Revision Pack Topic 4- Bioenergetics

Photosynthesis	R/A/G
Photosynthesis is represented by the equation $\text{carbon dioxide} + \text{water} \xrightarrow{\text{light}} \text{glucose} + \text{oxygen}$	
Symbols for this reaction are CO_2, H_20, O_2 and $C_6H_{12}O_6$	
Photosynthesis is an endothermic reaction	
Energy from light is absorbed by chloroplasts	
The rate of photosynthesis can be changed due to light intensity, amount of carbon dioxide, chlorophyll and temperature these are known as limiting factors	
Measure and calculate the rate of photosynthesis	
Analyse, interpret and plot graphs that provide information on photosynthesis	
HIGHER: understand that more than one limiting factor can affect photosynthesis	
HIGHER: Inverse square law – how light intensity shows inverse proportion	
HIGHER: identify that limiting factors are used to enhance greenhouses and provide the maximum rate of photosynthesis to maintain profit in industry	
Required practical activity 5: Investigating the effect of light intensity on the rate of photosynthesis on pondweed	
Understand that the closer the light source is to the pondweed the more photosynthesis occurs. Photosynthesis was measured by counting the bubbles of oxygen produced in a set time.	
Uses of glucose	
Glucose from photosynthesis can be used for: • Respiration • Converted into insoluble starch for storage • Used to produce fat/oils for storage • Used to produces cellulose to strengthen cell walls • Used to produce amino acids for protein synthesis	
To make proteins plants must absorb nitrate ions from the soil	
Respiration	
Respiration in cells in an exothermic reaction that in continuous in living cells	
Energy from respiration is needed for all living processes such as • Chemical reactions to build larger molecules • Movement • Keeping warm (thermoregulation)	
Respiration can be aerobic (with oxygen) or anaerobic (without oxygen)	
Aerobic Respiration	
Oxygen is required for this type of respiration	
Lots of energy is produced during aerobic respiration	
Equation for aerobic respiration is: $\text{glucose} + \text{oxygen} \rightarrow \text{carbon dioxide} + \text{water}$ Symbols for this reaction are CO_2, H_20, O_2 and $C_6H_{12}O_6$	
Anaerobic Respiration	
Oxygen is not required for anaerobic respiration which is used for short amounts of time	
Much less energy is produced in anaerobic respiration as breakdown of glucose is incomplete	
Equation for anaerobic respiration in muscles is:	

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glucose → lactic acid	
Anaerobic respiration can also take place in yeast cells and is represented by: glucose → ethanol + carbon dioxide	
In yeast cells anaerobic respiration is called fermentation and is used to make alcohol and bread.	
Response to exercise	
The human body reacts to increased demand for energy during exercise	
Heart rate, breathing rate and breath volume all increase	
More oxygen is supplied to muscles and there is more oxygenated blood	
During anaerobic respiration, lactic acid builds up and creates an oxygen debt, muscles can become fatigued and stop contract efficiently after long periods of anaerobic activity	
Oxygen debt is repaid after exercise as the person continues to breath heavily	
HIGHER: blood flowing through the muscles transports lactic acid back to the liver where it is converted back to glucose.	
Metabolism	
Sugars, amino acids, fatty acids and glycerol are synthesised	
Carbohydrates, proteins and lipids are broken down	
Metabolism is the sum of all the reactions in the cell or body	
Energy from respiration is used for enzyme controlled processes that make new molecules	
Metabolism includes • Glucose to starch / glycogen or cellulose in plants • Formation of lipids from glycerol and fatty acids • Glucose and nitrates forming amino acids and then proteins • Respiration • Breakdown of proteins to form urea for excretion	

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Photosynthesis

Complete the equation

_____ + glucose → _____ + _____

Can you complete write a symbol equation

_____ + $C_6H_{12}O_6$ → _____ + _____

Stuck? Pick from this box

CO_2	NaCl	H_2SO_4	H_2O
Cl_2	$CaCO_3$	O_2	

Identify which organelle photosynthesis takes place in

_____

_____

State what can be found inside this organelle and how it helps photosynthesis take place

_____

_____

_____

Select the correct answer and fill in the gaps:

Photosynthesis is an exothermic / endothermic reaction. Exothermic reactions take in / release heat to the surroundings whereas endothermic reactions take in / release heat from the surroundings

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Uses of glucose

Plants use glucose in five different ways, match up the key uses to explanations

For respiration		Glucose is stored in roots, stems and leaves in this form and can be used when photosynthesis rate is low (e.g. in winter)
Making cellulose		Energy from glucose provides the plant with energy to change glucose into other stores
Making amino acids		Glucose is turned into lipids and stored in roots, stems and leaves
Stored as fats / oils		This provides strong plant cell walls
Stored as starch		Glucose combines with nitrate ions from the soil to make proteins for the plant

Limiting factors

Define the term 'limiting factor'_____

_____

The three limiting factors are:

