AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.6.1.3 CONTROL OF HEART RATE

SCORE	PERCENTAGE
/130	%

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Q1.

(a) Exercise causes an increase in heart rate.

Describe the role of receptors and of the nervous system in this process.

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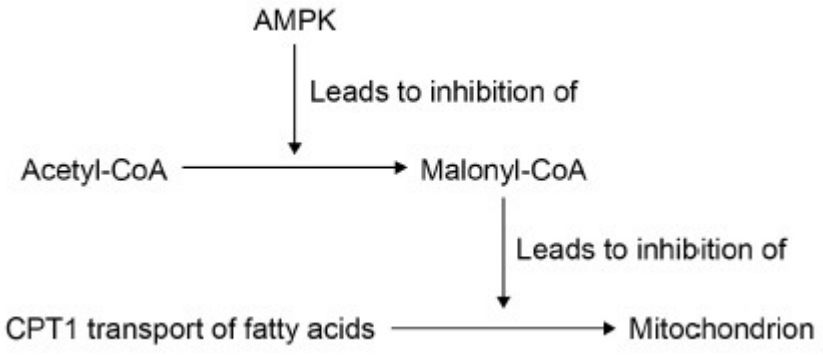
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(4)

(b) AMP-activated protein kinase (AMPK) is an enzyme that regulates a number of cellular processes. Exercise leads to activation of AMPK.

The diagram shows one effect of activation of AMPK during exercise.



CPT1 is a channel protein that transports fatty acids into mitochondria.

Using the diagram above, explain the benefit of activation of AMPK during exercise.

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(3)

(Total 7 marks)

Q2.

Body position	Pulse rate / beats per minute			
	Reading 1	Reading 2	Reading 3	Mean
Sitting	80	76	76	77
Standing	84	88	92	88
Lying down	68	72	68	69

(a) Using the results in the table above, calculate the percentage decrease in mean pulse rate when lying down compared with when standing.

Answer = _____ %

(2)

(b) When the heart beats, both ventricles contract at the same time.
Explain how this is coordinated in the heart after initiation of the heartbeat by the SAN.

_____

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_____

(2)

(Total 4 marks)

Q3.

(a) Give **two** ways in which people with type 1 diabetes control their blood glucose concentration.

1. _____

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2. _____

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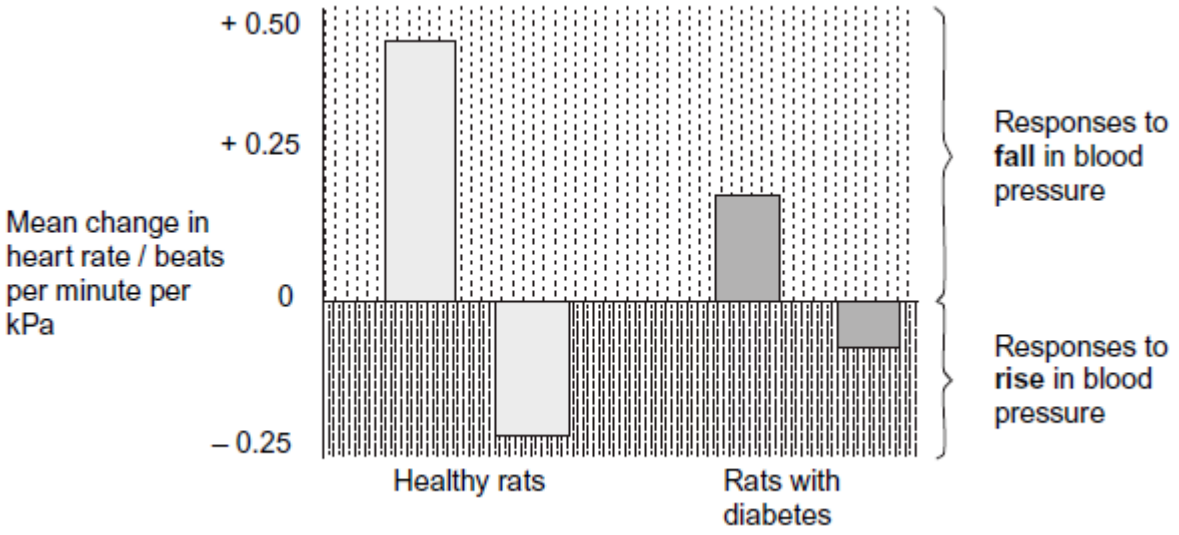
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(2)

(b) Scientists investigated the effect of diabetes on the control of heart rate in response to changes in blood pressure in rats.

The scientists found the mean changes in heart rates of healthy rats and rats with diabetes in response to rises or falls in blood pressure.

The diagram shows their results in the form they were presented.



