Bioenergetics biology Revision materials

Content will be tested on Biology Paper 1

Checklist

Keypoints:	☺	☹
Bioenergetics		
Describe the processes of aerobic and anaerobic respiration and represent them using word equations		
Compare aerobic with anaerobic respiration		
Describe and explain the changes in the body during exercise		
Explain why anaerobic respiration cannot be maintained for long periods		
Describe the process of photosynthesis and represent it using a word equation		
Describe how the rate of photosynthesis can be measured and how it can be affected		
Explain what is meant by a limiting factor		
Interpret graphs showing rates of photosynthesis and suggest how the rate may be increased		
Explain factors that farmers would take into account before manipulating conditions		
Describe what is meant by metabolism and give examples of metabolic reactions		

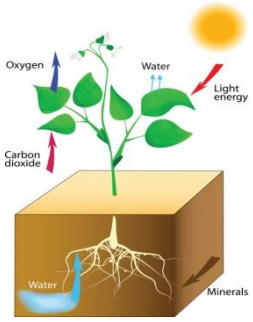
Sections

4.4.1.1 Photosynthesis

Photosynthesis: the process plants use to create glucose using light

Photosynthesis	***Plants make use of light energy from the environment (ENDOTHERMIC) to make food (glucose)***	Carbon dioxide + Water ➔ Oxygen + Glucose	
		$6\ CO_2 + 6\ H_2O$ ➔ $6\ O_2 + C_6H_{12}O_6$	

During photosynthesis:

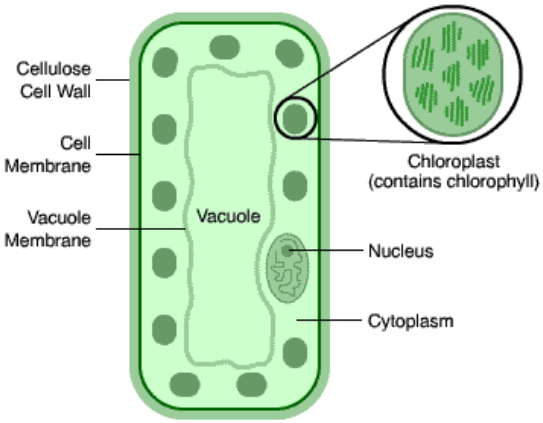


- Light energy is absorbed by a green substance called **chlorophyll**, which is found in **chloroplasts** in some plant cells and algae.
- This **energy** is used by converting carbon dioxide (from the air) and water (from the soil) into sugar (glucose).
- **Oxygen** is **released** as a by-product.

Where does photosynthesis happen? Leaves are the main site of photosynthesis.

- Photosynthesis mainly in occurs in the mesophyll cells.
  - These cells **contain lots of chloroplasts**.
    - Chloroplasts contain chlorophyll.

A palisade mesophyll cell:



How do plants and algae use glucose?

- The glucose produced in photosynthesis may be converted into insoluble starch for storage
- Plant cells use some of the glucose produced during photosynthesis for respiration.
- Some glucose in plants and algae is used:
  - to produce fat or oil for storage
  - to produce cellulose, which strengthens the cell wall
  - to produce proteins:
    - To produce proteins, plants also use nitrate ions that are absorbed from the soil.

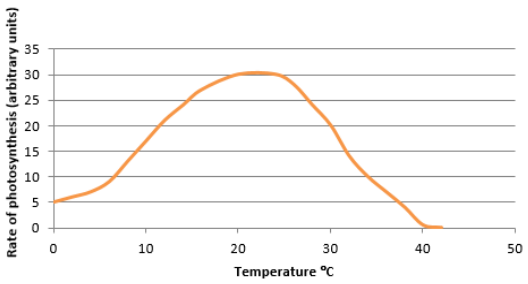
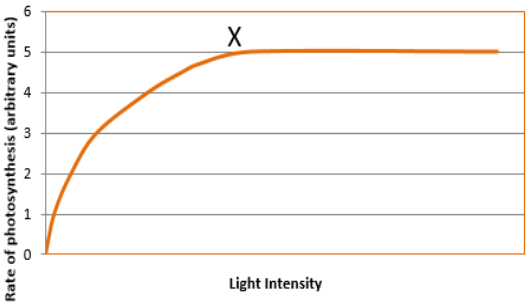
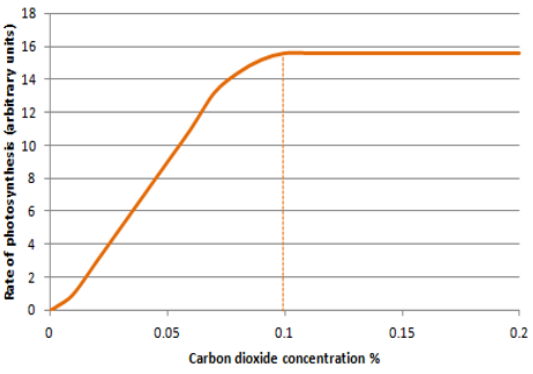
4.4.1.2 Rate of photosynthesis

Factors that limit the rate of photosynthesis

1) Temperature: A low temperature will limit the rate as the molecules will move less and therefore the reaction happens slower
2) Carbon dioxide: A shortage of CO_2 will limit the rate as fewer molecules will be available for the reaction.
3) Light intensity: A shortage of light means there is less energy to power the reaction.

Limiting factors explained:

- Light, temperature and the availability of carbon dioxide interact and in practice any one of them may be the factor that limits photosynthesis.
    - If one of these factors is closest to its minimum value it will limit the rate.
    - Increasing this factor will increase the rate.
    - The rate will continue to increase until another factor becomes limiting.
    - Any further increase in the original factor will now not increase the rate.
    - With no limiting factors, increasing a factor above a certain level will not increase the rate. All chlorophyll molecules are being used.

Factors affecting the rate of photosynthesis	Factor	Limiting factors (why the rate stops going up)	
	Temperature	Photosynthesis is an enzyme controlled reaction. If the temperature increases too much, then the enzymes become denatured and the rate of reaction will decrease and stop	
	Light intensity	At point X another factor is limiting the rate of photosynthesis. This could be carbon dioxide concentration, temperature or the amount of chlorophyll	
	Carbon dioxide concentration	At point X another factor is limiting the rate of photosynthesis. This could be light intensity, temperature or the amount of chlorophyll	

Exam practice 1

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?