-
-
-

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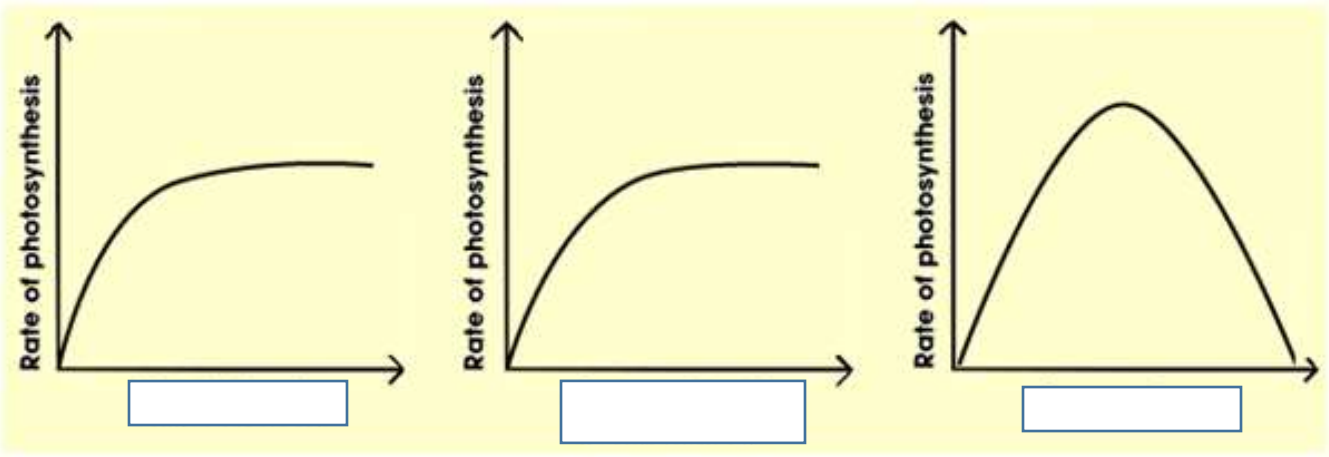
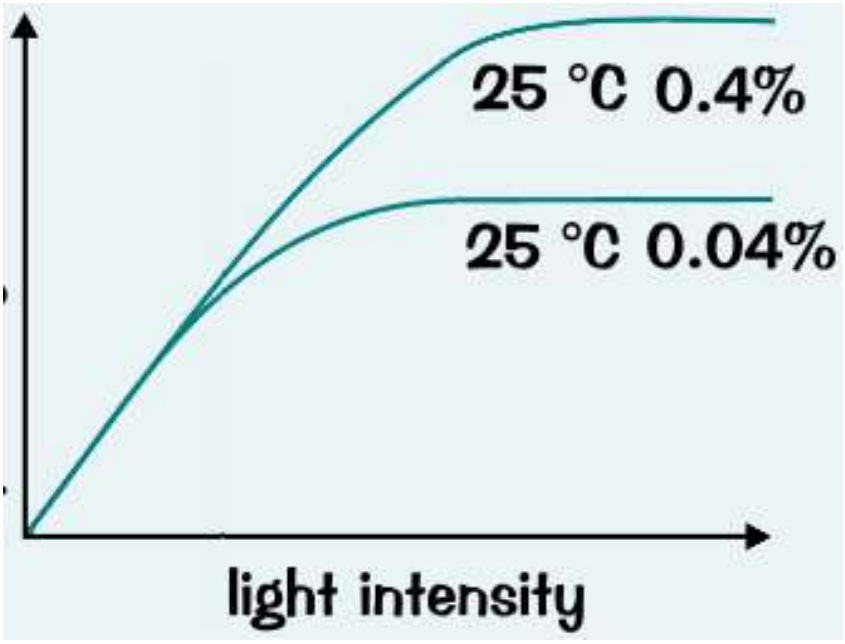
Match each limiting factor to the correct graph



Describe graph 3, particularly explain why the graph decreases after 40 °C

Use this graph to explain what the ideal conditions are for photosynthesis.



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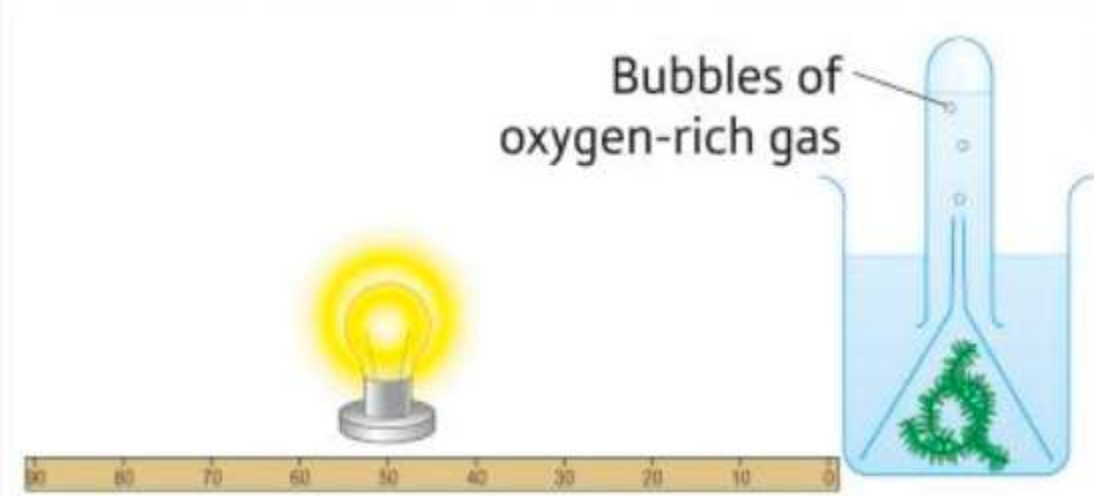
Required practical – rate of photosynthesis

Use the picture to help you answer the questions



1. Identify the control, independent and dependant variable in this investigation

_____

_____

_____

2. Write a short method for this practical
    1.
    2.
    3.
    4.
    5.

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HIGHER TIER ONLY The **inverse square law** links light intensity and distance. The relationship between light and distance is said to be inversely proportional.

Use this equation to answer the following questions:

$$\text{Light intensity} \propto \frac{1}{\text{distance}^2}$$

1. Use the inverse square law to calculate the light intensity when the lamp is 10cm from the pondweed

2. What is the light intensity when the lamp is 32cm from the sunflower?

3. EXT: what is the distance when the light intensity is 0.02 a.u.?

ALL STUDENTS SHOULD KNOW:

Farmer John wants to grow Strawberries in Sheffield, the weather doesn't allow him to grow strawberries all year round. John is thinking of investigating in an artificial green house.

Advise farmer John what he could put in his green house to guarantee his strawberry plants grow.

Hint…think limiting factors!

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RESPIRATION

Define respiration:

Respiration is takes place in all/some of our cells and occurs when we need it / continuously. All living things respire including plants, respiration is an exothermic / endothermic reaction/

Energy from respiration can be used for all kinds of things, identify three ways it is used:

1.

2.

3.

METABOLISM

All the reactions that occur in cells or the body are called metabolism.

Find an example of larger molecules being broken down into smaller ones:

Find an example of smaller molecules being built into bigger ones:

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AEROBIC OR ANAEROBIC

Aerobic respiration occurs in all plant and animal cells. It is respiration using _____. It is the most efficient way to transfer energy from glucose. Aerobic respiration occurs in the _____. This type of respiration is used the majority of the time in cells.

