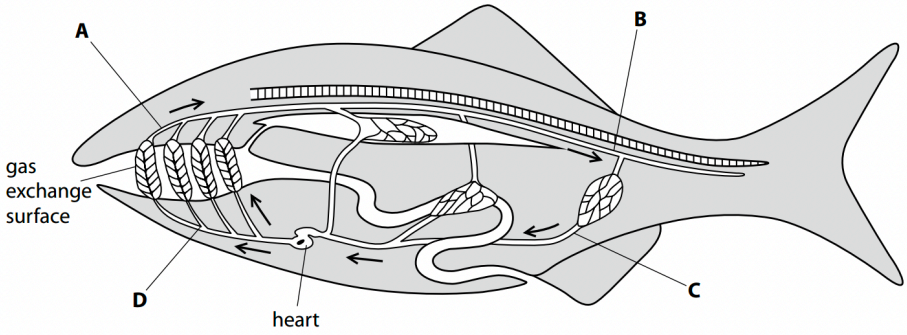
(b) The diagram shows the direction of blood flow in a fish.



(i) Which labelled part of this circulatory system has the lowest concentration of carbon dioxide?

(1)

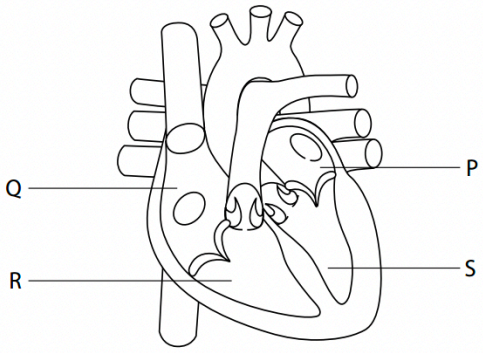
- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(ii) Which labelled part of this circulatory system has the highest blood pressure?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

8 This diagram shows the structure of a normal human heart.



(a) (i) Which chamber of the heart generates the highest blood pressure?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** S

(ii) Which stage of the cardiac cycle is shown in the diagram of the heart?

(1)

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

3 Many animals, such as mammals, have a heart and circulation. This helps them to meet their requirements by overcoming the limitations of diffusion.

*(a) Describe the structure of the mammalian heart.

(5)

2 As levels of activity increase, the heart can respond to the changing demand for oxygen.

(a) Which term describes the ability of heart muscle to contract without external stimulation?

(1)

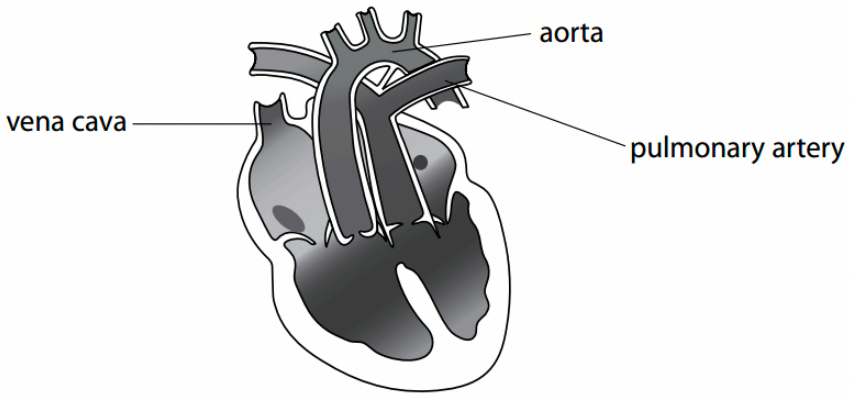
- ☒ **A** autonomic
- ☒ **B** cardiac
- ☒ **C** myogenic
- ☒ **D** systolic

Q2b

(b) Describe how the sinoatrial node (SAN) is involved in bringing about a change in heart rate as the level of activity increases.

(2)

(b) A baby was born with an abnormal heart. The diagram shows the heart of this baby. There is a hole in the septum between the two ventricles.



(i) Identify the problem with the blood vessels of this heart.