_____

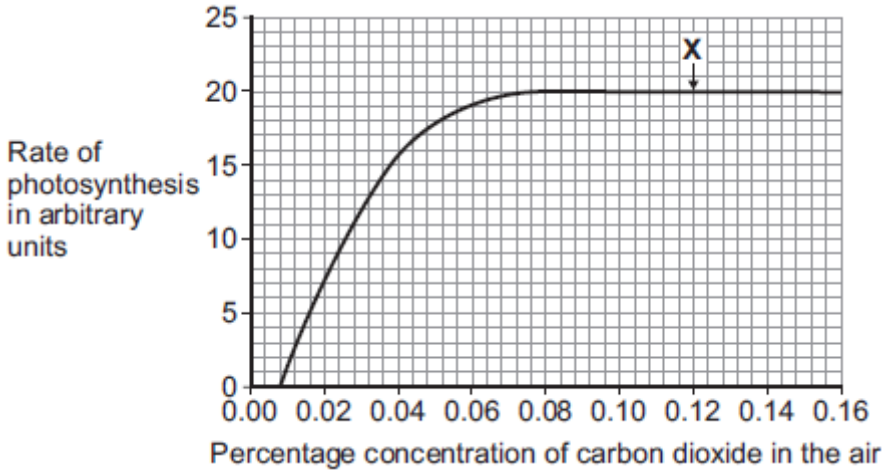
(1)

(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?

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. This question is about photosynthesis.

(a) Plants make glucose during photosynthesis. Some of the glucose is changed into insoluble starch.

What happens to this starch?

Tick (✓) **one** box.

The starch is converted into oxygen. ☐

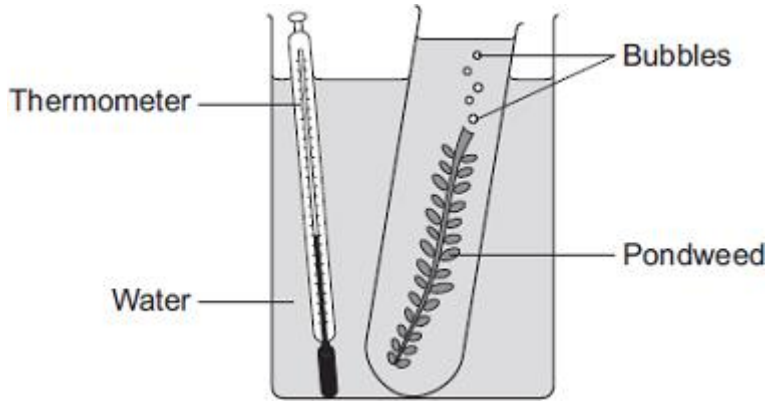
The starch is stored for use later. ☐

The starch is used to make the leaf green. ☐

(1)

(b) A student investigated the effect of temperature on the rate of photosynthesis in pondweed.

The diagram shows the way the experiment was set up.



(i) The student needed to control some variables to make the investigation fair.

State **two** variables the student needed to control in this investigation.

1. _____

2. _____

(2)

(ii) The bubbles of gas are only produced while photosynthesis is taking place.

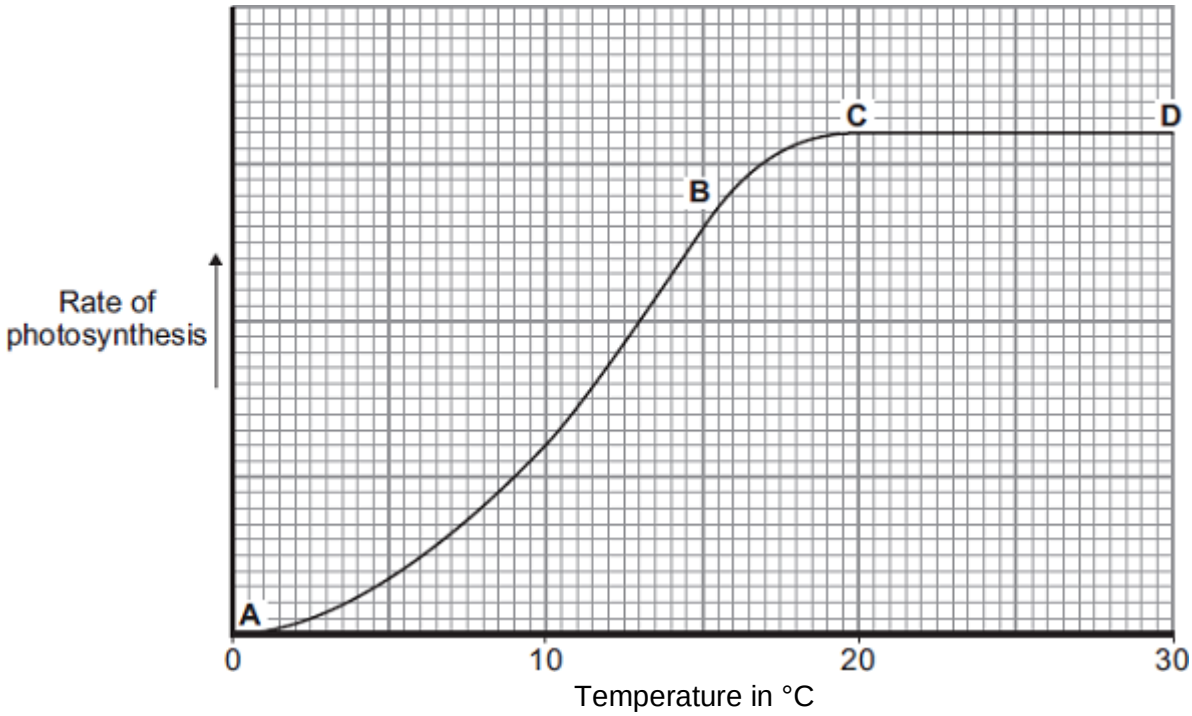
What **two** measurements would the student make to calculate the rate of photosynthesis?

1. _____

2. _____

(2)

(c) The graph shows the effect of temperature on the rate of photosynthesis in the pondweed.



(i) Name the factor that limits the rate of photosynthesis between the points labelled **A** and **B** on the graph.