The word equation is:

_____ + glucose → _____ + _____

The symbol equation in:

_____ + $C_6H_{12}O_6$ → _____ + _____

Stuck? Use the box to help you…

CO_2	mitochondria	Oxygen	H_2O	chloroplast
Oxygen		Carbon dioxide	O_2	water

Anaerobic respiration occurs when there is not enough _____. It is the not as efficient as aerobic respiration. Breakdown of glucose is complete / incomplete and **L**_____ **A**_____ is made as a waste product.

The word equation is:

glucose → _____

As there isn't enough _____ the glucose is not **fully oxidised** so this type of respiration is only used in emergencies or for short bursts of fast exercise (e.g. Usain Bolt – 100m sprint)

Anaerobic respiration in plants:

Plants and yeast produce _____ instead of **L**_____ **A**_____ during anaerobic respiration. In Yeast cells this is called **F**_____**.**

The word equation is:

glucose → _____ + _____

This is a useful process that can be used to make alcoholic drinks such as _____ and also to make bread. The waste product _____ causes the bread to rise.

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What are the differences between aerobic and anaerobic respiration?

Aerobic	Anaerobic

EXERCISE

During exercise changes occur within your body. Identify 4 things that change when exercising:

1.

2.

3.

4.

If you exercise for a long time what can happen to your muscles?

_____

_____

HINT – think about what cramp is!

Anaerobic respiration can lead to 'Oxygen Debt', explain what an oxygen debt is and why it occurs.

_____

_____

_____

Describe how the oxygen debt is repaid after exercise:

_____

_____

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INVESTIGATING EXERCISE

Heart rate can be taken by finding your: _____

This can be found by placing two fingers on which part of your body: _____

Outline a method to investigate the effect of exercise on the body:

Equipment list:

-
-
-
-

Method:

-
-
-
-
-

How could you make sure you're results were valid and precise?

_____

_____

_____

Imagine this graph showed your results, what conclusion can be made?

**hint think about the relationship that is shown by the graph and use data to support your answer

_____

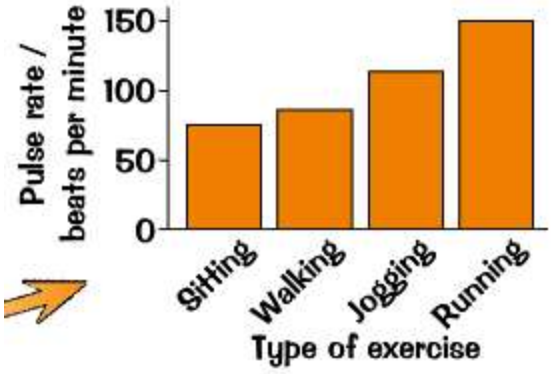
_____

_____

_____

_____

_____



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Q1. Photosynthesis uses carbon dioxide to make glucose.

(a) (i) Complete the equation for photosynthesis.

carbon dioxide + ... $\xrightarrow{\text{energy}}$ glucose + ...**(2)**

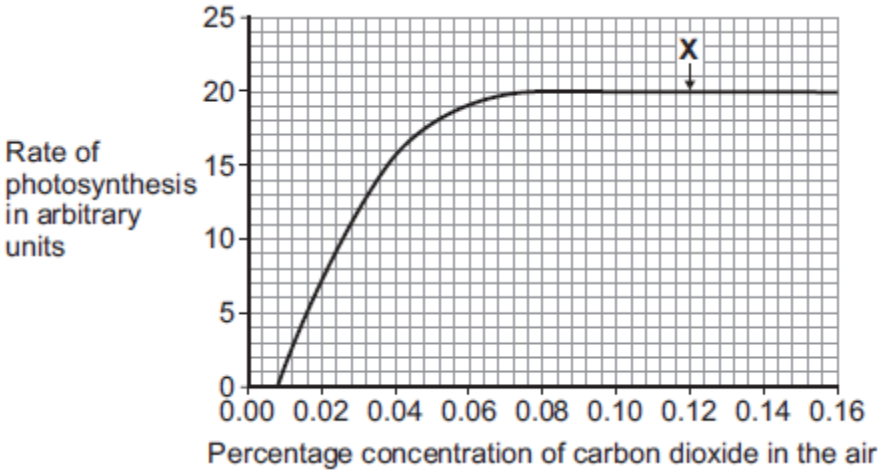
(ii) What type of energy does a plant use in photosynthesis?

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

(iii) Which part of a plant cell absorbs the energy needed for photosynthesis?

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

(b) The graph shows the effect of the concentration of carbon dioxide on the rate of photosynthesis in tomato plants at 20 °C.



(i) What is the maximum rate of photosynthesis of the tomato plants shown in the graph?

..... arbitrary units **(1)**

(ii) At point **X**, carbon dioxide is **not** a limiting factor of photosynthesis.

Suggest **one** factor that is limiting the rate of photosynthesis at point **X**.

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

(c) A farmer plans to grow tomatoes in a large greenhouse.

The concentration of carbon dioxide in the atmosphere is 0.04%.
The farmer adds carbon dioxide to the greenhouse so that its concentration is 0.08%.

(i) Why does the farmer use 0.08% carbon dioxide?

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Tick (✓) **one** box.

To increase the rate of growth of the tomato plants ☐

To increase the rate of respiration of the tomato plants ☐

To increase water uptake by the tomato plants ☐

(1)

(ii) Why does the farmer **not** use a concentration of carbon dioxide higher than 0.08%?

Tick (✓) **two** boxes.

Because it would cost more money than using 0.08% ☐

Because it would decrease the temperature of the greenhouse ☐

Because it would not increase the rate of photosynthesis of the tomato plants any further ☐

Because it would increase water loss from the tomato plants ☐

(2)

(Total 9 marks)

Q2.(a) Complete the word equation for photosynthesis.

carbon dioxide + water $\xrightarrow{\text{energy}}$ glucose + ...

(1)

(b) Draw a ring around the correct answer to complete each sentence.

(i) The energy needed for photosynthesis comes from

light.
osmosis.
respiration.

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(1)

(ii) Energy is absorbed by a green pigment called

chloride.
chloroplast.
chlorophyll.

(1)

(iii) If the temperature is decreased the rate of photosynthesis will

decrease.
increase.
stay the same.

(1)

(c) Give **three** ways in which plants use the glucose made in photosynthesis.

1 .....

.....

2 .....

.....

3 .....

