B2 4 Respiration

- 87 minutes
- 83 marks
Q1. Energy is obtained from both aerobic and anaerobic respiration during exercise.

(a) Give three differences between aerobic and anaerobic respiration.

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3 .................................................................................................................................................. 
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(b) Two students did the same step-up exercise for 3 minutes.
One of the students was fit. The other student was unfit.

The graph shows how the students’ heart rate changed during the exercise and after the exercise.

(b) Suggest which student was the fitter. Draw a ring around your answer. Student X / Student Y

Give three reasons for your answer.

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2 ........................................................................................................................................

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3 ........................................................................................................................................

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Q2. Oxygen from our lungs is carried, by our blood, to cells in our body where aerobic respiration takes place.

(i) Complete the two spaces to balance the chemical reaction for aerobic respiration.

\[ \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow \ldots \text{CO}_2 + \ldots \text{H}_2\text{O} \]

(ii) Name the substance with the formula \( \text{C}_6\text{H}_{12}\text{O}_6 \).

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(iii) Name the structures in the cytoplasm of our cells where aerobic respiration takes place.

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(Total 3 marks)

Q3. Respiration is a process which takes place in living cells. What is the purpose of \textit{respiration}?

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(1)
(b) (i) Balance the equation for the process of respiration when oxygen is available.

\[ \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]

(1)

(ii) What is the name of the substance in the equation with the formula \( \text{C}_6\text{H}_{12}\text{O}_6 \) ?

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(1)

(c) Oxygen is absorbed through the alveoli in the lungs.

(i) How are the alveoli adapted for this function?

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(2)

(ii) Name the gas which is excreted through the alveoli.

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(1)

(d) (i) What is the name of the process of respiration when oxygen is not available?

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(1)

(ii) Describe the process of respiration which takes place in human beings when oxygen is not available and give an effect.

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(3) (Total 10 marks)
Q4. Paula is training for a marathon. When she runs, her heart beats faster than it does when she is resting.

Complete the sentences, using words from the box.

\[
\begin{array}{cccc}
\text{blood} & \text{breathe} & \text{carbon dioxide} & \text{glucose} \\
\text{heat} & \text{nitrogen} & \text{oxygen} & \text{respire}
\end{array}
\]

When she is running, Paula's muscle activity increases. To do this, her muscle cells ................................................. at a faster rate to give her more energy. Her muscles need to be supplied with ........................................... and ................................................................. more quickly. Her heart beats faster to increase the flow of ......................................................... which carries the products ................................................................. and ................................................................. away from her muscles.

(Total 6 marks)
Q5. A student's breathing was monitored before and after vigorous exercise. The student breathed in and out through a special apparatus. The graphs show the changes in the volume of air inside the apparatus. Each time the student breathed in, the line on the graph dropped. Each time the student breathed out, the line went up.
(a) How many times did the student breathe in per minute:
   before exercise: ...........................................................................................................
   after exercise? .............................................................................................................

(b) On each graph, the line A – B shows how much oxygen was used. The rate of oxygen use before exercise was 0.5 dm$^3$ per minute. Calculate the rate of oxygen use after exercise.
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   Rate of oxygen use after exercise = ................................................. dm$^3$ per minute

(c) The breathing rate and the amount of oxygen used were still higher after exercise, even though the student sat down to rest. Why were they still higher?
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(Total 7 marks)
Q6. Regular exercise is important, as it helps to maintain an efficient supply of blood to the muscles, the heart and the lungs. This is helped by an increase in the heart rate during exercise.

Explain why it is necessary for the heart rate to increase during exercise.

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(Total 4 marks)

Q7. (a) (i) The table shows an athlete’s breathing rate after the end of a race.

The results can be put onto a graph. Three of the points are already plotted. Plot the other points shown in the table. Then draw the graph.

<table>
<thead>
<tr>
<th>Time after end of race (minutes)</th>
<th>Breathing rate (litres per second)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>
(ii) What is the athlete’s breathing rate ½ (half) a minute after the end of the race?

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(b) One of the reasons for breathing is to get rid of carbon dioxide from your body. Choose words from the list to complete the sentences below about how your body does this.

| blood | heart | kidneys | lungs | urine |

Carbon dioxide gets out of your body from your .........................................................

The carbon dioxide is carried to this part of your body by your .................................

