1.13 The Circulatory System and Heart: 1-hour Pack

AQA 8464 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The heart is a muscular organ that pumps blood around the body.

(a) State the total number of chambers in the human heart. **(1)**

(b) Name the chamber of the heart that pumps deoxygenated blood to the lungs. **(1)**

(Total for Question 1 is 2 marks)

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2 The heart has several structural features that keep blood flowing correctly and efficiently.

(a) The heart has a septum that separates the left and right sides. Explain why this is important. **(2)**

(b) Explain the function of the valves found in the heart. **(2)**

(c) The wall of the left ventricle is thicker and more muscular than the wall of the right ventricle. Explain why. **(2)**

(Total for Question 2 is 6 marks)

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3 Humans have a double circulatory system.

(a) Describe what is meant by a 'double circulatory system'. **(2)**

(b) Explain one advantage of a double circulatory system compared with a single circulatory system. **(2)**

(Total for Question 3 is 4 marks)

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4 Blood is made up of several different components, each with a specific role.

(a) Name four components of blood. **(2)**

(b) Describe two adaptations of red blood cells that help them transport oxygen efficiently. **(2)**

(c) State the function of platelets in the blood. **(1)**

(d) State the function of white blood cells in the blood. **(1)**

(Total for Question 4 is 6 marks)

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5 A student called Priya carried out a practical investigation into the effect of exercise on pulse rate. She measured her pulse rate before exercise, then performed star jumps continuously for different durations, immediately counting the number of pulse beats felt at her wrist for 15 seconds after each period of exercise. Her results are shown in Table 1.

Table 1

Exercise duration (s)	Beats counted in 15 s	Pulse rate (bpm)
0	18	72
30	23	92
60	27	108
90	30	120
120	34	?

(a) Identify the independent variable in this investigation. **(1)**

(b) Identify the dependent variable in this investigation. **(1)**

(c) Give one variable that Priya should control to make this a fair test. **(1)**

(d) Priya counted 34 beats in 15 seconds after 120 seconds of exercise. Calculate her pulse rate, in beats per minute, to complete Table 1. **(2)**

(e) Suggest why Priya counted the pulse beats for only 15 seconds, rather than for a full 60 seconds, after each period of exercise. **(2)**

(f) Describe the pattern shown by the results in Table 1. **(2)**

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(g) Explain, in terms of processes happening in the muscles, why pulse rate increases during exercise. **(3)**

(h) Suggest one improvement Priya could make to her method to produce more reliable results. **(1)**

(Total for Question 5 is 13 marks)

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6 A student uses a light microscope to measure the diameter of a capillary in a prepared slide. The microscope eyepiece graticule reading for the capillary is 24 divisions. The calibration (stage micrometer) shows 10 divisions on the graticule = 50 micrometres. Calculate the diameter of the capillary in micrometres. Give your answer to the nearest micrometre.

(a) Calculate the calibration scale: micrometres per graticule division. **(1)**

(b) Use the calibration to calculate the capillary diameter in micrometres to the nearest micrometre. **(2)**

(Total for Question 6 is 3 marks)

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7 Arteries, veins and capillaries have different structures related to their functions.

(a) Give two differences in structure between an artery and a vein. **(2)**

(b) Explain how the structure of an artery is adapted to carry blood at high pressure away from the heart. **(3)**

(c) Explain how the structure of a capillary is adapted for the efficient exchange of substances with body tissues. **(2)**

(Total for Question 7 is 7 marks)

8 Explain how the structure of the heart and valves ensures unidirectional flow of blood through the heart. You should include the roles of chambers, valves and muscle thickness in your answer.

(Total for Question 8 is 6 marks)

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Mark scheme · 1.13 The Circulatory System and Heart: 1-hour Pack

Question 1

(a) 4 (four) cao **B1**

(a) Answer: 4

(b) right ventricle oe **B1**

(b) Answer: Right ventricle

Question 2

(a) prevents/stops oxygenated and deoxygenated blood from mixing, oe **B1**

(a) so blood pumped to the body has the highest possible concentration of oxygen, allowing efficient aerobic respiration in body cells, oe **B1**

(a) Answer: The septum stops oxygenated and deoxygenated blood mixing, so the blood sent to the body carries as much oxygen as possible.