(1)

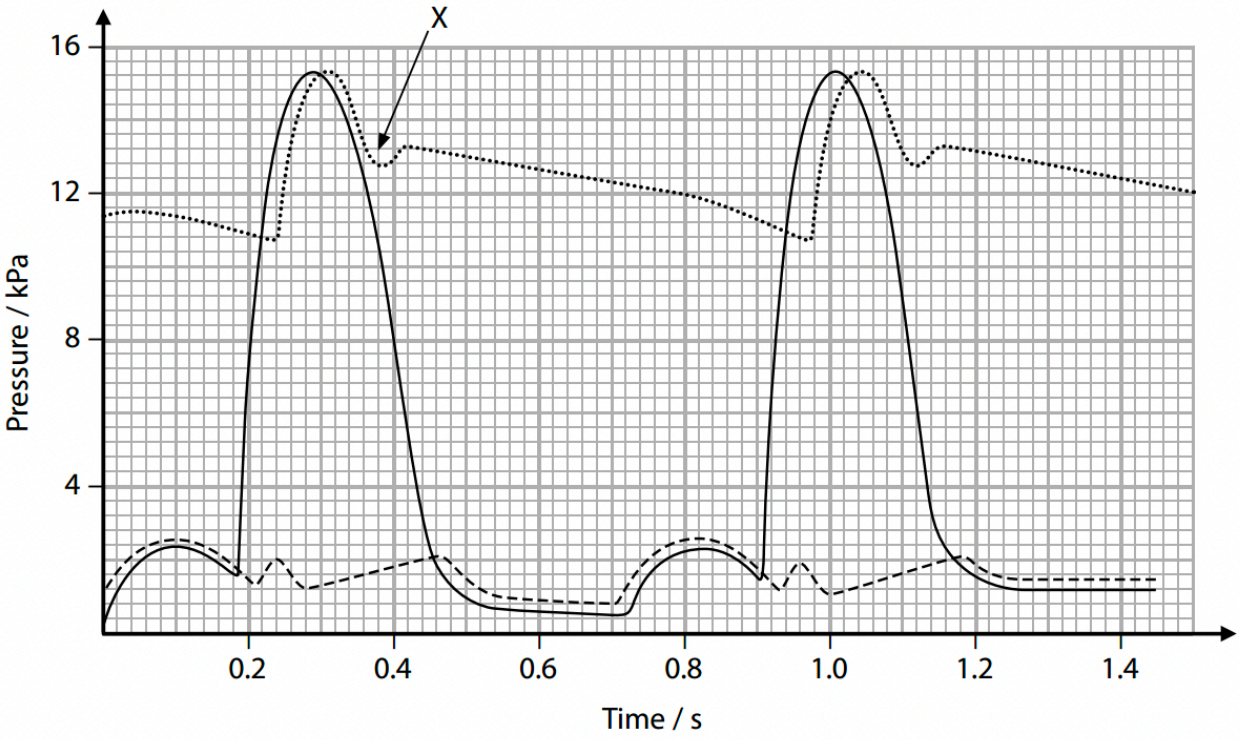
(ii) The baby survived because of the hole in the septum of the heart.

Explain how the hole in the septum allowed this baby to survive.

(3)

4 During the cardiac cycle, there are pressure changes in the left atrium, left ventricle and aorta.

The graph shows these pressure changes in the left atrium, left ventricle and aorta of a person.



Key

..... aorta

——— left ventricle

- - - - - left atrium

(a) (i) Which time period corresponds with ventricular systole?

(1)

☒ **A** 0.52 to 0.72

☒ **B** 0.72 to 0.92

☒ **C** 0.92 to 1.20

☒ **D** 0.24 to 0.98

(ii) Which of the following is occurring in the heart at 1.0 second on the graph?

(1)

☒ **A** semilunar valve is closed and atrioventricular valve is closed

☒ **B** semilunar valve is closed and atrioventricular valve is open

☒ **C** semilunar valve is open and atrioventricular valve is closed

☒ **D** semilunar valve is open and atrioventricular valve is open

(iii) Use the information on the graph to calculate the heart rate of this person.

(2)

Answer ..... beats per minute

5 Q4b

(b) When the heart valves close, they make a sound. This sound can be detected and recorded.

(i) State a time from the graph when the sound of an atrioventricular valve closing would be detected.

(1)