.....**(3) (Total 7 marks)**

Q3. Plants absorb light to photosynthesise. (a) What is the correct word equation for photosynthesis?

Tick **one** box.

carbon dioxide + glucose ⟶ oxygen + water ☐

glucose + oxygen ⟶ carbon dioxide + water ☐

oxygen + water ⟶ carbon dioxide + glucose ☐

water + carbon dioxide ⟶ oxygen + glucose ☐

1)

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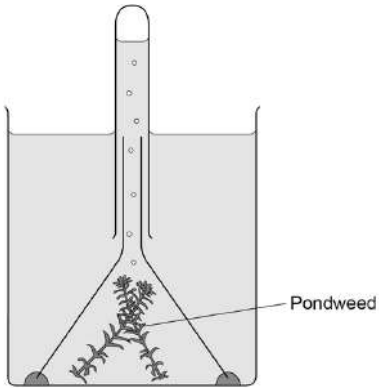
(b) **Figure 1** shows some of the apparatus that can be used to measure the rate of photosynthesis.

Figure 1



The rate of photosynthesis in the pondweed is affected by different colours of light. Describe a method you could use to investigate this.

You should include:

- what you would measure
- variables you would control.

.....

.....

.....

.....

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.....

.....

.....**(6)**

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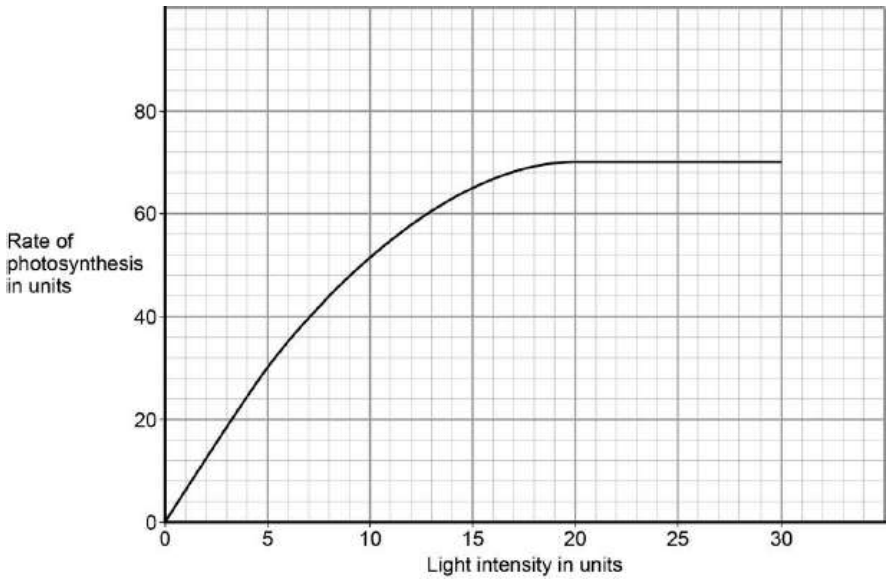
(c) A scientist carried out a similar investigation. Her results are shown in **the graph.**

The scientist said: **'Light stops being a limiting factor at a light intensity of 20 units.'**

Give evidence from **Figure 2** to support this statement



.....

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

(d) What could be limiting the rate of photosynthesis at a light intensity of 25 units? Give **one** factor.

.....**(1) Total 9 marks**

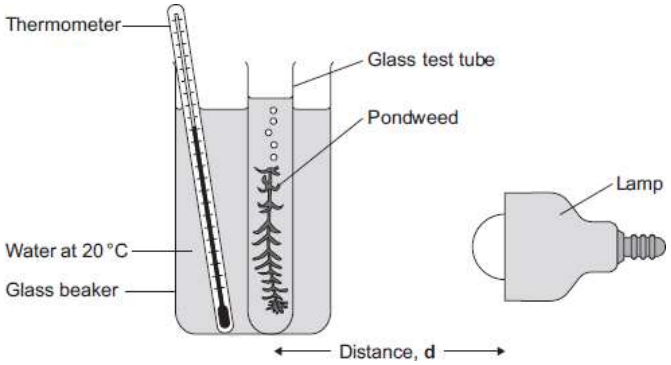
Q4.(a) Complete the equation for photosynthesis. Draw a ring around each correct answer.

Carbon dioxide	+	hydrogen nitrogen water	light energy →	alcohol glucose methane	+ oxygen

(2)

Some students investigated the effect of light intensity on the rate of photosynthesis in pondweed.

The diagram shows the apparatus the students used.



The closer the lamp is to the pondweed, the more light the pondweed receives.

The students placed the lamp at different distances, **d**, from the pondweed.

They counted the number of bubbles of gas released from the pondweed in 1 minute for each distance.

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(b) A thermometer was placed in the glass beaker. Why was it important to use a thermometer in this investigation?

.....

.....

.....

.....**(3)**

(c) The students counted the bubbles four times at each distance and calculated the correct mean value of their results. The table shows the students' results.

Distance d in cm	**Number of bubbles per minute**				
	1	**2**	**3**	**4**	**Mean**
10	52	52	54	54	53
20	49	51	48	52	50
30	32	30	27	31	30
40	30	10	9	11	

(i) Calculate the mean number of bubbles released per minute when the lamp was 40 cm from the pondweed.

.....

.....

Mean number of bubbles at 40 cm = ...**(2)**

(ii) On the graph paper below, draw a graph to show the students' results:

- add a label to the vertical axis
- plot the **mean values** of the number of bubbles
- draw a line of best fit.