Diabetes can damage the nervous system. The response of the rats with diabetes is different from the response of the healthy rats. Use your knowledge of the control of heart rate by the nervous system to suggest an explanation for these results.

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(4)

(Total 6 marks)

Q4.

(a) Describe how a Pacinian corpuscle produces a generator potential when stimulated.

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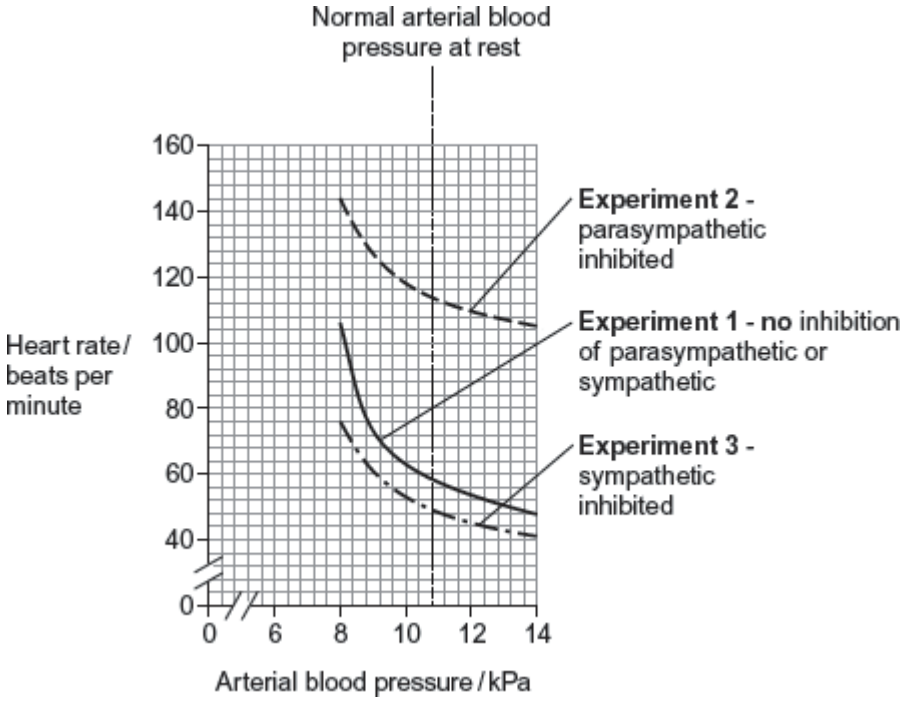
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(3)

Doctors investigated the relationship between heart rate and arterial blood pressure. They recruited healthy volunteers. For each volunteer, they recorded their normal arterial blood pressure at rest. With each volunteer, they then carried out the following experiments.

Experiment 1 They recorded heart rate at different blood pressures.
Experiment 2 They repeated **experiment 1** after injecting a drug that inhibited the parasympathetic nervous system.
Experiment 3 They repeated **experiment 1** after injecting a drug that inhibited the sympathetic nervous system.

The graph shows the results for one volunteer.



(b) Calculate the ratio of heart rate in **experiment 2** to heart rate in **experiment 3** at an arterial blood pressure of 10 kPa.
Show your working.

Answer = _____

(2)

(c) What do these data suggest about the control of heart rate by the parasympathetic and sympathetic nervous systems in response to changes in arterial blood pressure?

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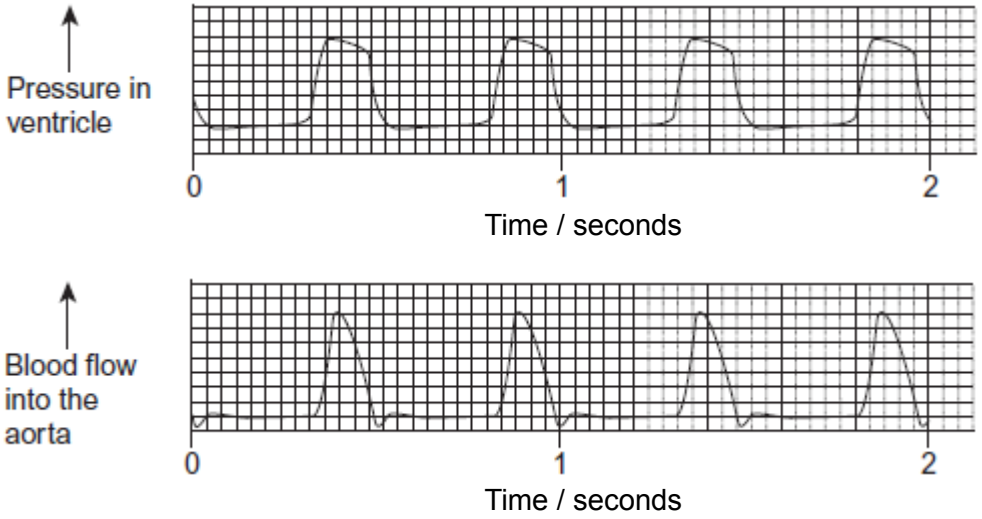
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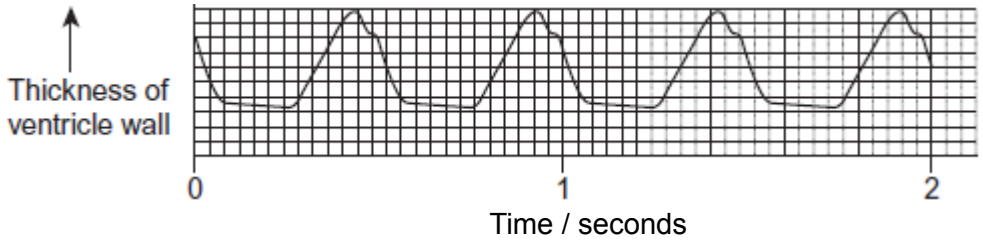
(3)