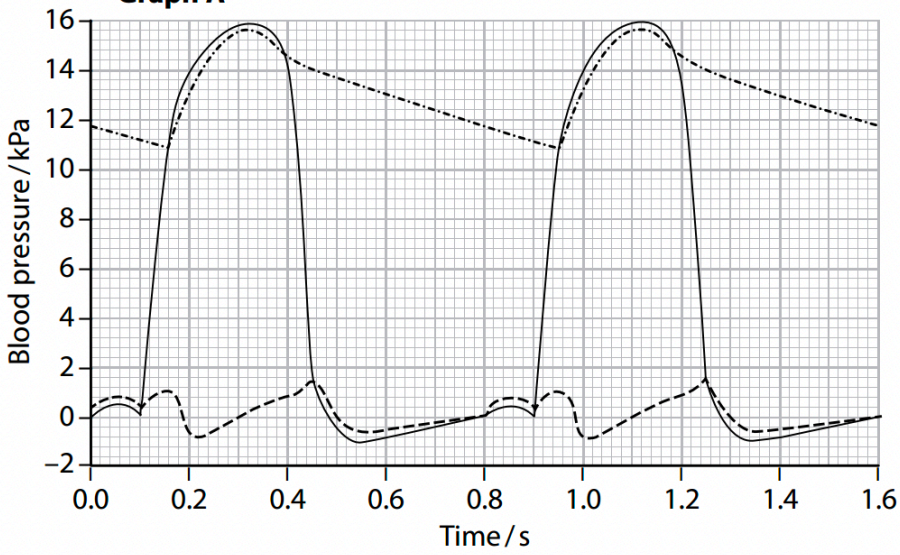
(ii) Explain why the atrioventricular valves need to close.

(2)

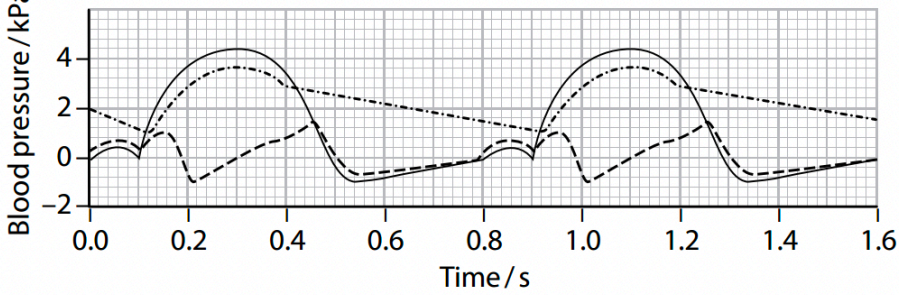
5 The pressure of the blood passing through the heart can vary.

Graph A shows the changes in blood pressure in one side of the heart. Graph B shows the changes in blood pressure in the other side of the heart over the same time period.

Graph A



Graph B



(a) (i) Calculate the heart rate.

(2)

Answer .....

(b) (i) Explain which side of the human heart is represented by graph B.

(2)

(ii) In graph A, which blood vessel carries the blood leaving the heart?

(1)

- ☒ **A** aorta
- ☒ **B** pulmonary artery
- ☒ **C** pulmonary vein
- ☒ **D** vena cava

(iii) In graph A, the blood pressure inside the ventricle changes between 0.0 and 0.45 seconds.

Explain how these changes in blood pressure occur in this part of the cardiac cycle.

(4)

(ii) Explain how the respiratory centre is involved in the control of ventilation rate in the 10 minutes of rest after exercise.

(5)

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(c) At the start of exercise, breathing rate increases.

Explain how starting to exercise causes an increase in breathing rate.

(3)

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0 1 . 1 Exercise causes an increase in heart rate.

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

[4 marks]

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1 0 . 2 During hibernation, the heart rate and the metabolic rate of black bears decrease (lines 3–5).

Use your knowledge of the nervous control of heart rate to describe how these are linked.

[4 marks]

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4 A moderate amount of exercise is considered good for the human body.

(a) A student carried out 20 minutes of physical exercise. During this time, her heart rate and level of sweating increased.

Shortly after completing the exercise, the student noted that her heart rate and level of sweating decreased.

(i) Explain the role of the brain in reducing the student's heart rate after the exercise.

(2)

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(ii) Describe how the brain reduces the activity of the sweat glands after the exercise.

(2)

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(b) The student wrote the following summary about the control of heart rate.

When the heart rate is too low the level of carboxylic acid in the blood becomes higher than normal. The vagus nerve sends action potentials to the AVN to increase the contraction rate of the heart muscle. The baroreceptors in the walls of the blood vessels then detect that the pH of the blood is normal, so heart rate can return to resting.

The endocrine system can also change heart rate. Release of the hormone adrenaline from the adrenal medulla causes the smooth muscle of the heart to contract more frequently.

Identify **and** correct any biological errors in the student's summary.

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[4]

(b) Outline the **hormonal** and **nervous** mechanisms involved in the control of heart rate.

In your answer, you should use the appropriate technical terms, spelt correctly.