(2)

(c) The bar charts show what happens in an athlete’s muscles when running in two races of different distances.
(i) Compare what happens in the athlete’s muscles when running in the two races.

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(ii) Use the information in the box to explain your answer to (i).

<table>
<thead>
<tr>
<th>aerobic respiration</th>
<th>glucose + oxygen → carbon dioxide + water</th>
</tr>
</thead>
<tbody>
<tr>
<td>anaerobic respiration</td>
<td>glucose → lactic acid</td>
</tr>
</tbody>
</table>

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(Q8. The graph shows the effect of increasing the carbon dioxide content of the inhaled air on:

- the number of breaths per minute;
- the total volume of air breathed per minute.

![Graph showing the effect of carbon dioxide content on breaths and volume](image_url)
(i) Describe the effect of increasing the percentage of carbon dioxide in the inhaled air on the total volume of air breathed.

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(2)

(ii) Suggest why the total volume of inhaled air is not directly proportional to the number of breaths per minute.

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(2)

(Total 4 marks)

Q9. **Person A** and **Person B** measured their pulse rates over a period of five minutes. For one minute of this time they exercised by stepping on and off a box. At other times they sat still. The graph shows the results for **Person A**.
(i) What does the graph tell you about the changes in the pulse rate of Person A within the five minute period?

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(3)

(ii) What was the pulse rate of Person A at the end of the five minute period?

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(1)

(iii) The table shows the results obtained for Person B.

<table>
<thead>
<tr>
<th>Time in minutes</th>
<th>Pulse rate per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>68</td>
</tr>
<tr>
<td>1</td>
<td>68</td>
</tr>
<tr>
<td>2</td>
<td>110</td>
</tr>
<tr>
<td>3</td>
<td>96</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
</tr>
<tr>
<td>5</td>
<td>68</td>
</tr>
</tbody>
</table>

Plot these results on the graph.

(2)

(Total 6 marks)
Q10. In an investigation four groups of athletes were studied. The maximum rate of oxygen consumption for each athlete was measured and the mean for each group was calculated. The athletes then ran 10 mile races and the mean of the best times was calculated for each group. The results are shown in the table below.

<table>
<thead>
<tr>
<th>GROUP OF ATHLETES</th>
<th>MAXIMUM RATE OF OXYGEN CONSUMPTION (cm³ per kg per min)</th>
<th>BEST TIME IN 10 MILE RACE (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>78.6</td>
<td>48.9</td>
</tr>
<tr>
<td>B</td>
<td>67.5</td>
<td>55.1</td>
</tr>
<tr>
<td>C</td>
<td>63.0</td>
<td>58.7</td>
</tr>
<tr>
<td>D</td>
<td>57.4</td>
<td>64.6</td>
</tr>
</tbody>
</table>

(i) What is the relationship between maximum rate of oxygen consumption and time for a 10 mile race?

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............................................................................................................................................... (1)

(ii) Suggest an explanation for this relationship.

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(Total 4 marks)
A person did five different activities in turn. These activities needed increasing amounts of energy. For each activity two measurements were made. These were the rate of contraction of the left ventricle and its stroke volume (the volume of blood pumped at each beat). From these measurements the cardiac volume was calculated.

Some of these results are shown in the table and the bar chart.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Rate of contraction of left ventricle in beats per minute</th>
<th>Cardiac output in cm(^3) per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting upright</td>
<td>68</td>
<td>5 500</td>
</tr>
<tr>
<td>Slow walking</td>
<td>98</td>
<td>8 000</td>
</tr>
<tr>
<td>Moderate walking</td>
<td>130</td>
<td>12 000</td>
</tr>
<tr>
<td>Fast walking</td>
<td>150</td>
<td>17 500</td>
</tr>
<tr>
<td>Running</td>
<td>190</td>
<td>19 000</td>
</tr>
</tbody>
</table>

(a) (i) Describe how a person can count the rate of beating of the left ventricle.

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................................................. (1)

(ii) Calculate the rate of ventricle contraction in beats per minute when the person was walking slowly. Show clearly how you work out your final answer.

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Rate of ventricle contraction......................... beats per minute.

................................................. (2)
(iii) The pattern of results for stroke volume shows an anomalous result when the person is running. In what way is it anomalous?

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(1)

(iv) There was a change in cardiac output when the person's movement changed from fast walking to running. How did the heart produce this change?