_____

(1)

(ii) Suggest which factor, carbon dioxide, oxygen or water, might limit the rate of photosynthesis between the points labelled **C** and **D** on the graph.

_____

(1)

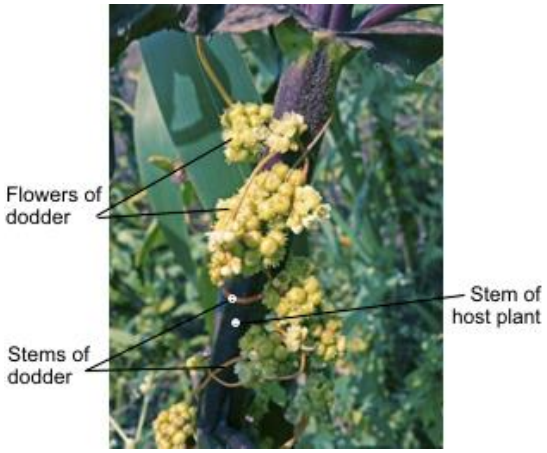
(Total 7 marks)

Q3.(a) Dodder is an unusual flowering plant. It is a parasite.

The dodder plant:

- has no chlorophyll
- has no roots
- has no leaves
- grows attached to the stem of a host plant.

The image below shows dodder attached to its host plant.



(i) Dodder has no chlorophyll. Most plants have leaves containing chlorophyll.

What is the function of chlorophyll in most plants?

_____

_____

_____ **(2)**

Q4. Green plants can make glucose.

(a) Plants need energy to make glucose.

How do plants get this energy?

_____

_____

_____

_____

(2)

(b) Plants can use the glucose they have made to supply them with energy.

Give **four** other ways in which plants use the glucose they have made.

(4)
(Total 6 marks)

Required practical activity 5: investigate the effect of light intensity on the rate of photosynthesis.

GCSE Required Practical – Biology 1 – Light and Photosynthesis

Photosynthesis: when plants use carbon dioxide and water to make glucose (and oxygen). Happens in the chloroplast and needs light to happen.

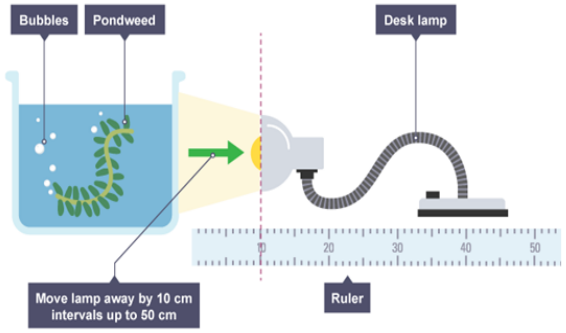
What's the point of the practical?
To find out what happens to the rate of photosynthesis when we change the light intensity

Photosynthesis

$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

carbon dioxide + water → glucose + oxygen

Example Apparatus



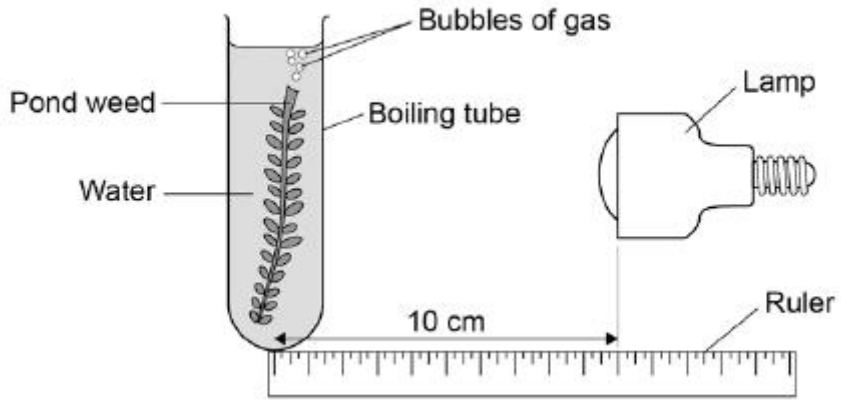
Results
- The closer the lamp, the quicker the bubbles are produced (so higher rate of photosynthesis)

What may they ask us about?
- Why results may be inaccurate (*difficult to count very small bubbles, each bubble counts as '1' no matter how big it is*)
- Why should you leave the plant for a few minutes before starting to count bubbles (*as it takes time for the plant to adjust to the light/temperature and for photosynthesis to reach the correct rate*).
- Heat from the lamp is a source of error, how could you avoid this? (*Place a glass screen in front of the beaker so that light gets through but heat doesn't*)
- What are the other limiting factors apart from light? Why will rate of photosynthesis level off, even with maximum light? (*The plant also needs enough temperature and CO_2*)

Exam practice 2

Q1. A student investigated the effect of light intensity on the rate of photosynthesis.

The diagram shows the apparatus the student used.



This is the method used.

1. Set up the apparatus as shown in the diagram above.
2. Place the lamp 10 cm from the pondweed.
3. Turn the lamp on and count the number of bubbles produced in one minute.
4. Repeat with the lamp at different distances from the pondweed.

(a) Complete the hypothesis for the student's investigation.

'As light intensity increases, _____

_____ .'

(1)

(b) What was the independent variable in this investigation?

Tick **one** box.

Light intensity	☐
Number of bubbles produced	☐
Temperature	☐
Time	☐

(1)

(c) The teacher suggests putting the boiling tube into a beaker of water during the investigation.

Suggest why this would make the results more valid.

_____

_____

(1)

Table 1 shows the student's results.

Table 1

Distance of lamp from pondweed in cm	**Number of bubbles produced per minute**			
	Trial 1	**Trial 2**	**Trial 3**	**Mean**
10	67	66	69	67
20	61	64	62	62.3
30	53	51	52	**X**
40	30	32	31	31
50	13	15	15	14

(d) Calculate value **X** in **Table 1**.

_____

_____

X = _____ bubbles per minute

(1)

(e) State **one** error the student has made when completing the results at 20 cm.

_____

_____

(1)

(f) What evidence in **Table 1** shows that the data is repeatable?

Tick **one** box.

The number of bubbles decreases as distance decreases.	☐
The numbers of bubbles at each distance are similar.	☐
The student calculated a mean for each distance.	☐
The student did the experiment three times.	☐

(1)

Another student investigated the effect of the colour of light on the rate of photosynthesis.