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..... **[5]**

Question Number	Answer	Mark
***3(a)QWC**	**Take into account quality of written communication when awarding the following points.** 1. idea that there are four chambers ; 2. correct reference to relative position of *atria* and *ventricles* ; 3. idea of left and right sides separate / *septum* ; 4. reference to muscular nature of walls ; 5. reference to *cardiac* muscle ; 6. idea of relative thickness of *ventricle* (walls) ; 7. correct reference to position of {*atrioventricular valves* / eq} ; 8. correct reference to position of *semilunar valves* ; 9. reference to position of {*tendons / tendinous cords / papillary muscles* / eq} ; 10. correct reference to position of {*aorta / pulmonary artery*} ; 11. correct reference to position of {*vena cava / pulmonary vein*} ; 12. correct reference to *coronary arteries* ; 13. reference to {*SAN / Sino Atrial Node / pacemaker/ AVN /Atrioventricular Node / Purkinje fibres /Purkyne fibres / Bundle of His/eq* } ;	**(5)**

2 As levels of activity increase, the heart can respond to the changing demand for oxygen.

(a) Which term describes the ability of heart muscle to contract without external stimulation?

(1)

☒ **A** autonomic

☒ **B** cardiac

☒ **C** myogenic C

☒ **D** systolic

Q2b

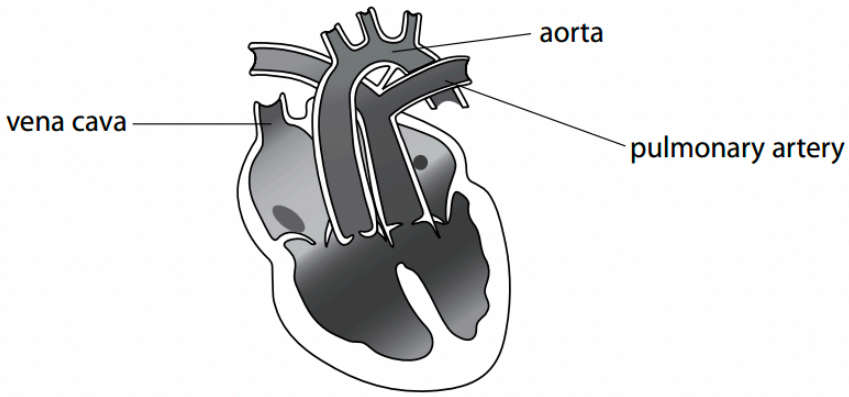
(b) Describe how the sinoatrial node (SAN) is involved in bringing about a change in heart rate as the level of activity increases.

(2)

A description that makes reference to two of the following points:

1. more { stimulation / depolarisation } of the SAN (from the sympathetic nervous system) / more impulses to the SAN (1)
2. (causing) more frequent waves of depolarisation from the SAN (to the atria) (1)
3. leading to more frequent { contraction of atria / stimulation of AVN } (1)

(b) A baby was born with an abnormal heart. The diagram shows the heart of this baby. There is a hole in the septum between the two ventricles.



(i) Identify the problem with the blood vessels of this heart.

(1)

The aorta and pulmonary artery are { attached to the wrong ventricles / the wrong way around }

Allow aorta leaves the right ventricle and the pulmonary artery leaves the left ventricle

(ii) The baby survived because of the hole in the septum of the heart.

Explain how the hole in the septum allowed this baby to survive.

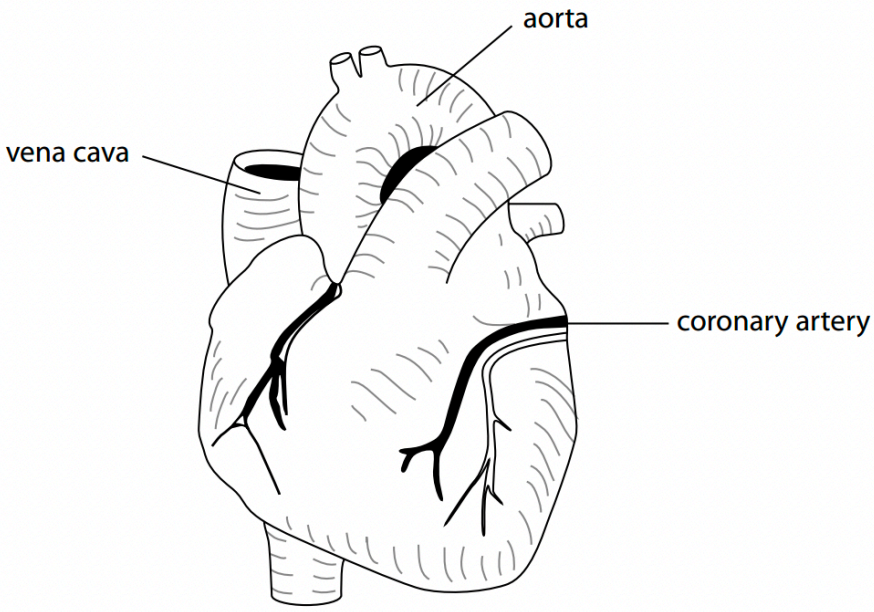
(3)