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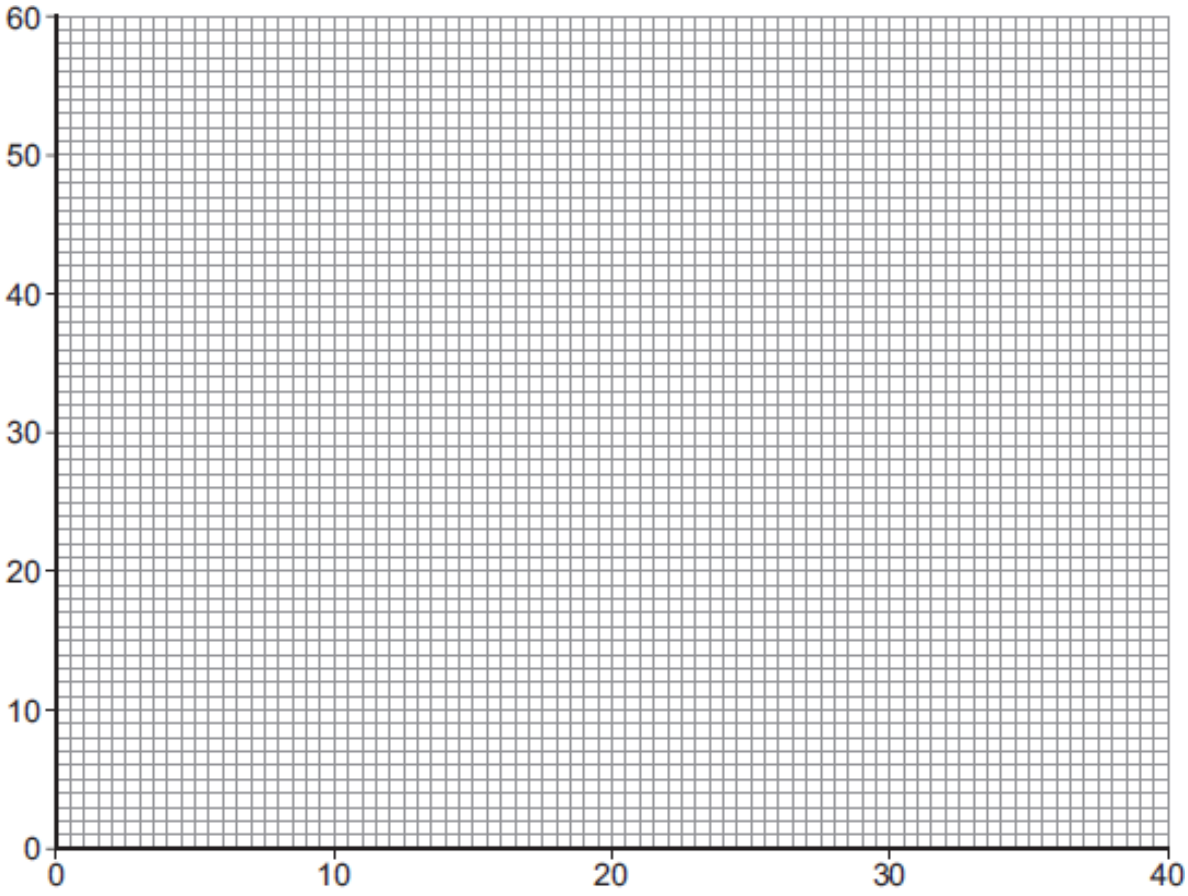

Distance **d** in cm **(4)**

(iii) One student concluded that the rate of photosynthesis was inversely proportional to the distance of the lamp from the plant. Does the data support this conclusion?

Explain your answer.

.....

.....

.....

.....**(2)**

(d) Light intensity, temperature and concentration of carbon dioxide are factors that affect the rate of photosynthesis. Scientists investigated the effects of these three factors on the rate of photosynthesis in tomato plants growing in a greenhouse.

The graph below shows the scientists' results.

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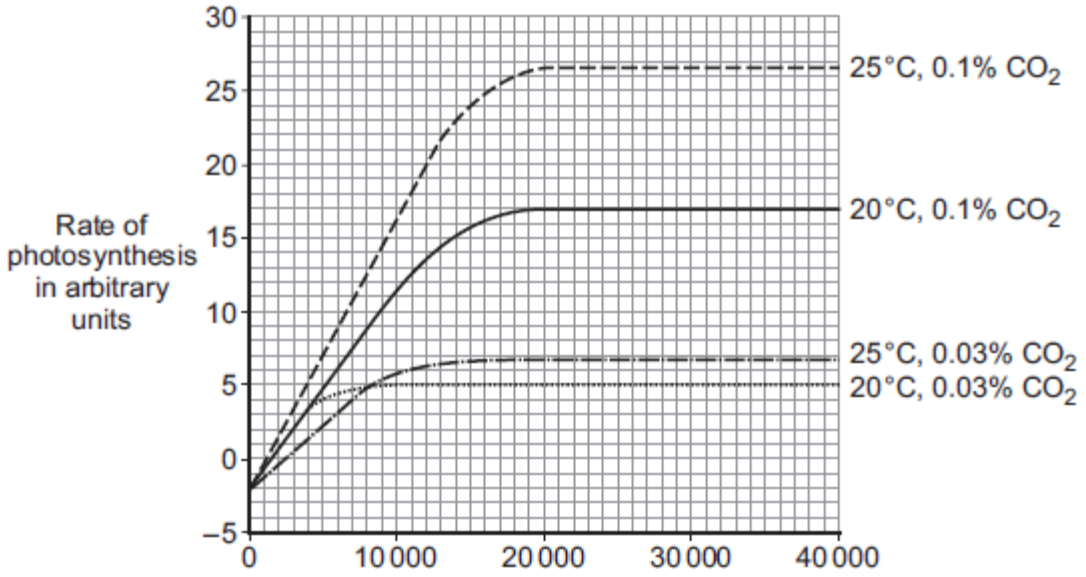

A farmer in the UK wants to grow tomatoes commercially in a greenhouse. The farmer read about the scientists' investigation.
During the growing season for tomatoes in the UK, natural daylight has an intensity higher than 30 000 lux.

The farmer therefore decided to use the following conditions in his greenhouse during the day:

- 20°C
- 0.1% CO_2
- no extra lighting.

Suggest why the farmer decided to use these conditions for growing the tomatoes. You should use information from the scientists' graph in your answer.

.....

.....

.....

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..... **(4)(Total 17 marks)**

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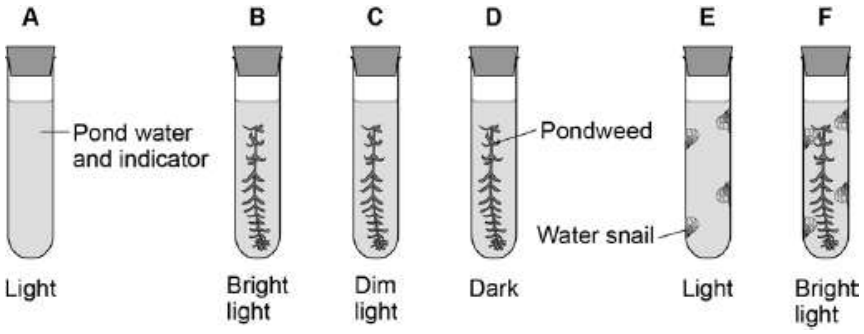
Q5.A student investigated the effect of pond organisms on the amount of carbon dioxide in their surroundings.