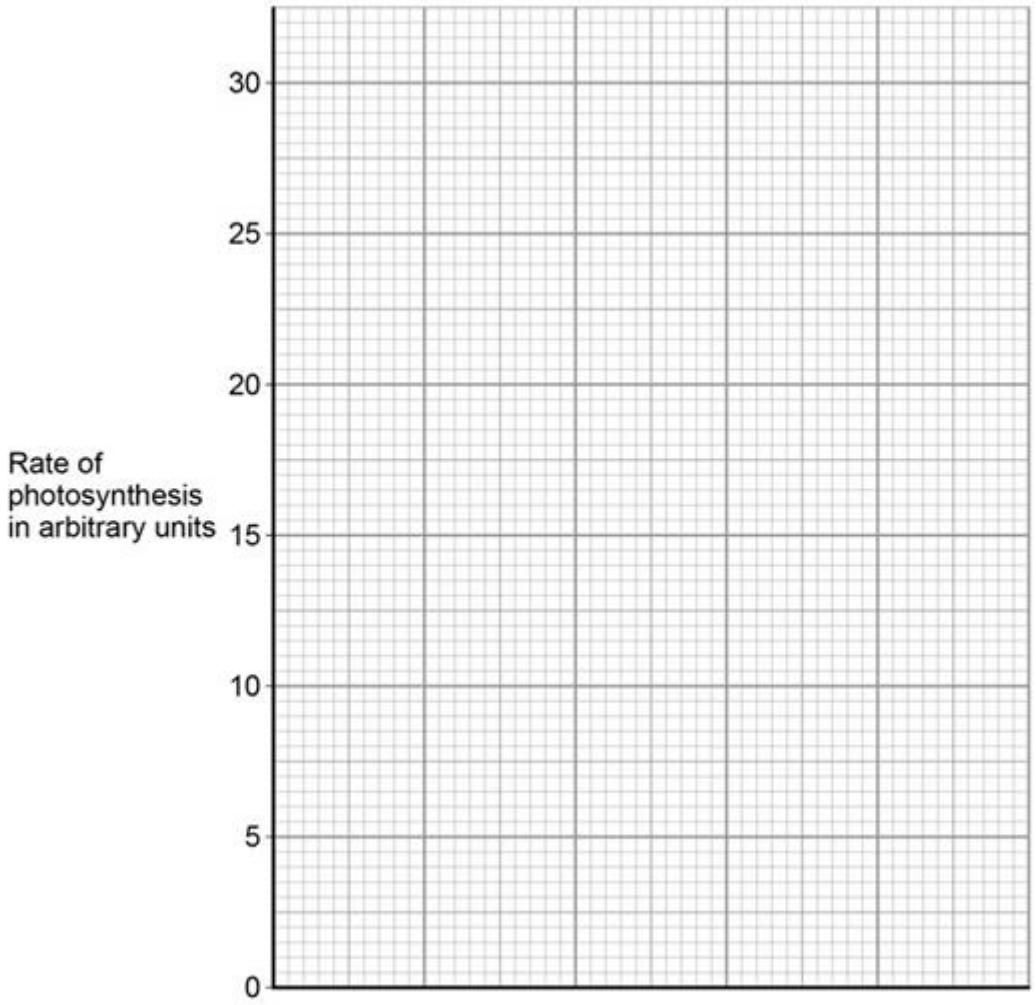
The results are shown in **Table 2**.

Table 2

Colour of light	Rate of photosynthesis in arbitrary units
Blue	24
Green	4
Red	17
Yellow	8

(g) Plot the data from **Table 2** on the graph.

You should label the x-axis.



(3)

(h) Give **two** conclusions from the graph above.

1. _____

_____

2. _____

_____

(2)

(i) The glucose produced in photosynthesis can be converted into amino acids to make new proteins for the plant.

Complete the sentences.

The glucose produced in photosynthesis can also be used in other ways.

Glucose can be used in respiration to release _____ .

Glucose can be converted to cellulose to strengthen the _____ .

Glucose can be stored as _____ .

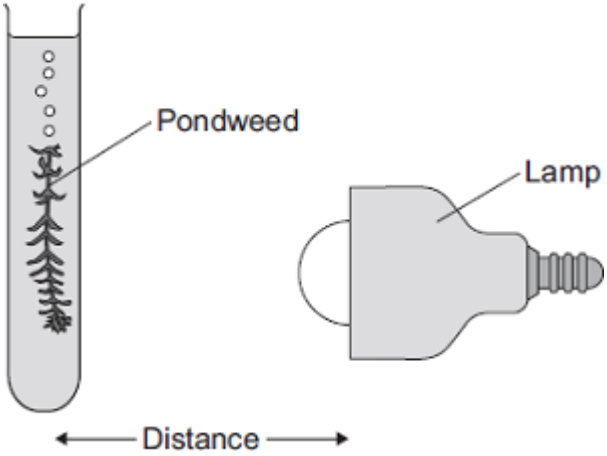
(3)

(Total 14 marks)

Q2. Some students investigated the effect of light intensity on the rate of photosynthesis.

They used the apparatus shown in **Diagram 1**.

Diagram 1



The students:

- placed the lamp 10 cm from the pondweed
- counted the number of bubbles of gas released from the pondweed in 1 minute
- repeated this for different distances between the lamp and the pondweed.

(a) The lamp gives out heat as well as light.

What could the students do to make sure that heat from the lamp did **not** affect the rate of photosynthesis?

_____

_____

(1)

(b) The table shows the students' results.

Distance in cm	Number of bubbles per minute
10	84
15	84
20	76
40	52
50	26

(i) At distances between 15 cm and 50 cm, light was a limiting factor for photosynthesis.

What evidence is there for this in the table?

_____

_____

(1)

(ii) Give **one** factor that could have limited the rate of photosynthesis when the distance was between 10 cm and 15 cm.

