i> <i>C is incorrect as the bundle of His is after the atrioventricular node</i>		1

Q11.

Question Number	Answer	Additional Guidance	Mark
(i)	• 1.3 N (1)		1
(ii)	An explanation that makes reference to three of the following: - arteries stretch more / (have weaker collagen which means that) less force produces a longer extension (1) - because the elastic constant is lower (1) - and (blood in arteries) has high pressure (1) - and less force is required to break the artery (1)	Allow less elasticity in arteries Allow arterial blood has high hydrostatic pressure	3

Q12.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to 5 from: - the mean clotting time has increased for both drugs / for drug A and drug B (1) - there is little variation in the control group (1) - there is high variation with drug B (1) - drug B does not change clotting rate for some (blood types) as there is overlap with the control group (1) - drug B has a slower clearance time so patients would be at risk of bleeding (1) - drug A would be better as it works for all samples and is cleared from body faster / will allow blood to clot sooner after dialysis (1)	piece together Allow low range in control group / with no drug Allow largest range / drug B has more spread / variation than drug A Allow drug A increased clotting time for all samples as there is no overlap with control	5

Q13.

Question Number	Answer	Additional Guidance	Mark
(i)	pie chart drawn showing lipid content of safflower oil, labelled	saturated section less than monounsaturated and polyunsaturated three quarters by eye	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	- percentage of polyunsaturated lipids in 500 g {beef / oil} calculated (1) 355 (g) (1)	Example of calculation: $(3 + 1) \times (500 \div 100) = 20$ $75 \times (500 \div 100) = 375$ Correct answer with no working gains full marks	(2)
(iii)	An explanation that makes reference to the following: - because plant products will contain less {cholesterol / saturated lipids} (than animal products) (1) - therefore there will be less cholesterol (in the blood stream) to {build up / form a plaque / form an atheroma} in an artery (1)	ACCEPT converse explanation ACCEPT more polyunsaturated lipids	(2)

Q14.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to two of the following: {increasing mass / more} (snake venom) decreases clotting time (1) {small mass / 0.002 µg} of snake venom has a shorter clotting time (than Xa) (1) {larger masses / 0.004 µg and over / 0.02 and 0.04} has little effect on clotting time (1)	ACCEPT clotting time is faster converse ACCEPT takes less time / faster rate ACCEPT 0.004 µg has slight increase and 0.02 µg and 0.04 µg has slight decrease	(2)

Q15.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • { stress / fear } causes the adrenal glands to release adrenaline into the bloodstream (1) • because of impulses along sympathetic nerve (1) • from the { cardiac control centre / medulla (oblongata) } in the brain (1) • increase in heart rate caused by increased rate of depolarisation of SAN (1) • due to release of noradrenaline at SAN (1) ATP than other cells		(5)

Q16.

Question Number	Indicative content
* (i)	Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.

	<u>Indicative content</u> • Dox decreases the concentration of (all) amino acids shown • largest actual decrease is glu and asp ($3.6 \mu\text{mol cm}^{-3}$) • smallest actual decrease is ser ($0.9 \mu\text{mol cm}^{-3}$) • relative decrease is least for pro (16.67%) • relative decrease is greatest for asp (85.71%) • data not available for all amino acids • polar and non-polar amino acids are affected • polar amino acids affected most (total $14.4 \mu\text{mol cm}^{-3}$ compared to total $11.7 \mu\text{mol cm}^{-3}$ / mean $2.4 \mu\text{mol cm}^{-3}$ compared to mean $1.95 \mu\text{mol cm}^{-3}$) • effect on non-polar amino acids is within a {narrower range for actual decrease / wider range for percentage decrease}
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	Level 1 : comments on overall effect of Dox 1 mark = level 1 comment only 2 marks = level 1 comment backed up with figures / level 2 comment but no figures given Level 2 : comments on effect of Dox on polar and non-polar amino acids 3 marks = level 2 comment only / level 1 comment with a level 2 calculation (= actual decrease in concentration) 4 marks = level 2 comment backed up with a level 2 calculation Level 3 : comments about amino acids within the group of polar / non-polar amino acids 5 marks = level 3 comment / level 2 comment with a level 3 calculation (= percentage decrease in calculation) 6 marks = comment backed up with a level 3 calculation
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Level 0	Marks	No awardable content
Level 1	1-2	An answer may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The answer will contain basic information with some attempt to describe the data shown in the graph
Level 2	3-4	An answer will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The answer shows some linkages and lines of scientific reasoning with some structure between the graph and the different types of amino acids
Level 3	5-6	An answer is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The answer shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: - a decrease in some amino acids may mean that {certain proteins cannot be formed / less protein made} (1) - if these proteins are involved in heart muscle structure then it will be weaker (1) - these proteins may affect heart muscle function (1)	ACCEPT named example e.g. actin, myosin, collagen ACCEPT named example e.g. collagen, haemoglobin, myoglobin, cytochromes	