The student set up six boiling tubes as shown in the figure below. They were left for 2 days.

Each boiling tube contained pond water with an indicator. The indicator was pink at the start of the investigation.

- If the amount of carbon dioxide in the water increased the indicator turned yellow.
- If the amount of carbon dioxide in the water decreased the indicator turned purple.



(a) What is the purpose of boiling tube **A**?

.....

.....

.....

.....**(2)**

(b) In which boiling tube would the indicator be the **most yellow** after 2 days? Explain your answer.

Boiling tube .....

Explanation .....

.....

.....**(3**

(c) The colour of the indicator in boiling tube **C** had not changed after 2 days. Suggest why.

.....

.....**(1)(Total 6 marks)**

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Q6. Muscles need energy during exercise. Draw a ring around the correct answer in parts (a) and (b) to complete each sentence.

(a) (i) The substance stored in the muscles and used during exercise is

glycogen.
lactic acid.
protein.

(1

(ii) The process that releases energy in muscles is

digestion.
respiration.
transpiration.

(1)

(b) The table shows how much energy is used by two men of different masses when swimming at different speeds.

Speed of swimming in metres per minute	Energy used in kJ per hour	
	34 kg man	**70 kg man**
25	651	1155
50	1134	2103

i) When the 34 kg man swims at 50 metres per minute instead of at 25 metres per minute,

the extra energy he uses each hour is

36 kJ.
483 kJ.
948 kJ.

(1)

(ii) When swimming at 50 metres per minute, each man's heart rate is faster than when swimming at 25 metres per minute.

A faster heart rate helps to supply the muscles with more

carbon dioxide.
glycogen.
oxygen.

(1)

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(iii) During the exercise the arteries supplying the muscles would

constrict.
dilate.
pump harder.

(1)

(c) When a person starts to swim, the breathing rate increases. Give **one** way in which this increase helps the swimmer.

.....

.....**1)(Total 6 marks)**

Q7. Respiration can happen aerobically or anaerobically. Respiration transfers energy from glucose.

(a) Draw **one** line from each type of respiration in human cells to the correct information.

Type of respiration in human cells	**Information**
	Produces ethanol
Aerobic respiration	Uses oxygen
Anaerobic respiration	Uses carbon dioxide
	Produces lactic acid

(2)

(b) The table below shows the amount of energy released by aerobic and anaerobic respiration.

	Energy in kJ transferred from 1 g of glucose
Aerobic respiration	16.1
Anaerobic respiration	1.2

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Suggest why human cells might respire anaerobically, even though only a small amount of energy is transferred.

.....

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

(c) Yeast is used in the brewing and baking industries. Why is yeast used in these industries?

.....

.....

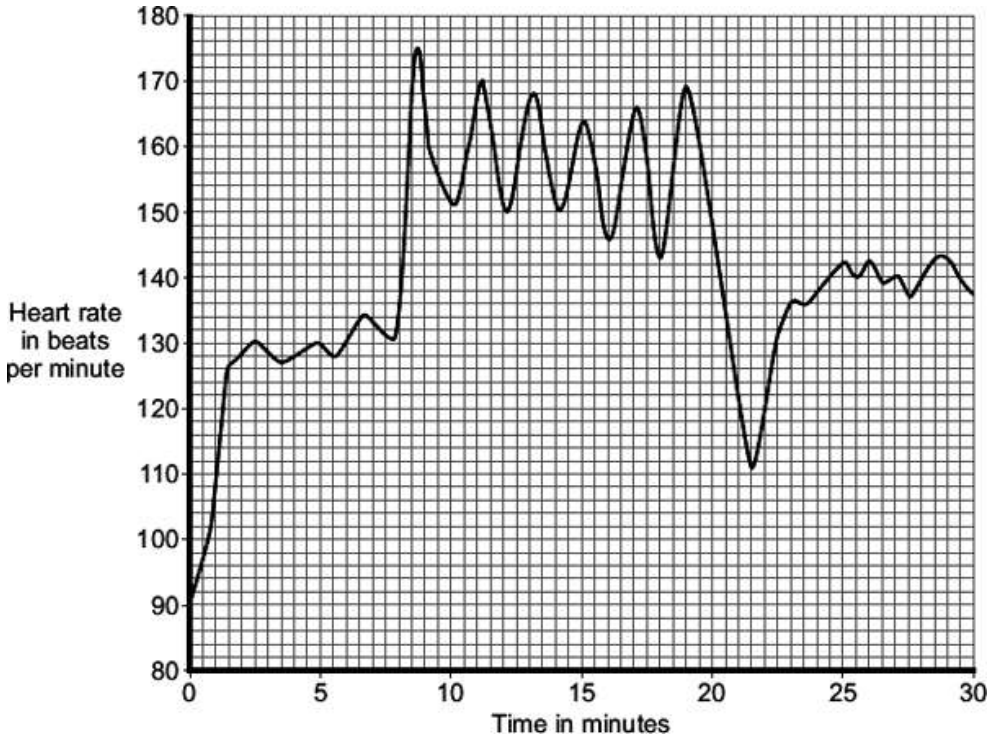
.....

.....

.....

..... **(4)(Total 7 marks)**

Q8. One type of training exercise involves alternating periods of walking and running. The graph shows how an athlete's heart rate changed during one 30-minute training session.



(a) (i) The athlete ran 6 times during the 30-minute training session. Describe the evidence for this in the graph.

.....

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

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(ii) Immediately after the final run, the athlete rested for a short time before he started to walk again.

For how many minutes did this rest last?

..... minutes **(1)**

(b) The heart rate increases during exercise. This increase in heart rate increases blood flow to the muscles.
Explain, as fully as you can, why this increase in heart rate is necessary.

.....

.....

.....

.....

.....

.....

.....