An explanation that makes reference to the following:

1. the hole allows oxygenated and deoxygenated blood to mix (between the two ventricles) (1)
2. oxygenated blood { travels to the body / enters aorta } / deoxygenated blood { travels to the lungs / enters pulmonary artery } (1)
3. providing some oxygen for respiration (1)

Allow converse

3 A student studied the external view of a mammalian heart, as shown in the diagram.



(a) The student wanted to compare the size of the aorta and the vena cava of this heart.

She determined the cross-sectional area of the aorta, which was 72.22 mm^2.
She also measured the diameter of the vena cava which was 17.0 mm.

(i) Calculate the difference in the cross-sectional area of the vena cava and the aorta.

(2)

8.5 x 8.5 = 72.25
72.25 x π= 226.98 (mm^2) (1)

Allow rounded values of π (e.g. 3.142)

226.98 – 72.22 = 154.76 (mm2) (1)

Correct answer gains full marks, no working

(ii) The student also compared the thickness of the aorta wall of this heart with the thickness of the aorta wall in a giraffe. The thickness of the aorta wall in this heart is 3 mm and in a giraffe it is 15 mm.

Give one reason why the aorta wall in a giraffe is much thicker.

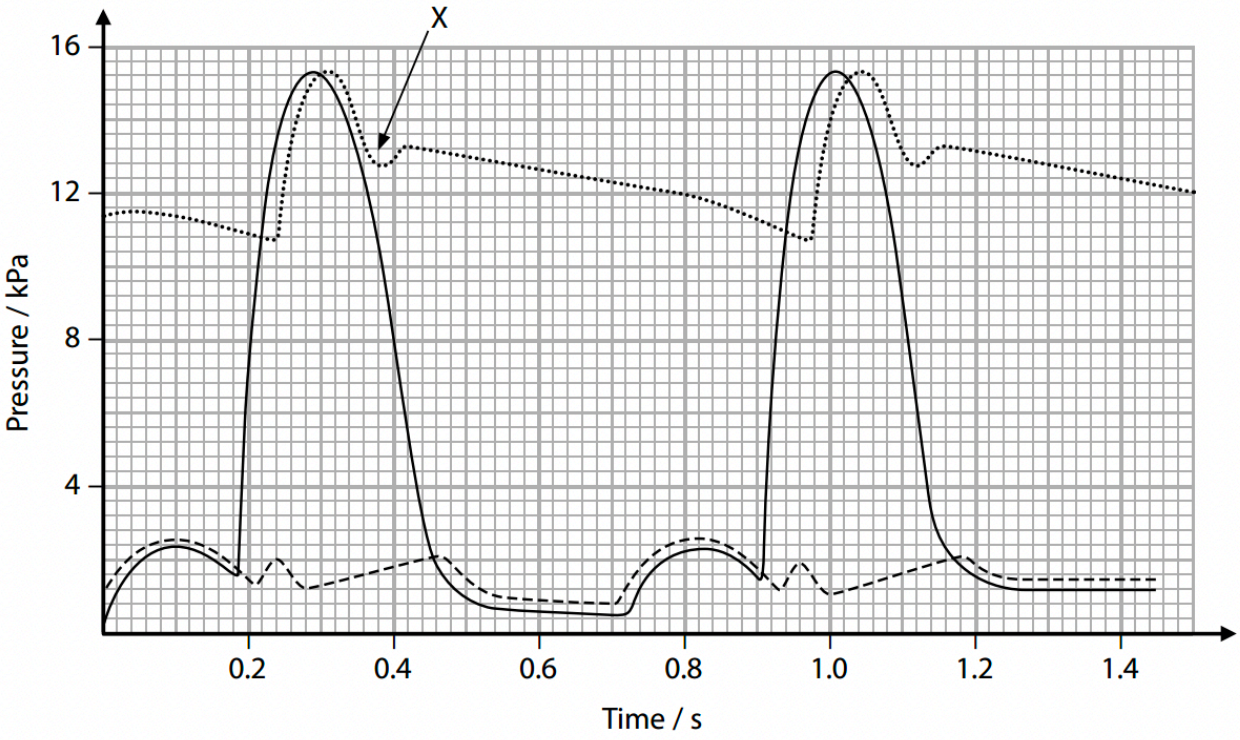
(1)

Answer that makes reference to the following:

• Need to withstand hihger pressure from the left ventricle / need to have more elastic tissue to create pressure to move blood against gravity

4 During the cardiac cycle, there are pressure changes in the left atrium, left ventricle and aorta.

The graph shows these pressure changes in the left atrium, left ventricle and aorta of a person.



