1.20 Respiration, Exercise and Metabolism: 30-minute Pack

Total Marks

AQA 8464 · Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 During very vigorous exercise, muscle cells cannot always get enough oxygen to respire aerobically.

(a) State the word equation for anaerobic respiration in muscle cells. **(2)**

(b) State one situation in which muscle cells respire anaerobically rather than aerobically. **(1)**

(Total for Question 1 is 3 marks)

2 Aerobic respiration is the main way that cells release the energy they need.

(a) Define aerobic respiration. **(1)**

(b) Write the word equation for aerobic respiration. **(2)**

(c) Name the type of cell structure (organelle) in which most of the reactions of aerobic respiration take place. **(1)**

(Total for Question 2 is 4 marks)

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3 A group of students investigated the required practical: the effect of exercise on heart rate. Aisha stepped on and off a low box repeatedly for different lengths of time, then measured her heart rate. She carried out the investigation on 03/03/2026 and repeated each reading three times.

Exercise duration (minutes)	Repeat 1 (bpm)	Repeat 2 (bpm)	Repeat 3 (bpm)
0 (resting)	72	76	74
1	98	102	100
2	118	152	120
3	134	138	136

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

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

(c) Give three variables that should be controlled to make this a fair test. **(3)**

(d) Aisha counted her pulse for 15 seconds immediately after stepping, then multiplied the count by 4 to get a rate in beats per minute, rather than counting for a full 60 seconds. Explain why this method gives a more valid result. **(2)**

(e) One of the repeats at 2 minutes is anomalous. Identify this anomalous result and calculate the mean heart rate at 2 minutes, excluding it. **(3)**

(f) Describe the trend shown by Aisha's results, excluding the anomaly. **(2)**

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(g) Aisha concluded: 'Exercise increases heart rate because muscles need more energy.' Evaluate this conclusion using your knowledge of respiration. **(3)**

(Total for Question 3 is 15 marks)

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4 After exercise, lactic acid must be removed from Ffion's muscles and blood.

(a) Name the organ that converts lactic acid back into glucose. **(1)**

(b) State what the liver needs, in addition to enzymes, in order to break down lactic acid. **(1)**

(c) Explain how lactic acid produced in Ffion's leg muscles reaches her liver. **(2)**

(Total for Question 4 is 4 marks)

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Mark scheme · 1.20 Respiration, Exercise and Metabolism: 30-minute Pack

Question 1

(a) glucose as the only reactant (no oxygen) **B1**

(a) lactic acid as the only product **B1**

(a) Answer: glucose -> lactic acid

(b) during vigorous/strenuous exercise, when the oxygen supplied to the muscles cannot meet demand, oe **B1**

(b) Answer: During vigorous exercise, when the body cannot supply oxygen to the muscles fast enough to meet demand (oe).

Question 2

(a) the process in cells that releases energy from glucose by combining it with oxygen, oe **B1**

(a) Answer: The process in cells that releases energy from glucose by reacting glucose with oxygen (oe).

(b) glucose + oxygen on the reactant side **B1**

(b) carbon dioxide + water on the product side, with the arrow pointing from reactants to products **B1**

(b) Answer: glucose + oxygen -> carbon dioxide + water

(c) mitochondria / mitochondrion **B1**

(c) Answer: Mitochondria (singular: mitochondrion).

Question 3

(a) duration of exercise (time spent stepping) **B1**

(a) Answer: The duration of exercise (the length of time spent stepping on and off the box).

(b) heart rate (in beats per minute) **B1**

(b) Answer: Heart rate, measured in beats per minute (bpm).

(c) the same person (Aisha) tested each time **B1**

(c) the same height of box and the same stepping rate (so exercise intensity is the same) each time **B1**

(c) any other valid control, e.g. full recovery back to resting heart rate before each repeat, or the same room temperature **B1**

(c) Answer: Any three of: the same person tested throughout; the same height of step and the same stepping rate, so exercise intensity is the same; a full recovery back to resting heart rate before each repeat; the same room temperature.

(d) heart rate starts to fall back towards its resting value as soon as exercise stops (recovery begins immediately), oe **B1**

(d) so a full 60 second count would include this falling heart rate and underestimate the rate reached during/immediately after exercise; a quick 15 second count x 4 is closer to the true rate at that moment, oe **B1**

(d) Answer: Heart rate starts to fall as soon as exercise stops, so a full 60 second count taken after stopping would include this recovery and underestimate the heart rate reached during exercise. Counting for just 15 seconds, then multiplying by 4 to convert to bpm, captures a rate much closer to the true value immediately after exercise, making it more valid (oe).

(e) identifies 152 bpm as the anomalous result (much higher than the other two repeats at 2 minutes) **M1**

(e) correct method excluding the anomaly, e.g. (118 + 120) / 2 **M1**

(e) 119 bpm cao **A1**

(e) Answer: The anomalous result is 152 bpm. Mean, excluding it, = (118 + 120) / 2 = 119 bpm.

(f) as exercise duration increases, heart rate increases, oe **B1**

(f) reference to specific data, e.g. from about 74 bpm at rest to about 136 bpm at 3 minutes **B1**

(f) Answer: As the duration of exercise increases, Aisha's heart rate increases, rising from around 74 bpm at rest to around 136 bpm after 3 minutes of stepping (oe).

(g) the data supports the general conclusion, since heart rate clearly increases as exercise duration increases, oe **B1**

(g) the conclusion could be improved by explaining that muscles need more energy for aerobic respiration, which requires oxygen and glucose to be delivered faster, so the heart beats faster to supply this, oe **B1**

(g) a limitation, e.g. only one person was tested, so the result may not apply to everyone, or heart rate was measured manually by counting a pulse, which is less accurate than an electronic heart rate monitor, oe **B1**

(g) Answer: The data does support Aisha's conclusion, as heart rate rises consistently as exercise duration increases. However, the conclusion could be more precise: exercising muscles need more energy for aerobic respiration, which requires oxygen and glucose to be delivered faster, so heart rate increases to pump blood around the body more quickly. The conclusion is also limited because it is based on only one person, and heart rate was measured manually by counting a pulse, which is less accurate and reliable than using an electronic heart rate monitor.

Question 4

(a) liver **B1**

(a) Answer: The liver.

(b) oxygen **B1**

(b) Answer: Oxygen.

(c) lactic acid diffuses out of the muscle cells into the blood plasma, down a concentration gradient, oe **B1**

(c) the blood transports/carries the lactic acid to the liver, oe **B1**

(c) Answer: Lactic acid diffuses out of the muscle cells into the blood plasma, down a concentration gradient, and is then carried by the blood to the liver (oe).

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