(b) prevent the backflow of blood, oe **B1**

(b) ensuring blood only flows in one direction through the heart, maintaining efficient circulation, oe **B1**

(b) Answer: Valves stop blood flowing backwards, keeping blood flowing in one direction through the heart.

(c) the left ventricle must pump blood all the way around the whole body (systemic circulation), which requires a greater force/higher pressure than the right ventricle, which only pumps blood to the nearby lungs (pulmonary circulation), oe **B1**

(c) a thicker, more muscular wall allows the left ventricle to contract with greater force, generating this higher pressure, oe **B1**

(c) Answer: The left ventricle pumps blood around the whole body, which needs a higher pressure than pumping just to the lungs, so it has a thicker, more muscular wall to generate that force.

Question 3

(a) blood passes through the heart twice for each complete circuit of the body, oe **B1**

(a) once around the pulmonary circuit (heart to lungs and back) and once around the systemic circuit (heart to the rest of the body and back), oe **B1**

(a) Answer: Blood passes through the heart twice on each full circuit: once to the lungs and back (pulmonary circuit), and once to the rest of the body and back (systemic circuit).

(b) blood returning from the lungs passes back through the heart before travelling to the body, so its pressure/speed is boosted between the two circuits, oe **B1**

(b) this means oxygenated blood reaches body cells faster and at a higher pressure, allowing more efficient/faster delivery of oxygen for aerobic respiration, oe **B1**

(b) Answer: Blood is repressurised by the heart after returning from the lungs, so oxygenated blood reaches the body faster and at higher pressure than in a single circulatory system.

Question 4

(a) any two of: red blood cells, white blood cells, platelets, plasma **B1**

(a) a further two different components from: red blood cells, white blood cells, platelets, plasma (all four different components needed for both marks) **B1**

(a) Answer: Red blood cells, white blood cells, platelets and plasma.

(b) any one valid adaptation, e.g. biconcave disc shape, giving a large surface area (to volume ratio) for the diffusion of oxygen; no nucleus, leaving more space for haemoglobin; packed with haemoglobin, which binds oxygen; small and flexible, so they can squeeze through capillaries, oe **B1**

(b) a second, different valid adaptation from the same list, oe **B1**

(b) Answer: Any two, e.g. red blood cells have a biconcave disc shape, increasing surface area for diffusion, and no nucleus, leaving more room for oxygen-carrying haemoglobin.

(c) help the blood to clot at a wound/site of damage, oe **B1**

(c) Answer: Platelets help the blood clot at a wound.

(d) defend the body against pathogens/infection, e.g. by engulfing pathogens or producing antibodies, oe **B1**

(d) Answer: White blood cells defend the body against pathogens, for example by engulfing them or producing antibodies.

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Question 5

(a) duration of exercise, oe **B1**

(a) Answer: Duration of exercise

(b) pulse rate (in beats per minute), oe **B1**

(b) Answer: Pulse rate (in beats per minute)

(c) any one of: the same person carries out the test each time / the same type of exercise (star jumps) is used each time / the same rest period is allowed before each repeat / room temperature is kept the same, oe **B1**

(c) Answer: E.g. the same type of exercise (star jumps) is used for every repeat.

(d) 34 x 4, oe **M1**

(d) 136 (bpm) cao **A1**

(d) Answer: 136 bpm

(e) counting for a shorter time is quicker, so the pulse rate can be measured very soon after exercise stops, before it starts to fall/recover, oe **B1**

(e) this also allows the measurement to be repeated more times (to check reliability/calculate a mean), and reduces the chance the pulse rate itself changes noticeably during the counting period, oe **B1**

(e) Answer: A 15-second count is quick enough to capture the pulse rate before it starts to recover, and allows repeats to check reliability.