(Total 8 marks)

Q5.

The figure below shows recordings made from the heart of a dog.





(a) Use information from the figure to explain how the pressure in the dog's ventricle is related to blood flow into the aorta.

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_____

_____

_____

(2)

(b) Use information from the figure to explain how the pressure in the dog's ventricle is related to the thickness of the ventricle wall.

_____

_____

_____

_____

(2)

(c) Use the figure to calculate the heart rate of the dog in beats per minute.
Show your working.

Heart rate _____ beats per minute

(2)

(Total 6 marks)

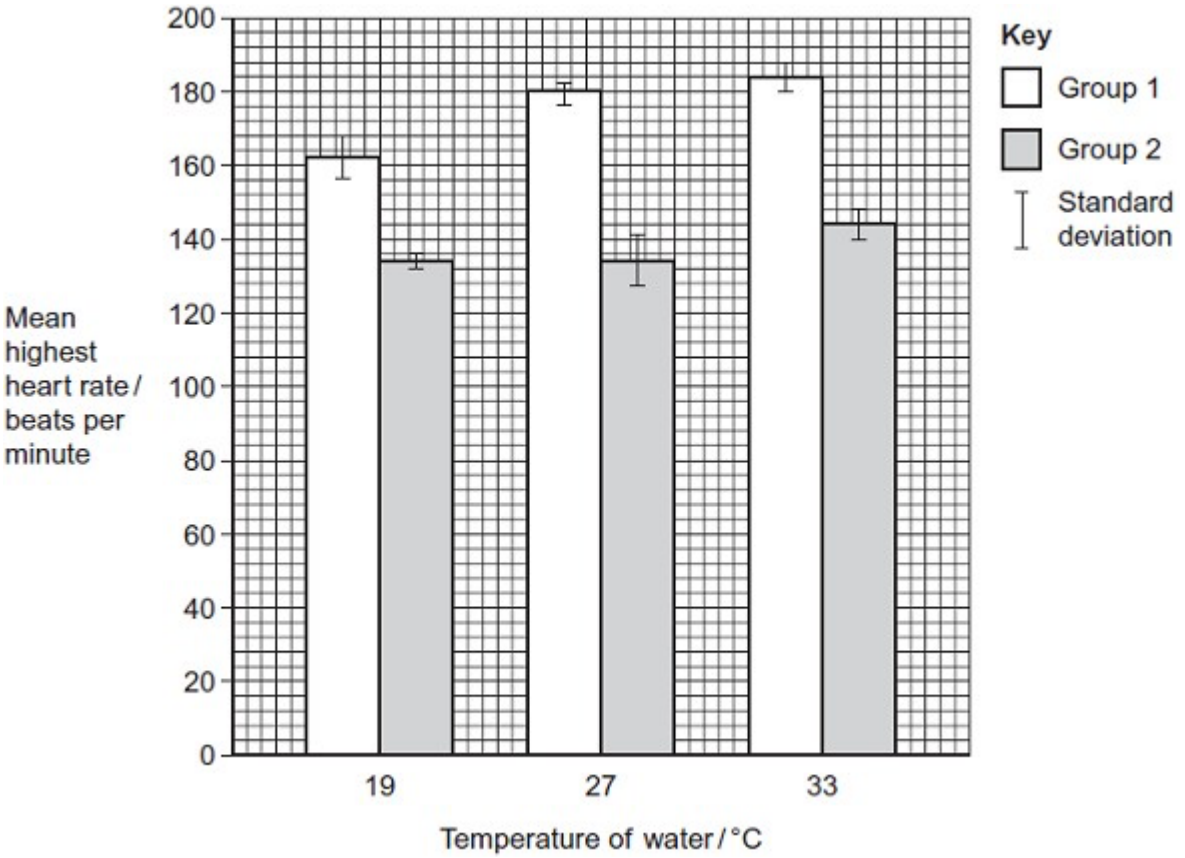
Q6.