_____

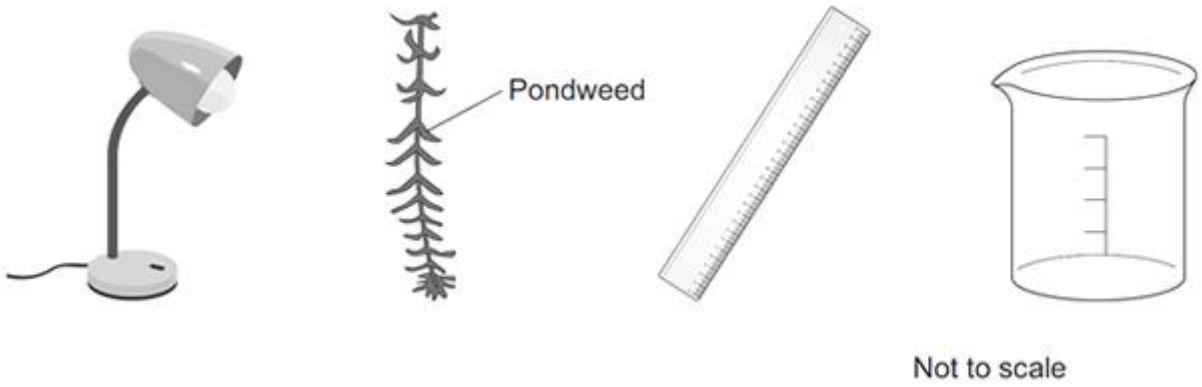
(1)

Q3.In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Light intensity, carbon dioxide concentration and temperature are three factors that affect the rate of photosynthesis.

How would you investigate the effect of **light intensity** on the rate of photosynthesis?

The image below shows some of the apparatus you might use.



You should include details of:

- how you would set up the apparatus and the materials you would use
- the measurements you would make
- how you could make this a fair test.

(Total 6 marks)

4.4.2.1. Aerobic and anaerobic respiration

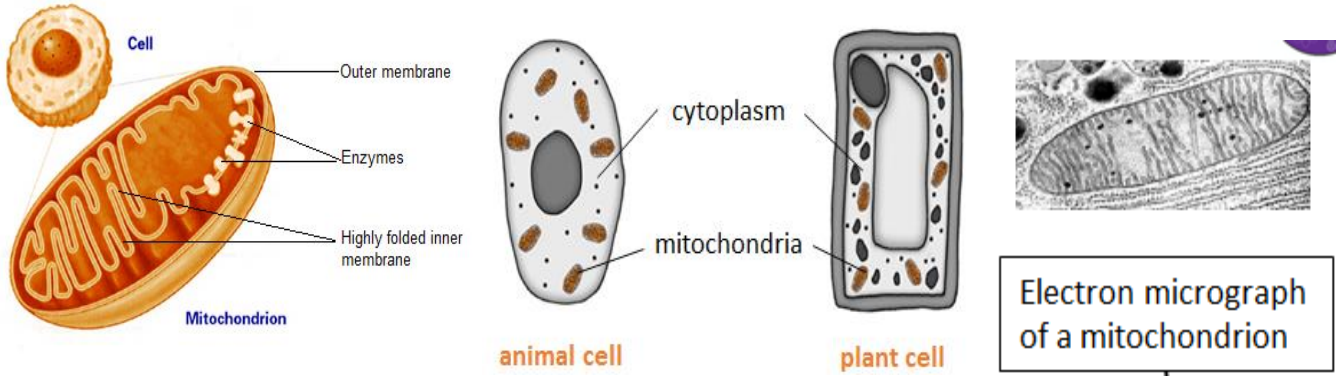
Respiration: The process of transferring energy from food molecules in every living cell.

Cellular respiration is an exothermic reaction which is continuously occurring in all living cells

The energy that is released during respiration is used:

- To build up larger molecules using smaller ones.
- In animals, to enable muscles to contract.
- In mammals and birds, to maintain a steady body temperature in colder surroundings.
- In plants, to build up sugars, nitrates and other nutrients into amino acids which are then built up into proteins.

Mitochondria: Most of the reactions in respiration happen in the mitochondria



- Aerobic respiration - uses oxygen
- Anaerobic respiration - uses no oxygen
- All chemical reactions inside cells are controlled by enzymes.

Aerobic respiration: Glucose reacts with oxygen, producing carbon dioxide and water as waste products. This takes place continuously in animals and plants.

Glucose + Oxygen ➔ Carbon dioxide + Water + Energy

$C_6H_{12}O_6 + 6O_2$ ➔ $6CO_2 + 6H_2O$

- Respiration involves a series of many small reactions.
- Each reaction is controlled by an enzyme.
- We **can test for carbon dioxide** using lime water, if carbon dioxide is **present limewater turns cloudy**.

Anaerobic respiration: Anaerobic respiration is the incomplete breakdown of glucose and produces lactic acid.

glucose ➔ lactic acid + small amount of energy released

Anaerobic respiration in plant and yeast cells

The end products are ethanol and carbon dioxide. Anaerobic respiration in yeast cells is called fermentation

glucose ➔ ethanol + carbon dioxide

Compare anaerobic respiration in a yeast cell with anaerobic respiration in a muscle cell.

.....

.....

.....

.....

.....

.....

.....

.....

(3)

Exam practice 3

Q1.(a) (i) Complete the word equation for the process of aerobic respiration.

Glucose + _____ → carbon dioxide + water

(1)

(ii) Which organ removes carbon dioxide from your body?

_____

(1)

(b) Use names from the box to complete the **two** spaces in the passage.

carbon dioxide	lactic acid	nitrogen	oxygen	water

Anaerobic respiration can occur when an athlete does vigorous exercise.

This is because there is not enough _____ in the body.

The product of anaerobic respiration is _____ .

(2)

(Total 4 marks)

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.

$C_6H_{12}O_6 + 6O_2 \rightarrow$ ____ CO_2 + ____ H_2O

(1)

(ii) Name the substance with the formula $C_6H_{12}O_6$.

_____

(1)

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

_____

(1)

(Total 3 marks)

Q3. Glucose is broken down in respiration.

(a) What is the chemical formula for glucose?

Tick **one** box.

$C_6H_6O_6$ ☐

$C_3H_6O_3$ ☐

$C_6H_{12}O_6$ ☐

$C_6H_{10}O_6$ ☐

(1)

Anaerobic respiration is another form of respiration in living organisms.

(e) What is produced during anaerobic respiration in humans?

Tick **one** box.

Carbon dioxide ☐

Carbon dioxide and lactic acid ☐

Lactic acid ☐

Oxygen and water ☐

(1)

(f) Complete the equation for anaerobic respiration in yeast.

glucose → carbon dioxide + _____

(1)

(Total 8 marks)

Q4. Scientists investigated how exercise affects blood flow to different organs in the body.