Key

..... aorta

——— left ventricle

- - - - - left atrium

(a) (i) Which time period corresponds with ventricular systole?

(1)

☒ **A** 0.52 to 0.72

☒ **B** 0.72 to 0.92

☒ **C** 0.92 to 1.20 C

☒ **D** 0.24 to 0.98

(ii) Which of the following is occurring in the heart at 1.0 second on the graph?

(1)

☒ **A** semilunar valve is closed and atrioventricular valve is closed

☒ **B** semilunar valve is closed and atrioventricular valve is open

☒ **C** semilunar valve is open and atrioventricular valve is closed C

☒ **D** semilunar valve is open and atrioventricular valve is open

(iii) Use the information on the graph to calculate the heart rate of this person.

(2)

Allow ± 0.02 s for the duration of the cycle
Allow full marks for the correct answer, no working

one cycle = 0.72 s (1)
60 ÷ 0.72 = 83.3 (1)

Answer ..... beats per minute

5 Q4b

(b) When the heart valves close, they make a sound. This sound can be detected and recorded.

(i) State a time from the graph when the sound of an atrioventricular valve closing would be detected.

(1)

0.19s/0.91s(1)

Allow ± 0.01 s

(ii) Explain why the atrioventricular valves need to close.

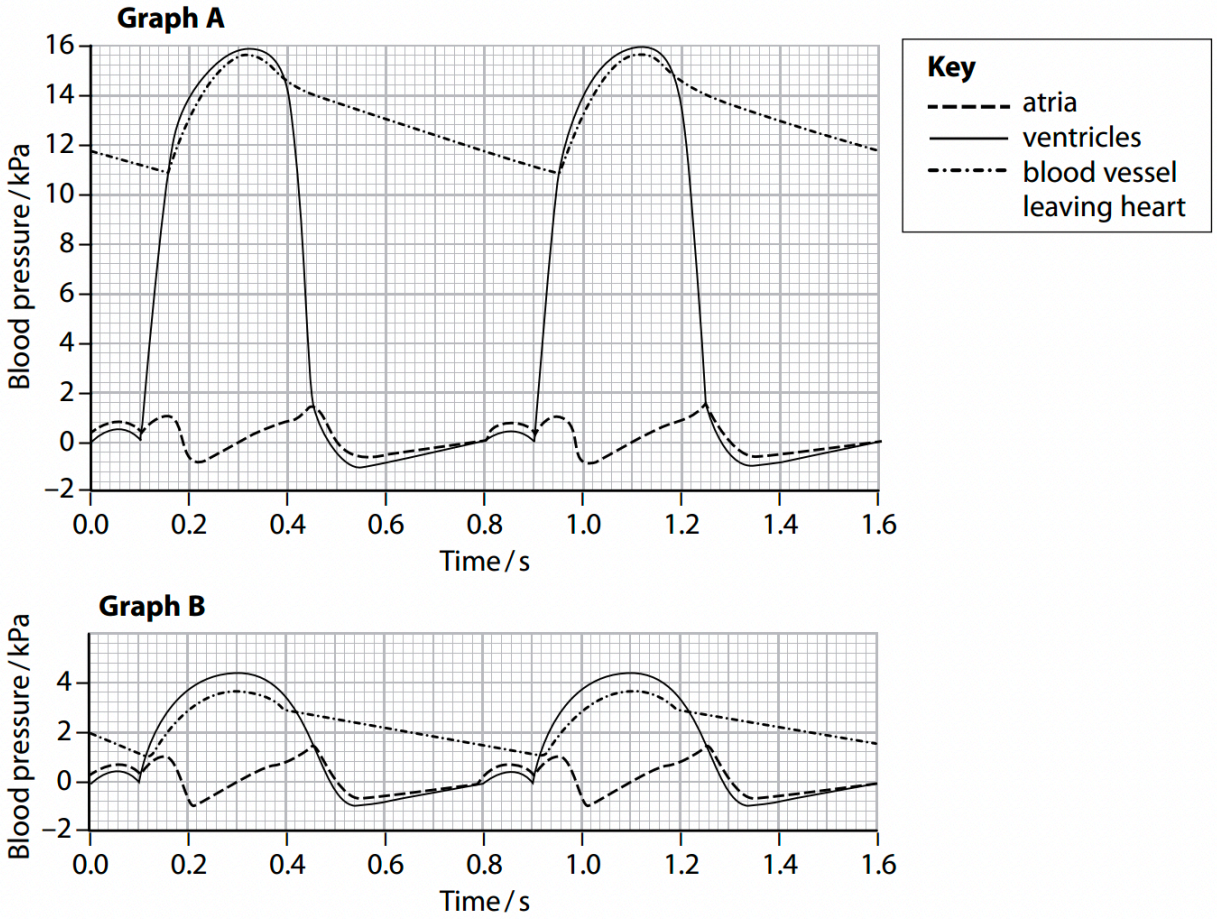
(2)