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(1)

(b) Over a period of time, regular exercise can strengthen the heart muscle. This change in the heart muscle enables a person to run for longer before lactic acid build up occurs. Explain the reason for this.

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(2)

(Total 7 marks)
Q12. (a) The volume of blood pumped out of the left ventricle at each beat was measured for a
person during six different activities. These activities showed an increasing energy
demand, with rest requiring the least energy and rowing a boat the most. The results of
these measurements are shown on the bar chart.

(i) The pulse rate was also measured for the person during the same activities. The
table shows the results that were obtained.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Pulse rate in beats per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest</td>
<td>70</td>
</tr>
<tr>
<td>Writing</td>
<td>85</td>
</tr>
<tr>
<td>Cleaning the floor</td>
<td>100</td>
</tr>
<tr>
<td>Wallpapering</td>
<td>120</td>
</tr>
<tr>
<td>Walking fast</td>
<td>132</td>
</tr>
<tr>
<td>Rowing a boat</td>
<td>153</td>
</tr>
</tbody>
</table>
(ii) Undertaking activities with increasing energy demand has an effect on the volume of blood pumped from the left ventricle (per beat) and on the pulse rate. What do the bar charts show these effects to be? Use only information shown in the bar charts in your answer.

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(2)

(b) The pulse rate changed when the activity changed. Explain the reason for this.

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(2)

(Total 6 marks)
M1.  
(a) any three from:

- oxygen used in aerobic respiration
- more energy from aerobic respiration
- carbon dioxide and water are end products of aerobic respiration
- lactic acid is end product of anaerobic respiration

(b) (Student Y)

*accept converse for student X*

- the lower resting heart rate
- the lower heart rate increase and
- the quicker recovery time

(c) when exercising the rate of respiration (in the muscles) is higher

(the increased heart rate delivers)

- more oxygen to the (respiring) muscles
- more glucose to the (respiring) muscles
- and results in faster removal of carbon dioxide and lactic acid

[10]

M2.  
(i) 6 in both spaces

*do not credit if any formula has been altered*

(ii) glucose

*allow fructose or dextrose*

(iii) mitochondria

*accept organelles*
M3.

(a) to transfer / provide / give release energy
   or production of ATP / adenosine triphosphate (molecules)
   accept to give heat

(b) (i) \( C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O \)
    accept any other
    \( n : 6n : 6n : 6n \) ratio
    do not credit if any other changes have been made

   (ii) glucose
        do not credit sugar / sucrose

(c) (i) any two from
    large surface
    thin (surface)
    moist (surface)
    (with a good) blood supply

   (ii) carbon dioxide
        accept water vapour
        do not credit just water

(d) (i) anaerobic (respiration)

   (ii) any three from
    in mitochondria
    glucose decomposes / breaks down / reacts
    or glucose \( \rightarrow \) lactic acid for (2) marks
    to give lactic acid
    or breathing hard
    or lactic acid \( \rightarrow \) CO2 + water
    causing pain
    (leaving an) oxygen debt
    (quick) source of energy
    (but) less efficient than aerobic respiration
    accept less efficient than with oxygen
M4. (a) respire

\[
\begin{aligned}
\text{oxygen / glucose} & \qquad \text{each once only} \\
\text{glucose / oxygen} & \\
\text{blood} & \\
\text{carbon dioxide / heat} & \qquad \text{each once only} \\
\text{heat / carbon dioxide} & \\
\end{aligned}
\]

1

[6]

M5. (a) (before exercise) – 9 to 11 and (after exercise) – 12 or 13

both correct

1

(b) 0.75 to 0.90

\[
\text{ignore working or lack of working}
\]

\[
\text{eg. } 2.35 - 1.55 \text{ or } \frac{(2.35 - 1.0) \times 60}{100} \text{ or other suitable figures for 1 mark}
\]

2

(c) any four from:

- still need to remove extra carbon dioxide
- still need to remove heat / to cool
- (some) anaerobic respiration (in exercise)
- lactic acid made (in exercise)
- oxygen needed to break down lactic acid or suitable reference to oxygen debt
- lactic acid broken down to \(CO_2\) and water or lactic acid changed into glucose