The scientists made measurements of blood flow to different organs of:

- a person resting in a room at 20°C
- the same person, in the same room, doing vigorous exercise at constant speed on an exercise cycle.

The table shows the scientists' results.

Organ	**Blood flow in cm^3 per minute whilst …**	
	resting	**doing vigorous exercise**
Brain	750	750
Heart	250	1000
Muscles	1200	22 000
Skin	500	600
Other	3100	650

(a) In this investigation, it was better to do the exercise indoors on an exercise cycle than to go cycling outdoors on the road.

Suggest **two** reasons why.

Do **not** include safety reasons.

1. _____

_____

2. _____

_____

(2)

(b) Blood flow to **one** organ did **not** change between resting and vigorous exercise.

Which organ?_____

(1)

(c) (i) How much more blood flowed to the muscles during vigorous exercise than when resting?

_____

_____

Answer = _____ cm^3 per minute

(2)

(ii) Name **two** substances needed in larger amounts by the muscles during vigorous exercise than when resting.

1. _____

2. _____

(2)

(iii) Tick (✓) **one** box to complete the sentence.

The substances you named in part (c)(ii) helped the muscles to

make more lactic acid.	☐
respire aerobically.	☐
make more glycogen.	☐

(1)

(iv) The higher rate of blood flow to the muscles during exercise removed larger amounts of waste products made by the muscles.

Which **two** substances need to be removed from the muscles in larger amounts during vigorous exercise?

Tick (✓) **two** boxes.

Amino acids	☐
Carbon dioxide	☐
Glycogen	☐
Lactic acid	☐

(2)

4.4.2.2 Response to exercise.

During exercise the human body reacts to increased demand for energy	***Heart rate increases***	This increases rate of blood flow to the muscles
	Breathing rate and breath volume increase	• This increases the rate of gas exchange. • More oxygen and glucose is taken into the blood. • More carbon dioxide and lactic acid is removed from the blood.

The role of respiration during exercise:

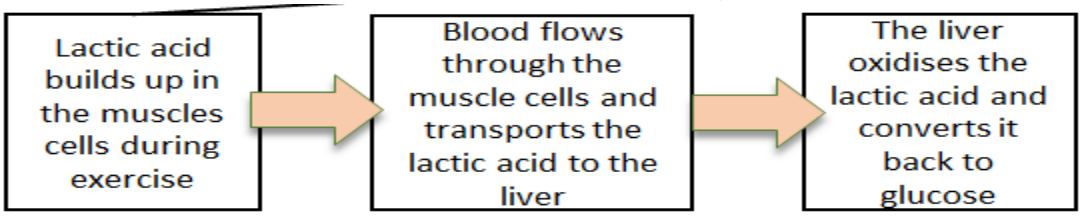
1) Muscles contract to move the bones in our bodies.
2) Respiration releases energy, which is used to contract the muscles:
    - When we exercise, our muscles contract more quickly and with more force.
    - This requires more energy.
    - This requires more glucose and oxygen. Also, more carbon dioxide is created which needs to be removed. The human body needs to react to the increased demand for energy during exercise.

- During exercise, if insufficient oxygen is reaching the muscles they use anaerobic respiration to obtain energy. As the breakdown of glucose is incomplete, much less energy is released than during aerobic respiration.

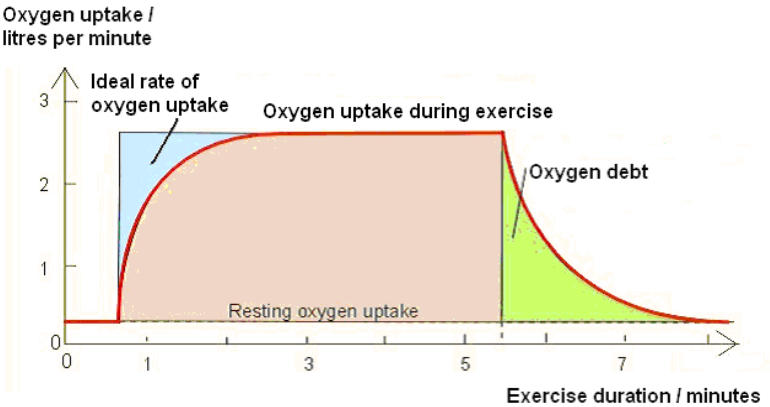
HIGHER TIER

However, lactic acid is poisonous. We can only tolerate small amounts in our body.

- If muscles are subjected to long periods of vigorous activity they become fatigued, i.e. they stop contracting efficiently.
    - One cause of muscle fatigue is the build up of lactic acid in the muscles.
    - Blood flowing through the muscles removes the lactic acid.
    - During and after exercise, we breathe heavily to take in extra oxygen to oxidise the lactic acid:



- The extra oxygen is called the **oxygen debt.**



Q1. 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.

blood	**breathe**	**carbon dioxide**	**glucose**
heat	**nitrogen**	**oxygen**	**respire**

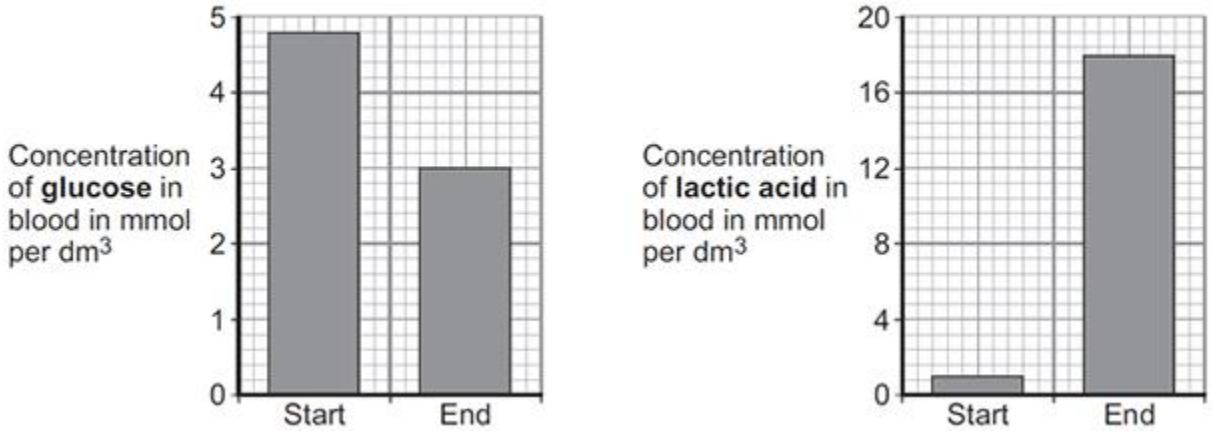
When she is running, Paula's muscle activity increases. To do this, her muscle cells _____ at a faster rate to give her more energy. Her muscles need to be supplied with _____ and _____ more quickly. Her heart beats faster to increase the flow of _____ which carries the products _____ and _____ away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

(Total 6 marks)

Q2. An athlete ran as fast as he could until he was exhausted.