An explanation that makes reference to the following:

- ventricle needs to contract and force blood into the {aorta / pulmonary artery / arteries} (1)
- so valves need to close to prevent backflow into the atria on contraction (1)

5 The pressure of the blood passing through the heart can vary.

Graph A shows the changes in blood pressure in one side of the heart. Graph B shows the changes in blood pressure in the other side of the heart over the same time period.



(a) (i) Calculate the heart rate.

(2)

- correct figures from graph
- correct answer with unit

Example of calculation
e.g. 120 and 1.6 or 60 and 0.8
120 ÷ 1.6 / 60 ÷ 0.8
75 bpm

Answer .....

(b) (i) Explain which side of the human heart is represented by graph B.

(2)

An explanation that makes reference to the following:

1. right (1)
2. because the pressure is lower (in blood transported from heart to the lungs) (1)

(ii) In graph A, which blood vessel carries the blood leaving the heart?

(1)

☒ **A** aorta

A

☒ **B** pulmonary artery

☒ **C** pulmonary vein

☒ **D** vena cava

(iii) In graph A, the blood pressure inside the ventricle changes between 0.0 and 0.45 seconds.

Explain how these changes in blood pressure occur in this part of the cardiac cycle.

(4)

An explanation which makes reference to the following:

1. from 0 s (to 0.05 s) pressure increases due to atrial systole (1)
2. ventricle fills with blood { from the atrium / due to atrial systole } (1)
3. after atrial systole finishes (from 0.05s to 0.1s) there is a fall in ventricular pressure (1)
4. from 0.1s (to 0.32 s) increase in pressure due to ventricular systole (1)
5. (from 0.32 s) ventricular pressure decreases due to (ventricular) diastole (1)

1. ALLOW contraction of (muscular)walls of atria
4. ALLOW contraction of (muscular walls of) ventricle
5. ALLOW relaxation of (muscular walls of) ventricle

(ii) Explain how the respiratory centre is involved in the control of ventilation rate in the 10 minutes of rest after exercise.

(5)

An explanation that makes reference to five of the following:

1. High CO2 in the blood stimulates the respiratory centre (1)
2. Increase in lactate / fall in pH stimulates the respiratory centre (1)
3. Reference to chemoreceptors in the medulla/carotid bodies/aortic bodies (1)
4. More impulses sent to diaphragm and intercostal muscles (1)
5. Resulting in an increase in the rate and depth of breathing (1)
6. pH returns to normal as CO2 is removed and ventilation rate decreases (1)

(c) At the start of exercise, breathing rate increases.

Explain how starting to exercise causes an increase in breathing rate.

(3)

1. exercise initiates impulses from the {motor cortex / stretch receptors in muscles / proprioceptors } (1)
2. (impulses sent to or from the) { ventilation centre / respiratory control centre / medulla oblongata } (1)
3. leading to increased impulses to { intercostal muscles / diaphragm } (1)

1. IGNORE reference to chemoreceptors and changes in carbon dioxide or temperature receptors

0 1 . 1 Exercise causes an increase in heart rate.

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

[4 marks]

1. Chemoreceptors detect rise in CO_2/H^+/acidity/carbonic acid/fall in pH
OR
Baro/pressure receptors detect rise in blood pressure;
2. Send impulses to cardiac centre/medulla;
3. More impulses to SAN;
4. By sympathetic (nervous system for chemoreceptors/CO_2)
OR
By parasympathetic (nervous system for baro/pressure receptors/blood pressure);

1. Ignore: location of receptors.
1. Ignore: chemoreceptors detect oxygen.
2 and 3. Accept: action potentials.
2. Reject: 'messages', 'signals', 'an impulse' or an 'action potential'.
3. Ignore: messages', 'signals', 'an impulse' or an 'action potential' as emphasis here is on increase in frequency.

10.2 During hibernation, the heart rate and the metabolic rate of black bears decrease (lines 3–5).

Use your knowledge of the nervous control of heart rate to describe how these are linked.