4

[7]
any four from:

more energy / respiration required
  accept it prevents / reduces anaerobic respiration or less / no lactic acid
  reference to increase must be made,
  but only needed once, provided
  inference is clear for remainder of points.
  accept ‘delivered more quickly’ for ‘increase’

increase oxygen uptake into blood (in lungs)
increase oxygen delivery to muscles
increase glucose delivery to muscles
increase removal of heat from muscles or increase delivery of heat to skin
increase removal of carbon dioxide from muscles
increase removal of carbon dioxide from blood (in lungs)

M7. (a) (i) points correctly plotted
  all correct gains 2 marks
  2 correct gains 1 mark
  each part of line correctly drawn (i.e. curve + straight line)
  for 1 mark each part of line

(ii) 3 (or according to plotted graph)
litres per second
  for 1 mark each

(b) lungs
blood
  for 1 mark each

(c) (i) ideas that
  • energy transferred faster in 100m race
  • carbon dioxide produced faster during 1500m race / more
  • carbon dioxide produced
    for 1 mark each
  correct reference to twice / half as fast in either / both cases
    for a further mark
(ii)

- respiration during 100m race (mainly) anaerobic
- respiration during 1500m race (mainly) aerobic
- aerobic respiration produced carbon dioxide
- anaerobic respiration produced / lactic acid
  
  *for 1 mark each*

M8. (i)  increase in CO$_2$ concentration leads to increase in volume of air inhaled
         increase of % carbon dioxide has little effect over most of range / large
         increase when % carbon dioxide > 5.6 %
         
         *each for 1 mark*

(ii)  *idea that*
       depth of breathing changes at low % carbon dioxide, increase in % CO$_2$
       results in volume of each breath increasing without increase / little increase
       in number of breaths
       
       *each for 1 mark*

M9.  (i)  *with exercise* rate rises:
       
       *accept between 1 – 2 minutes rate rises*

       (when exercise stops) rate falls slowly;
       
       *accept gentle fall or steady fall*
       
       *for answers which just describe a rise then a fall allow one mark*
       
       *only as an alternative to the first two points*

       rate does not return to normal or to starting or to resting rate
       
       *accept rate returns to normal after five minutes or three minutes of*
       
       rest or after recording ended

(ii)  86 (per minute);
(iii) plotting points;

deduct one mark for each error to max of two
if 68 wrongly plotted count as one error (ignore the quality of the line)

![Graph showing heart rate over time for different individuals.]

M10. (i) the higher the rate of oxygen consumption, the shorter the time taken to complete for 1 mark

(ii) the faster oxygen is taken into the blood, the faster energy can be released in the muscles, and the faster the athlete can run for 1 mark each

M11. (a) (i) count the pulse or count beats in artery in wrist neck or feel the pulse or take the pulse or find the pulse accept use of heart monitor or heart meter

(ii) 80 2 marks for correct answer 1f answer incorrect allow 1 mark for showing 8000 divided by 100 or indicating cardiac output divided by stroke volume
(iii) Increased activity stroke volume falls / gets less / should get higher / reach a peak
    accept does not increase or changes from 134 cm$^3$ to 127 cm$^3$

(iv) Increased / more ventricle contractions
    accept heart beat faster or it beats faster or more powerful contractions

(b) (stronger heart muscle) increases cardiac output or increases stroke volume
    accept pumps more blood (per beat) or pumps blood faster
    ignore heart bigger
    so more (oxygenated) blood can be sent to muscles
    accept more oxygen sent to muscles

M12. (a) (i) plotting values for pulse rates;
    2 marks - minus 1 mark for each error to a maximum of 2
    Accept values if plotted on blood volume bar chart
    Non-horizontal tops to bars producing variable values = 1 error
    If drawn as a line graph = 1 mark maximum
(ii) Either

volume of blood went up then fell;
   \textit{Accept went to a maximum then fell}

pulse rate increased (steadily);
   \textit{Accept went up steadily or kept going up}

Or

at first \textbf{or} with low activity \textbf{or} with moderate activity both pulse and volume increased;
   \textit{Accept activity up to wall-papering}

with more activity pulse continued to increase but volume fell;
(b) Any two of

with increased activity greater muscle use or greater respiration;

need more glucose or oxygen;

*Accept more sugar*

heart beat faster;

*Do not accept more air*

*Accept more blood needed or blood flows faster*

If 'more' or equivalent stated once it can be accepted elsewhere by implication