Scientists investigated the effects of water temperature on the heart rate of swimmers. Two groups of volunteers were asked to repeat the same swim at three different temperatures.

- **Group 1** volunteers were asked to swim 100 m as quickly as they could.
- **Group 2** volunteers were asked to swim continuously for 30 minutes.

The scientists recorded the highest heart rate for each swimmer during each swim.

Their mean results are shown in the following figure.



(a) Give **one** conclusion that can be made from the scientists' investigation.

_____

_____

_____

(1)

(b) After reading the scientists' report, a member of a swimming club stated that "the report shows that swimming flat out is better for you than swimming for a length of time." Evaluate this statement.

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(4)

(Total 5 marks)

Q7.

(a) Describe how a heartbeat is initiated and coordinated.

(5)

(b) Explain how the heart muscle and the heart valves maintain a one-way flow of blood from the left atrium to the aorta.

(5)

(Total 10 marks)

Q8.

Some people have a condition called *white-coat hypertension*. People with this condition develop a higher than normal heart rate and blood pressure when they are in a doctor's surgery. High heart rate is correlated with high blood pressure.

Doctors investigated differences in heart rate between men *with white-coat hypertension* and those without the condition. They measured the men's mean heart rates:

- in the doctor's surgery, by recording the pulse in the wrist for 1 minute, when the men were lying down
- at home, using a portable heart rate monitor when the men were walking around
- at home, using a portable heart rate monitor when the men were sleeping.

(a) The groups of men selected for this investigation were matched.

Other than being men, suggest **one** factor for which they should have been matched.

_____

(1)

(b) Explain why the pulse recordings in the doctor's surgery were taken when the men were lying down.

_____

_____

_____

(1)

(c) The pulse felt in the artery in the wrist can be recorded and used to measure heart rate.

Suggest why the pulse felt can be used to measure heart rate.

_____

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_____

_____

(2)

(d) The portable heart rate monitor recorded the men's heart rates continuously. This gave more reliable mean heart rates than those obtained by recording the pulse in the wrist for 1 minute.

Suggest why it is more reliable.

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(2)

(e) The table shows the doctors' results.

Where and how heart rate was measured	Mean heart rate / beats per minute	
	Men with white-coat hypertension	Men without white-coat hypertension
Doctor's surgery, recording pulse when lying down	67	63
At home, walking around, using heart monitor	76	73
At home, sleeping, using heart monitor	63	60

A journalist, who saw these results, stated that they showed there is no such thing as *white-coat hypertension*.

Do these data support this statement? Give reasons for your answer.

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(2)

(Total 8 marks)

Q9.

The heart controls and coordinates the regular contraction of the atria and ventricles. Describe how.

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(Total 5 marks)

Q10.

(a) Increased intensity of exercise leads to an increased heart rate. Explain how.

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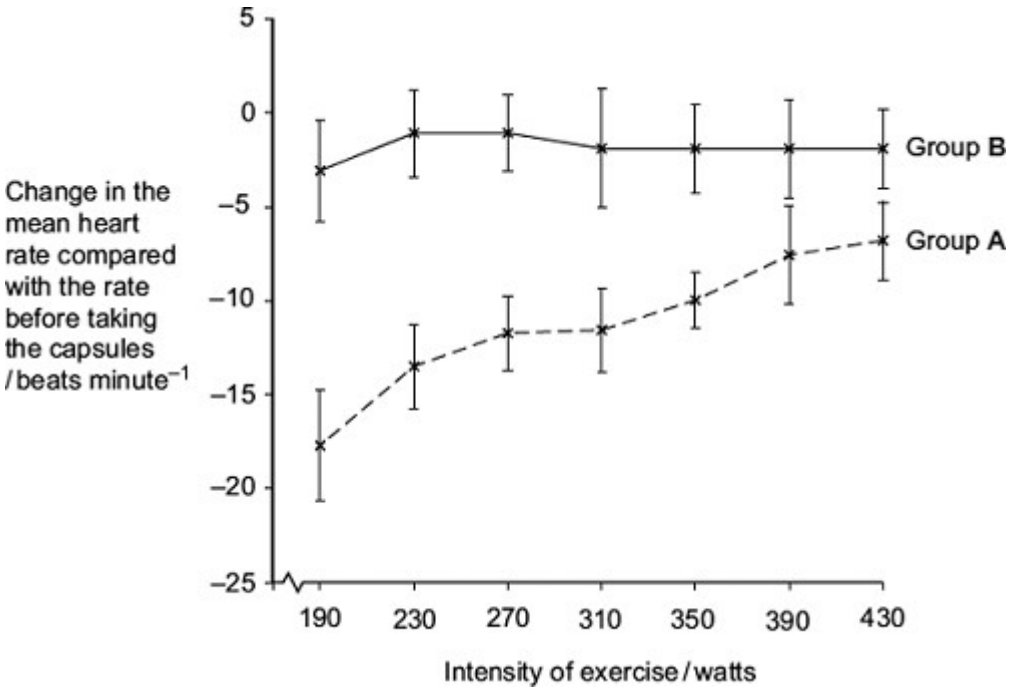
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(3)