4 max **[4 marks]**

1. (Lower metabolism so) less/low CO_2 (in blood);
2. (Detected by) chemoreceptors;
3. (Chemoreceptors) located in aorta/medulla
   OR
   (Chemoreceptors) located in carotid artery;
4. Fewer impulses to cardiac centre;
   OR
   Fewer impulses to medulla (oblongata);
5. (More) impulses along parasympathetic/vagus pathway/neurones/nerve
   OR
   Fewer impulses along sympathetic pathway/neurones/nerve;
6. (To) SAN;

4 A moderate amount of exercise is considered good for the human body.

(a) A student carried out 20 minutes of physical exercise. During this time, her heart rate and level of sweating increased.

Shortly after completing the exercise, the student noted that her heart rate and level of sweating decreased.

(i) Explain the role of the brain in reducing the student's heart rate after the exercise.

(2)

1. chemoreceptors detect a change in { carbon dioxide / pH } (1)
2. the cardiovascular control centre { receives impulses from chemoreceptors / sends impulses to the heart } (1)
3. (therefore impulses are transmitted) along the parasympathetic { nerve / nervous system / nerve pathway } to the SAN (reducing heart rate) (1)

2. ALLOW cardiac control centre
   ALLOW cardiovascular control centre sends impulses to the SAN
3. ALLOW vagus nerve

(ii) Describe how the brain reduces the activity of the sweat glands after the exercise.

(2)

- thermoreceptors detect a decrease in temperature (1)
- { hypothalamus / thermoregulatory centre } sends fewer impulses to sweat glands (1)

(b) The student wrote the following summary about the control of heart rate.

When the heart rate is too low the level of carboxylic acid in the blood becomes higher than normal. The vagus nerve sends action potentials to the AVN to increase the contraction rate of the heart muscle. The baroreceptors in the walls of the blood vessels then detect that the pH of the blood is normal, so heart rate can return to resting.

The endocrine system can also change heart rate. Release of the hormone adrenaline from the adrenal medulla causes the smooth muscle of the heart to contract more frequently.

Identify **and** correct any biological errors in the student's summary.

1 carboxylic acid should be carbonic acid / H_2CO_3 ✓
2 vagus (nerve) should be , accelerator / sympathetic / accelerans , (nerve)✓
3 AVN should be , SAN / sinoatrial node ✓

4 baroreceptors should be chemoreceptors
OR
pH should be pressure✓
5 smooth muscle should be cardiac muscle ✓

Error and correct term must be clearly identified.
ALLOW copied statements where correct terms replace errors.

1 IGNORE carbon dioxide
5 ALLOW specialised striated

[4]

Question			Expected Answers	Marks	Additional Guidance
5	(b)		1 **adrenalin(e)** increases , heart rate / stroke volume / cardiac output ; 2 **cardiovascular centre** in **medulla oblongata** ; 3 *idea of* nervous connection to , SAN / **sino-atrial node** ; 4 (which) controls frequency of waves of , excitation / depolarisation ; 5 **vagus / parasympathetic** , nerve decreases heart rate ; 6 **accelerator / sympathetic** , nerve increases heart rate ; 7 high blood pressure detected by , stretch receptors / baroreceptors ; 8 low blood pH / increased levels of blood CO_2 , detected by **chemoreceptors** ; 9 (receptors) in , aorta / **carotid** sinus / carotid arteries ;	4 max	1 2 **ACCEPT** 'cardiac' instead of cardiovascular but not for QWC 3 **ACCEPT** SAN for mp 3 but not for QWC 4 **CREDIT** in relation to mp 2 or mp 3 5 **ONLY CREDIT** vagus ***or*** parasympathetic for QWC 6 **ONLY CREDIT** accelerator ***or*** sympathetic for QWC **ACCEPT** phrenic nerve 7 **DO NOT CREDIT** proprioreceptor 8 9
			QWC – technical terms used appropriately with correct spelling ;	1	Correct use of **adrenalin(e)** (**Identify using the tick 1** ✓1 AND MUST BE INCLUDED FOR QWC TO BE AWARDED) **plus** use of **2** terms from: **cardiovascular centre, medulla oblongata, sino-atrial node, vagus or parasympathetic, carotid, accelerator or sympathetic, chemoreceptor** **You should use the GREEN DOT to identify the remaining QWC terms that you are crediting.** **Please insert a QWC symbol next to the PENCIL ICON, followed by a tick (✓) if QWC has been awarded or a cross (✗) if QWC has not been awarded**
			TOTAL	10	