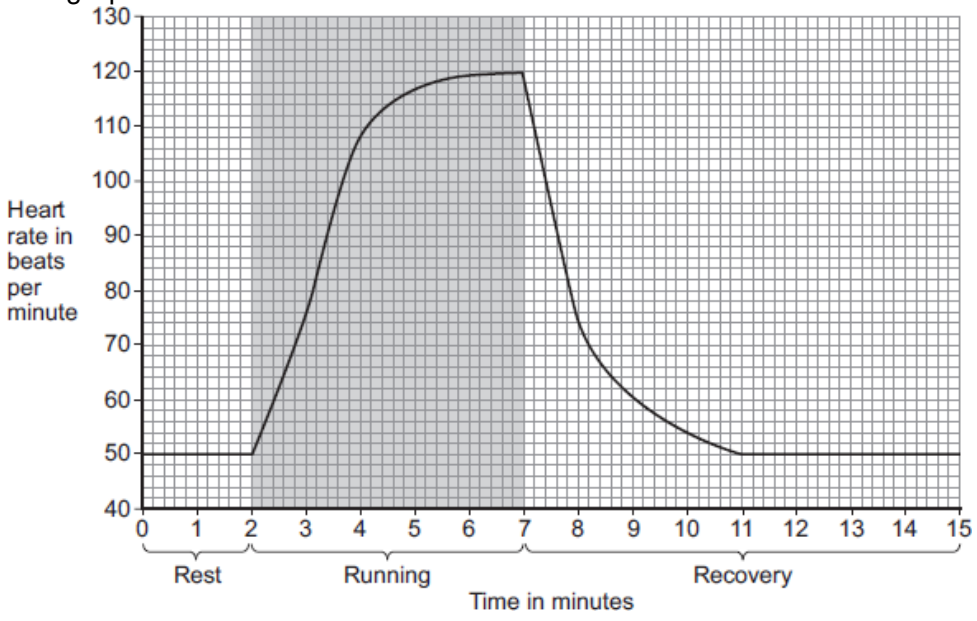
.....

.....

.....**(4) (Total 6 marks)**

Q9.A student ran on a treadmill for 5 minutes. The speed of the treadmill was set at 12 km per hour.

The graph below shows the effect of the run on the student's heart rate.



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(a) (i) What was the student's heart rate at rest?

..... beats per minute **(1)**

(ii) After the end of the run, how long did it take for the student's heart rate to return to the resting heart rate?

..... minutes **(1)**

(b) During the run, the student's muscles needed larger amounts of some substances than they needed at rest.

(i) Which **two** of the following substances were needed in larger amounts during the run? Tick (✓) **two** boxes.

carbon dioxide ☐

glucose ☐

lactic acid ☐

oxygen ☐

protein ☐

(2)

(ii) Why are the two substances you chose in part **(b)(i)** needed in larger amounts during the run? Tick (✓) **one** box.

To help make more muscle fibres ☐

To release more energy ☐

To help the muscles to cool down ☐

(1)

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(c) After exercise, a fit person recovers faster than an unfit person. Let the student's heart rate at the end of exercise = **a**. Let the student's heart rate after 2 minutes of recovery = **b**.

The table below shows how the difference between **a** and **b**, (**a** − **b**), is related to a person's level of fitness.

(a − b)	**Level of fitness**
< 22	Unfit
22 to 52	Normal fitness
53 to 58	Fit
59 to 65	Very fit
> 65	Top athlete

What is the student's level of fitness?

Use information from the graph and the table.

a = ... beats per minute

b = ... beats per minute

(**a − b**) = ... beats per minute

Level of fitness = ...**(3)**

(d) The student repeated the run with the treadmill set at 16 km per hour. The student's heart rate took 3 minutes longer to return to the normal resting rate than when running at 12 km per hour.

Give reasons why it took longer to recover after running faster.

.....

.....

.....

.....

.....

.....

.....**4)(Total 12 marks)**

Revision Pack Topic 4- Bioenergetics

MARK SCHEME – USE A GREEN PEN TO MAKE CHANGES

M1.(a) (i) LHS = water

accept H_2O

*do **not** accept H^2O / H2O* **1**

RHS = oxygen

accept O_2

*do **not** accept O / O^2 / O2* **1**

(ii) light / sunlight

ignore solar / sun / sunshine

*do **not** allow thermal / heat* **1**

(iii) chloroplasts

allow chlorophyll **1**

(b) (i) 20 **1**

(ii) any **one** from:

- light (intensity)
- temperature. **1**

(c) (i) To increase the rate of growth of the tomato plants **1**

(ii) Because it would cost more money than using 0.08% **1**

Because it would not increase the rate of photosynthesis of the tomato plants any further **1** **[9]**

M2.(a) oxygen

allow O_2 / O2

*do **not** accept O^2 or O* **1**

(b) (i) light **1**

(ii) chlorophyll **1**

(iii) decrease **1**

(c) any **three** from:

- for respiration / energy

  *do **not** accept use energy for photosynthesis*

- to make cellulose / starch

  accept named carbohydrate other than glucose

- to make lipid / fat / oil

  accept fatty acid / glycerol

- to make protein

  accept named protein / amino acid / named amino acid

- to build big molecules from small molecules / metabolism

  *if no other marks awarded for making molecules allow **1** mark for growth / repair / new cells* **3** **[7]**

M3.(a) water + carbon dioxide → oxygen + glucose

extra box ticked negates mark **1**

(b) **Level 3 (5–6 marks):** A coherent method is described with relevant detail, which demonstrates a broad understanding of the relevant techniques and procedures. The steps in the method are logically ordered. The method would lead to the production of valid results.

Level 2 (3–4 marks): The bulk of the method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques and procedures. The
method may not be in a completely logical order and may be missing some detail.

Level 1 (1–2 marks): Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques and procedures. The response may lack a logical structure and would not lead to the production of valid results.