(f) as the duration of exercise increases, pulse rate increases, oe **B1**

(f) quotes data to support this, e.g. pulse rate rises from 72 bpm at rest (0 s) to 120 bpm after 90 s of exercise, an increase that is roughly proportional to exercise duration, oe **B1**

(f) Answer: Pulse rate increases as exercise duration increases, rising from 72 bpm at rest to 120 bpm after 90 seconds of exercise.

(g) during exercise, muscle cells respire more/faster to release the energy needed for contraction, oe **B1**

(g) this increases the muscles' demand for oxygen and glucose, and increases the rate of production of carbon dioxide, oe **B1**

(g) the heart beats faster (pulse rate increases) to increase the rate of blood flow (cardiac output), delivering oxygen and glucose to the muscles and removing carbon dioxide more quickly, oe **B1**

(g) Answer: Exercising muscles respire faster, needing more oxygen and glucose and producing more carbon dioxide, so the heart beats faster to increase blood flow and meet this demand.

(h) repeat each measurement (at each exercise duration) several times and calculate a mean pulse rate (also accept: use a heart-rate monitor/pulse sensor instead of manually counting beats), oe **B1**

(h) Answer: Repeat each measurement several times and calculate a mean pulse rate.

Question 6

(a) states calibration: 50 micrometres / 10 divisions = 5 micrometres per division **B1**

(a) Answer: 5 micrometres per division

(b) multiplies graticule reading by calibration: 24 x 5 **M1**

(b) 120 micrometres cao **A1**

(b) Answer: 120 micrometres

Question 7

(a) an artery has a thicker, more muscular (and elastic) wall than a vein, oe **B1**

(a) an artery has a narrower lumen than a vein, and/or veins (but not arteries) contain valves, oe (any one further valid difference) **B1**

(a) Answer: An artery has a thicker, more muscular wall and a narrower lumen than a vein; veins also contain valves, which arteries do not.

(b) thick wall containing muscle and elastic fibres, oe **B1**

(b) the wall can withstand and stretch/recoil under the high pressure of blood leaving the heart, oe **B1**

(b) narrow lumen helps to maintain the high pressure of the blood, oe **B1**

(b) Answer: Arteries have thick, muscular, elastic walls that withstand and recoil under high pressure, and a narrow lumen that helps maintain that pressure.

(c) capillary walls are only one cell thick, oe **B1**

(c) this gives a short diffusion distance/pathway, allowing oxygen, glucose, carbon dioxide and other substances to diffuse quickly between blood and cells, oe **B1**

(c) Answer: Capillary walls are one cell thick, giving a short diffusion distance so substances can be exchanged quickly with body cells.

Question 8

Level 3 Detailed explanation. Candidate makes a clear description of how chambers, valves and muscle thickness interact to produce unidirectional flow; links anatomical features to function with clear causal explanation and uses correct examples (eg left ventricle thicker to pump to body; atrioventricular valves and semilunar valves close to prevent backflow). **5-6**

Level 2 Partial explanation. Candidate describes two or more relevant features and gives a basic link to function, but the causal chain is incomplete or lacks specific examples. **3-4**

Level 1 Simple statements about heart parts with limited or no explanation of how these produce unidirectional flow. **0-2**

Indicative content:

- Chambers: atria receive blood, ventricles pump blood out; right ventricle pumps to lungs, left ventricle to body.
- Valves: atrioventricular valves (tricuspid and mitral) between atria and ventricles prevent backflow when ventricles contract; semilunar valves (pulmonary and aortic) at exits prevent backflow when ventricles relax.
- Muscle thickness: left ventricle has thicker muscular wall to generate higher pressure to pump blood around the body; right ventricle thinner as it only pumps to the lungs.
- Sequence of contraction: atrial contraction followed by ventricular contraction and coordinated valve closure ensures blood moves forward; pressure differences open and close valves.
- How these features interact: valves respond to pressure changes created by contraction; valve closure prevents backward flow so blood is forced in one direction.

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