(a) **Figure 1** shows the concentrations of glucose and of lactic acid in the athlete's blood at the start and at the end of the run.

Figure 1



(i) Lactic acid is made during anaerobic respiration.

What does anaerobic mean?

_____

_____

(1)

(ii) Give evidence from **Figure 1** that the athlete respired anaerobically during the run.

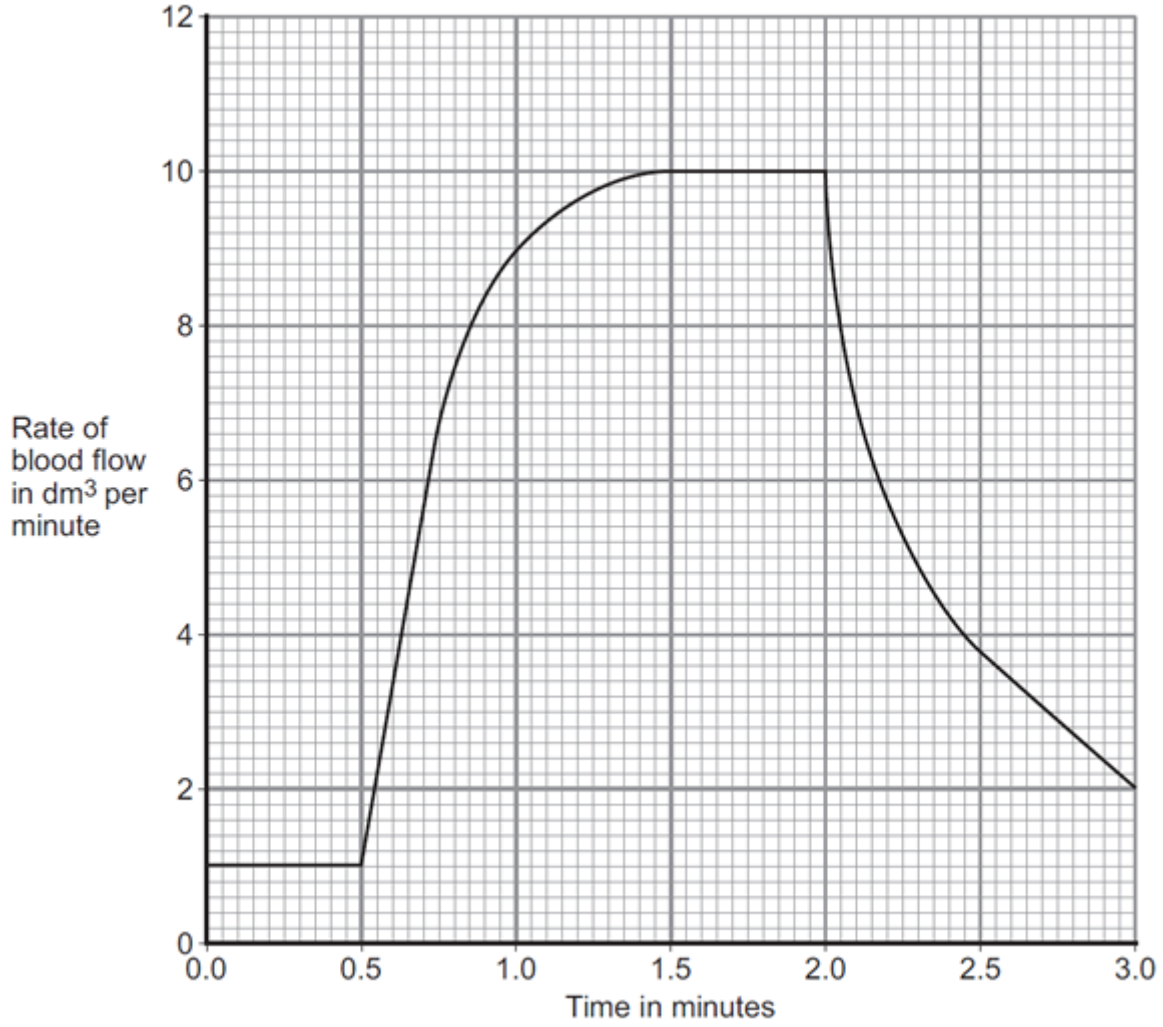
_____

_____

(1)

(b) **Figure 2** shows the effect of running on the rate of blood flow through the athlete's muscles.

Figure 2



(i) For how many minutes did the athlete run?

Time = _____ minutes

(1)

(ii) Describe what happens to the rate of blood flow through the athlete's muscles during the run.

Use data from **Figure 2** in your answer.

_____

_____

_____

_____

(2)

(iii) Explain how the change in blood flow to the athlete's muscles helps him to run.