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: - heart will not be able to pump as well (1) - so less {oxygenated blood / oxygen} will be delivered to the {cells / tissues / organs / named example} (1) - example of a consequence of this (1)	ACCEPT less carbon dioxide removed / lowers blood pH e.g. less aerobic respiration, build-up of lactic acid / fatigue / breathlessness	

Q17.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: - because the numbers_of erythrocytes to leucocytes can be determined (1) - and compared to the {normal / healthy / known CML} (smear) (1)	ACCEPT red blood cells to white blood cells named white blood cell	(2)

Q18.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	A (P)		(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • (no P wave on trace) (1) sinoatrial node / SAN not functioning • causing lack of electrical activity in the atria (1) • failing to pass electrical signal to the atrioventricular node (1)		(3)

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	• normal ECG trace rate is 60 beats per minute and person with Sick Sinus Syndrome rate is 50 beats per minute (1) • so difference 10 beats per minute (1)		(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(iv)	An explanation that makes reference to the following: • sinoatrial node is not working causing a slower heart beat rate (1) • causing lack of oxygen to { brain / muscles } (1)		(2)

Q19.

Question Number	Answer	Mark
(a)	1. heart rate increases / eq ; 2. {stroke volume / eq} increases / eq ; 3. {SAN /eq} activity increases / ; 4. AVN time delay decreases / eq ; 5. idea that more blood returning (to the heart) causes {heart / muscle} to stretch ; 6. idea that ventricles contract with greater force ;	(4)

Question Number	Answer	Mark																		
(b) (i)	<table><tr><th>Approximate value for</th><th>0.1 dm³</th><th>0.5 dm³</th><th>6 dm³ min⁻¹</th><th>6 breaths min⁻¹</th><th>12 breaths min⁻¹</th></tr><tr><td>Resting breathing rate</td><td></td><td></td><td></td><td></td><td>☐</td></tr><tr><td>Resting tidal volume</td><td></td><td>☐</td><td></td><td></td><td></td></tr></table>	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		☐				(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		☐																	

Question Number	Answer	Mark
(b)(ii)	1. more {peaks / eq} in the same time / higher frequency / distance between (consecutive) peaks would decrease ; 2. idea of distance from peak to trough would increase ;	(2)

Question Number	Answer	Mark
(c)	Any two from the following: 1. how often they play 2. age 3. body size / BMI / eq 4. gender / eq 5. fitness level / eq 6. health status / eq 7. lifestyle e.g. smoker or swimmer ; ;	(2)

Q20.

Question Number	Answer	Additional Guidance	Mark
*	(QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence) 1. increase in <i>respiration</i> rate in <i>muscle</i> cells ; 2. more {CO₂/carbonic acid/eq} in blood ; 3. more {lactate / lactic acid} in blood / eq ; 4. idea that <i>chemoreceptors</i> in <i>medulla</i> stimulated ; 5. ref to <i>cardiovascular</i> control centre in <i>medulla</i> ;	QWC emphasis is on spelling 2 OR 3 ACCEPT reduced blood pH 4. ACCEPT in <i>aorta</i>, <i>carotid</i>	

	6. ref to <i>autonomic nervous system</i> / <i>sympathetic nerve</i> ; 7. more <i>impulses</i> from {<i>medulla</i> / <i>cardiovascular control centre</i>} to SAN OR along neurones to SAN ; 8. More {<i>noradrenaline</i> / <i>norepinephrine</i>} released onto SAN ; 9. SAN (excitation) rate increased / eq ; 10.(causing an) increased {heart rate / eq} / eq ; 11.Comment on other mechanism e.g. presence of adrenaline, stretch receptor role ;	6. ACCEPT <i>accelerator nerve</i> 10. ACCEPT beats per min for heart rate	(6)
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