(b) Scientists investigated the effect of taking omega- fatty acids in fish oil on heart rate during exercise. They recruited two large groups of volunteers, **A** and **B**. For each group, they measured the mean heart rates at different intensities of exercise. The volunteers were then given capsules to take for 8 weeks.

- Group **A** was given capsules containing omega-3 fatty acids in fish oil.
- Group **B** was given capsules containing olive oil.

After 8 weeks, they repeated the measurements of mean heart rates at different intensities of exercise. The graph shows their results. The bars represent the standard deviations.



(i) Group **B** was given capsules containing olive oil. Explain why.

_____

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_____

(1)

(ii) The scientists concluded that omega-3 fatty acids lower the heart rate during exercise.
Explain how the information in the graph supports this conclusion.

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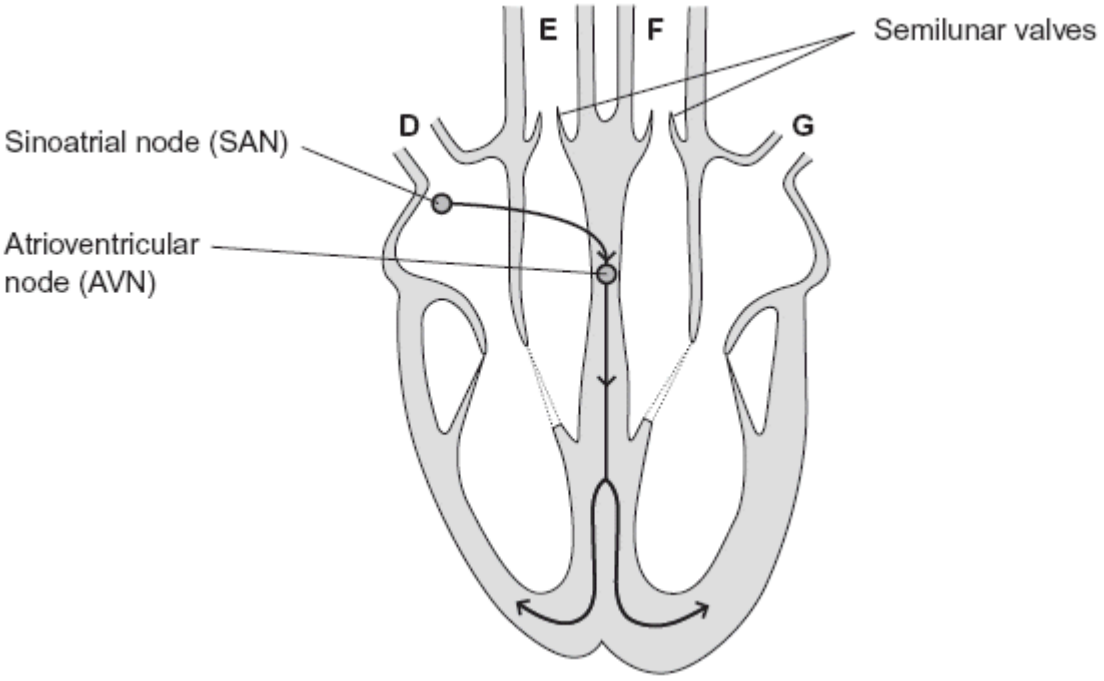
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(3)

(Total 7 marks)

Q11.

The diagram shows a human heart as seen from the front. The main blood vessels are labelled **D** to **G**. The arrows show the pathways taken by the electrical activity involved in coordinating the heartbeat in the cardiac cycle.



(a) Which of the blood vessels, **D** to **G**

(i) carries oxygenated blood to the heart



(1)

(ii) carries deoxygenated blood to the lungs?



(1)

(b) Explain, in terms of pressure, why the semilunar valves open.