0 marks: No relevant content

Indicative content

- description of how the apparatus would be used
- reference to control intensity of light / brightness
- use of ruler to measure distance of light from beaker / pondweed
- reference to varying colour of light or use of different filters
- plant releases gas / oxygen

- measure number of bubbles / volume of gas produced
- same length of time
- reference to control of temperature
- reference to control / supply of carbon dioxide in water
- do repeats and calculate a mean **6**

(c) rate does not increase further if light intensity increased beyond 20

allow graph levels off after 20 **1**

(d) any **one** from:

- temperature
- carbon dioxide (concentration)
- amount of chlorophyll

allow number of chloroplasts **1** **[9]**

M4.(a) LHS = water **1**

RHS = glucose **1**

(b) any **three** from:

- (measure) temperature

ignore reference to fair test

- to check that the temperature isn't changing
- rate of reaction changes with temperature
- temperature is a variable that needs to be controlled

allow lamp gives out heat **3**

(c) (i) 10

*correct answer = **2** marks*

*allow **1** mark for:* $\frac{(10+9+11)}{3}$

*allow **1** mark for correct calculation without removal of anomalous result ie 15* **2**

(ii) graph: *allow ecf from **(c)(i)***

label on y-axis as 'number of bubbles per minute' **1**

three points correct = **1** mark

allow ± 1 mm / **four** points correct = **2** marks **2**

line of best fit = smooth curve **1**

(iii) as distance increases, rate decreases – pro

allow yes between 20 – 40 **1**

but should be a straight line / but line curves – con / not quite pro

allow not between 10 – 20

if line of best fit is straight line, allow idea of poor fit **1**

(d) any **four** from:

- make more profit / cost effective
- raising temp. to 25 °C makes very little difference at 0.03% CO_2
- (at 20 °C) with CO_2 at 0.1%, raises rate
- (at 20 °C with CO_2 at 0.1%) → >3x rate / rises from 5 to 17
- although 25 °C → higher rate, cost of heating not economical
- extra light does not increase rate / already max. rate with daylight

accept ref to profits c.f. costs must be favourable **4 [17]**

M5.(a) control **1**

to check that the indicator colour does not change on its own

or

to check any changes in colour are due to the organisms **1**

(b) (tube) **E** **1**

<u>most</u> carbon dioxide **1**

(due to) <u>only</u> respiration occurring

allow no carbon dioxide used for photosynthesis

*allow **1** mark **max** if chose tube **D** and give a correct reason* **1**

(c) the amount of carbon dioxide produced by respiration equalled amount absorbed for photosynthesis **1 [6**

Revision Pack Topic 4- Bioenergetics

M6. (a) (i) glycogen **1**

(ii) respiration **1**

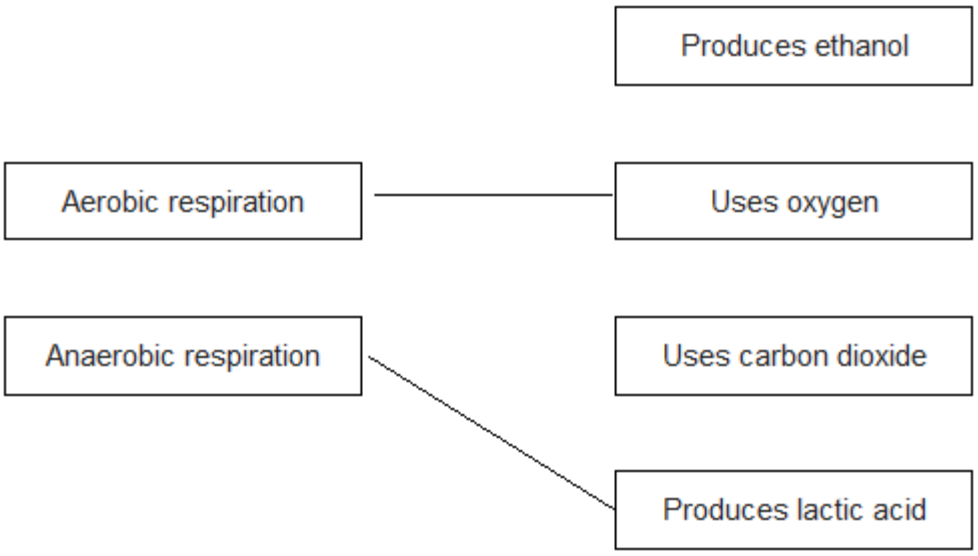
(b) (i) 483 Kj **1**

(ii) oxygen **1**

(iii) dilate **1**

(c) supplies more / a lot of oxygen **or** removes more carbon dioxide
or release more energy / faster respiration **1 [6]**

M7.(a)



an extra line from a LH box negates that mark **2**

(b) any **one** from:

- not enough oxygen present (for aerobic respiration)
- more energy required for exercise (than can be transferred by aerobic respiration)

1

allow named example for exercise

(c) produces carbon dioxide **1**

produces ethanol

plus any **two** from:

- (carbon dioxide) makes bread rise
- (carbon dioxide) makes beer / cider / (some) wines fizzy

  allow for alcoholic drinks / named drink
- (ethanol) is the alcohol in beer / cider / wine / spirits **2 [7]**

M8. (a) (i) 6 peaks in heart rate

*accept 6 increases / spikes **or** goes very high 6 times*

allow heart rate increases each time he runs **1**

(ii) 2.5 / 2½

allow 2 minutes 30 seconds

*do **not** accept 2.3 / 2:3 / 2.30* **1**

(b) *more / faster / a lot **must** be stated at least once for full marks*

(more) oxygen supplied / needed

allow less anaerobic (respiration)

or (more) aerobic respiration

***or** prevents oxygen debt* **1**

(more) glucose / sugar / food supplied / needed

ignore feeding **1**

(more) energy needed / released

allow energy produced / made **1**

(more) carbon dioxide / heat / lactic acid removed (from muscles) **or** more cooling

or less lactic acid formed **1 [6]**

M9.(a) (i) 50 **1**

(ii) 4 *accept 3.9 − 4.0* **1**

(b) (i) glucose **1**

oxygen **1**

(ii) to release more energy **1**

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(c) correct readings from graph:

a = 120

b = 60 *allow 60 – 61* **1**

calculation correct for candidate's figures:

e.g. a − b = 60 **1**

level of fitness correct for candidate's figures:

e.g. very fit **1**

(d) any **four** from:

- higher heart rate (at 16 km / h) (so takes longer to slow to normal)
- more energy needed
- not enough O_2 supplied / more O_2 needed / reference to O_2-debt
- (more) anaerobic respiration
- (more) lactic acid made / to be broken down / to remove / to oxidise
- higher blood flow needed to deliver (the required amount of) oxygen.

'more' must be given at least once for full marks

do not allow more energy produced

allow higher blood flow to remove lactic acid / remove (additional) CO_2

4 [12]