_____

_____

_____

(1)

(c) When a wave of electrical activity reaches the AVN, there is a short delay before a new wave leaves the AVN. Explain the importance of this short delay.

_____

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(2)

(d) The table shows the cardiac output and resting heart rate of an athlete before and after completing a training programme.

	Before training	**After training**
Cardiac out/cm^3	5000	5000
Resisting heart rate/beats per minute	70	55

(i) Calculate the athlete's stroke volume after training. Show your working.

_____ cm^3

(2)

(ii) Use information from the table to explain how training has caused the resting

heart rate of this athlete to be lower.

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(2)

(Total 9 marks)

Q12.

The cardiac cycle is controlled by the sinoatrial node (SAN) and the atrioventricular node (AVN).

Describe how.

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(Total 5 marks)

Q13.

(a) The sinoatrial node (SAN) is in the right atrium of the heart. Describe the role of the sinoatrial node.

_____

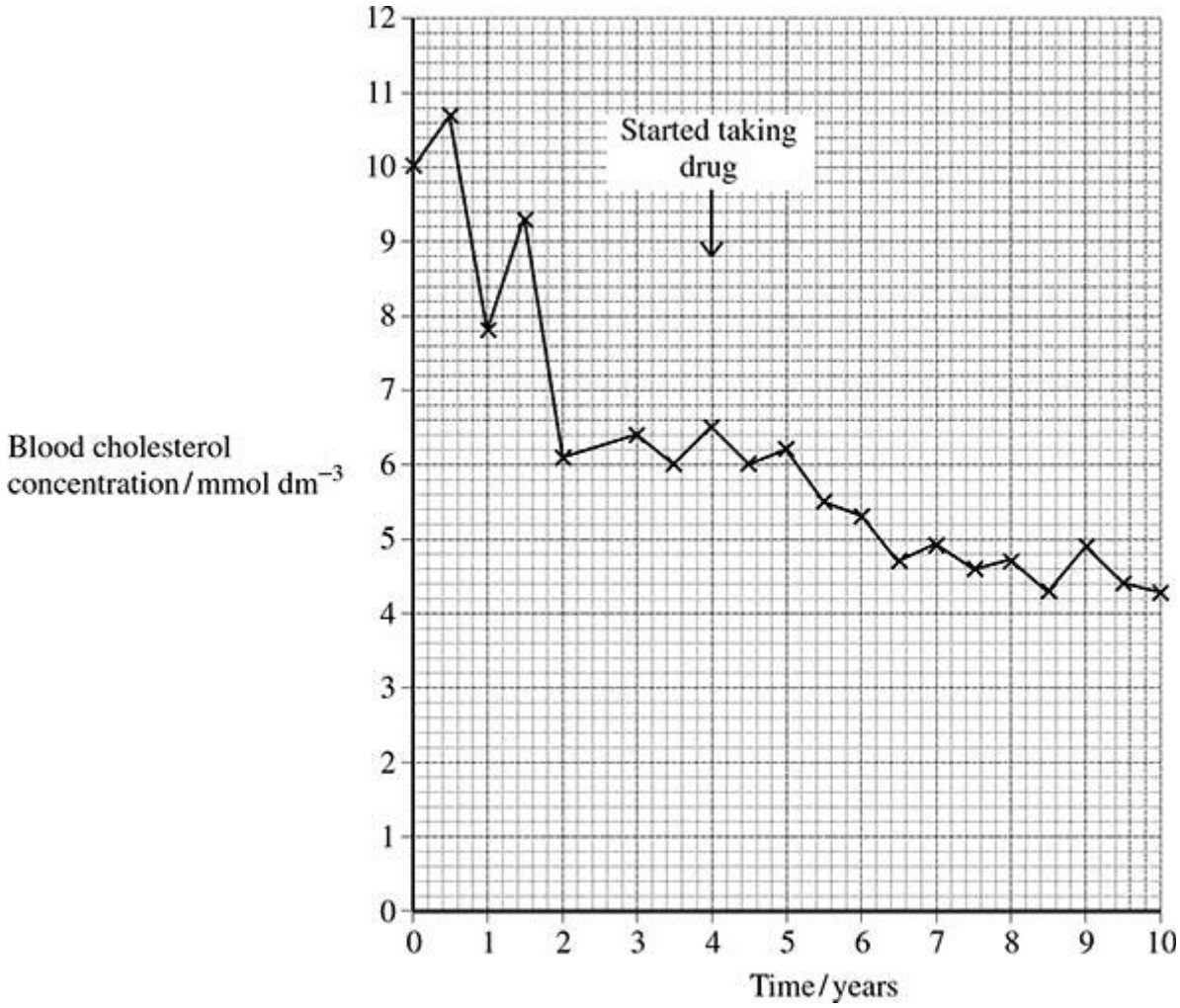
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(2)

Ten years ago, a woman was found to have a high concentration of cholesterol in her blood. As a result, she was put on a special diet. She has been on this diet ever since. Four years after starting the diet, she started taking a drug to lower her blood cholesterol. The graph shows the concentration of cholesterol in her blood over the ten-year period.



(b) Describe how the concentration of cholesterol in her blood changed over the ten-year period.

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(2)

(c) Explain the overall change in cholesterol concentration in the blood in the first two years.

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(2)

(d) Use the graph to evaluate the success of the special diet and of the drug in reducing the risk of coronary heart disease.

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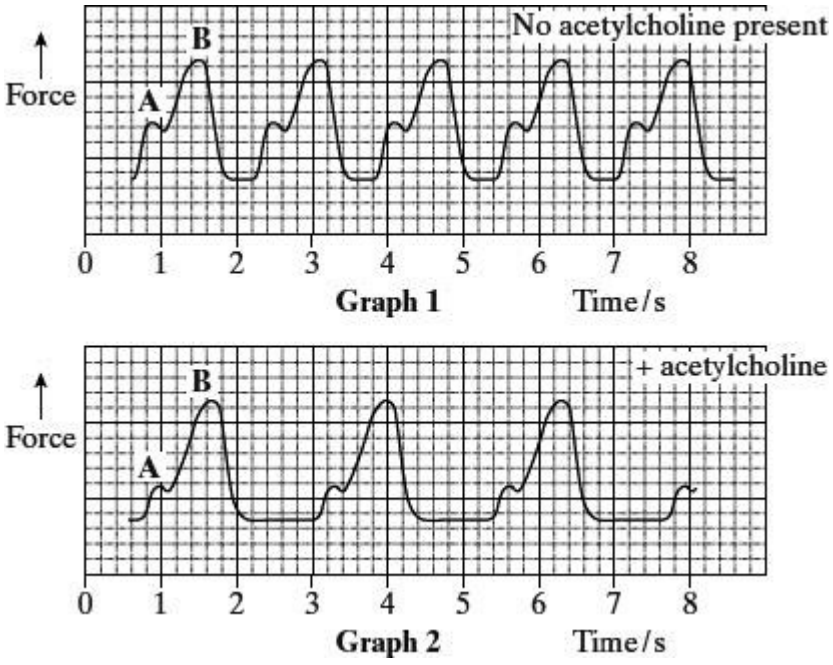
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(2)

(Total 8 marks)

Q14.

A frog's heart was attached to an instrument which measured the force produced as the heart contracted. **Graph 1** shows the changes in force when the heart was bathed in a solution of salts at 20 °C. **Graph 2** shows the results when the heart was bathed in the same solution at the same temperature, but including acetylcholine.



Graph 1

Graph 2

(a) Points **A** and **B** show when the atria and ventricle were contracting. Which point, **A** or **B**, shows contraction of the ventricle? Give **two** reasons for your answer.

Point _____

Reason 1 _____

_____

Reason 2 _____

_____

(2)

(b) Calculate the frog's heart rate when acetylcholine was **not** present. Show your working.

Heart rate = _____ beats per minute.

(2)

(c) (i) From the graphs, what can you conclude about the effect of acetylcholine on

heart rate;

_____

stroke volume?

_____

(2)

(ii) Use your answer to part (i) to explain the effect of acetylcholine on cardiac output.

_____

_____

(1)

(iii) Addition of acetylcholine in the experiment mimics the effect of one branch of the autonomic nervous system. Which branch is this?

_____

(1)

(d) (i) Explain how nervous control in a human can cause increased cardiac output during exercise.

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(4)

(ii) Explain why increased cardiac output is an advantage during exercise.

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(3)

(Total 15 marks)

Q15.

(a) Explain how a rise in blood pressure results in a decrease in the rate of heartbeat.

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(6)

(b) Some drugs inhibit the transmission of nerve impulses to the heart. Explain how these drugs reduce high blood pressure.

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(2)

(Total 8 marks)

Q16.

(a) A woman takes moderate exercise. Explain what causes her heart rate to increase while she exercises.

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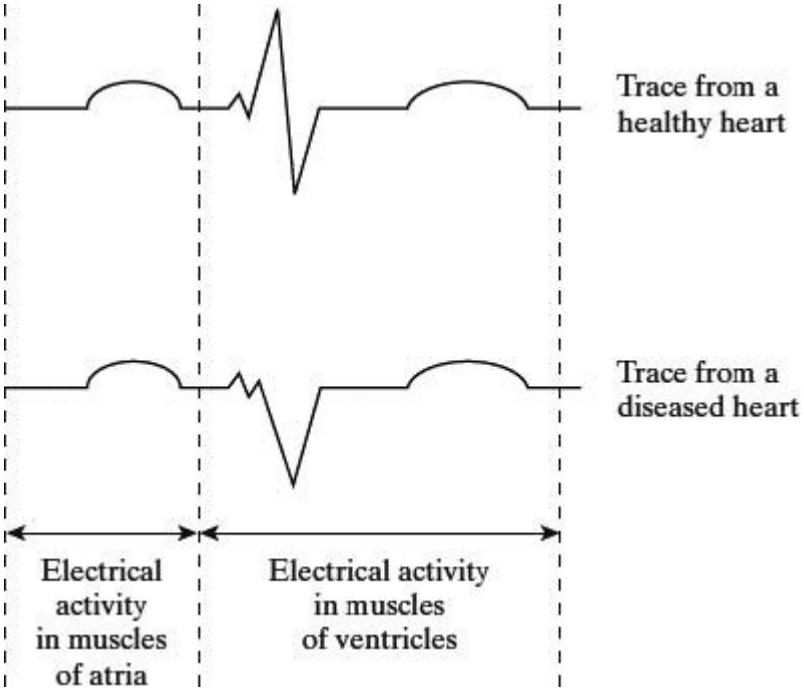
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(6)

(b) An electrocardiogram (ECG) measures the electrical changes occurring in cardiac muscle as a heart is beating. An ECG trace for a healthy person and an ECG trace for a person suffering from heart disease are shown.



(i) Describe the route taken when electrical impulses are transmitted from the sinoatrial node to the muscles of the ventricles in a healthy heart.

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_____

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(2)

(ii) Explain how information from these ECG traces suggests that the damage caused to the diseased heart is unlikely to have affected the sinoatrial node.

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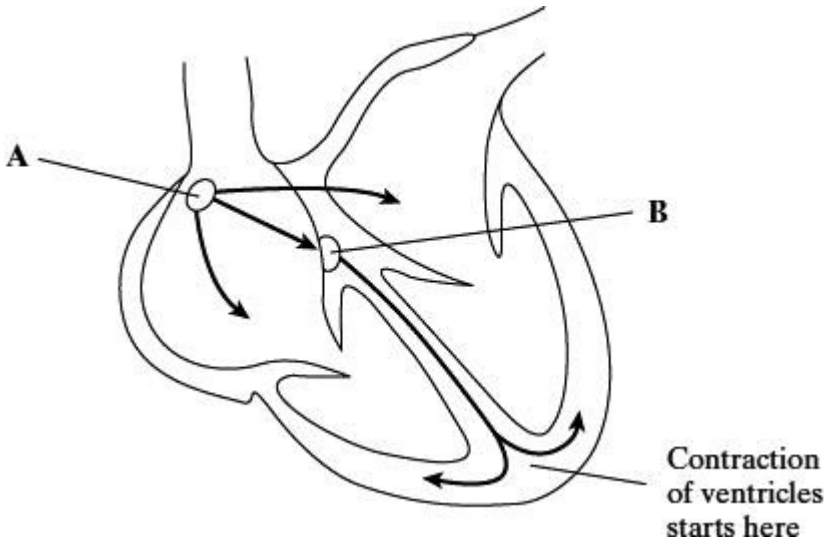
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(2)

(Total 10 marks)

Q17.

The diagram shows the pathways in the heart for the conduction of electrical impulses during the cardiac cycle.



(a) The table shows the blood pressure in the left atrium, the left ventricle and the aorta at different times during part of a cardiac cycle.

	Blood pressure / kPa		
Time / s	**Left atrium**	**Left ventricle**	**Aorta**
0.0	0.5	0.4	10.6
0.1	1.2	0.7	10.6
0.2	0.3	6.7	10.6
0.3	0.4	17.3	16.0
0.4	0.8	8.0	12.0

(i) At which time is blood flowing into the aorta?

_____

(1)

(ii) Between which times are the atrioventricular valves closed?

_____

(1)

(b) The maximum pressure in the left ventricle is higher than the maximum pressure in the right ventricle. What causes this difference in pressure?

_____

_____

(1)

(c) The information below compares some features of different blood vessels.

Blood vessel

		Artery	Capillary	Vain
Property	Mean diameter of vessel	4.0 mm	8.0 μm	5.0 mm
	Mean thickness of wall	1.0 mm	0.5 μm	0.5 mm
		Relative thickness (shown by length of bar)		
Tissues present in wall	Endothelium			
	Elastic tissue			
	Muscle			

Use the information to explain how the structures of the walls of arteries, veins and capillaries are related to their functions.

(6)

(Total 9 marks)