_____

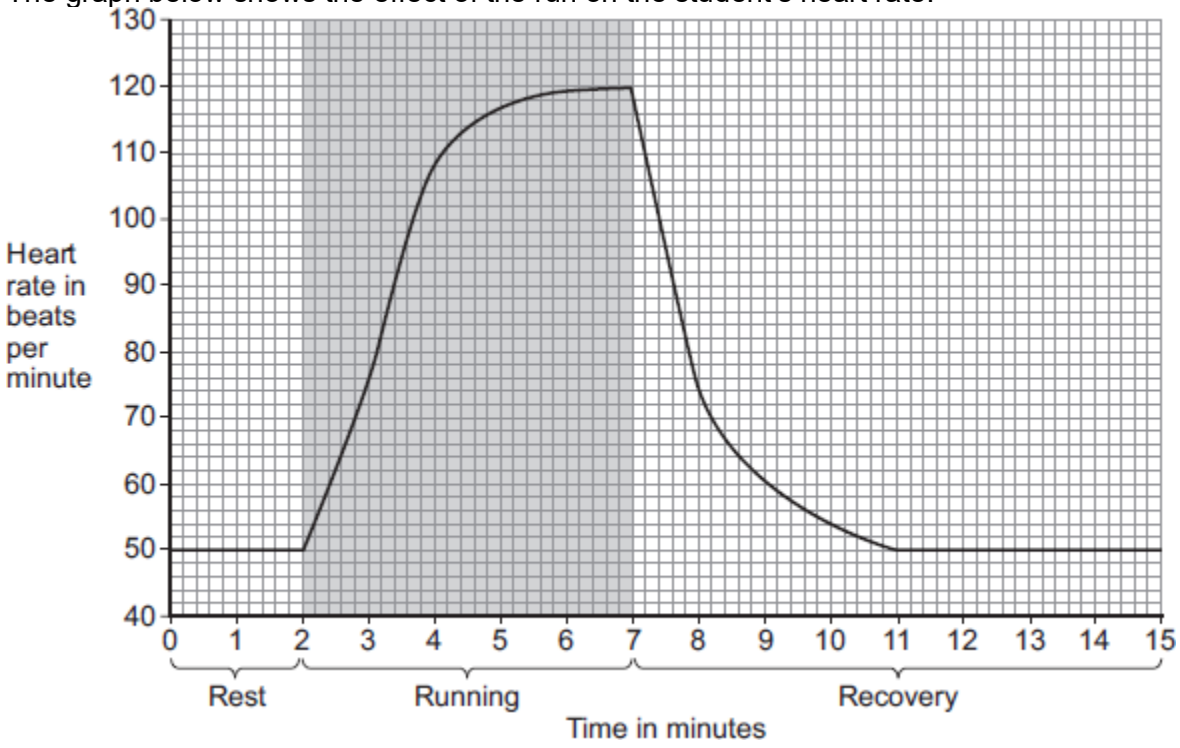
(4)

(Total 9 marks)

Q3. 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.



(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)

(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)

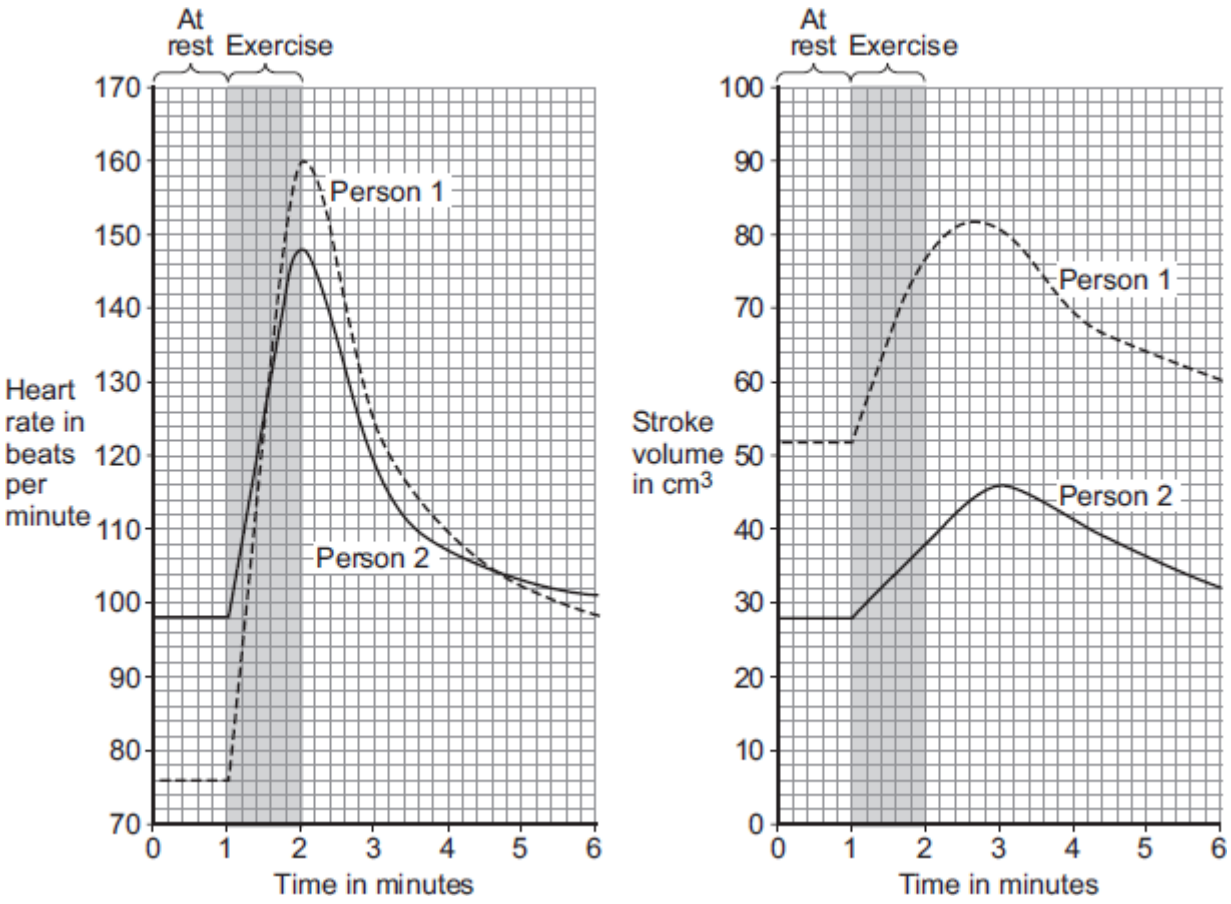
Q4.

During exercise, the heart beats faster and with greater force.

The 'heart rate' is the number of times the heart beats each minute.The volume of blood that travels out of the heart each time the heart beats is called the 'stroke volume'.

In an investigation, **Person 1** and **Person 2** ran as fast as they could for 1 minute. Scientists measured the heart rates and stroke volumes of **Person 1** and **Person 2** at rest, during the exercise and after the exercise.

The graph below shows the scientists' results.



(a) The 'cardiac output' is the volume of blood sent from the heart to the muscles each minute.

Cardiac output = Heart rate × Stroke volume

At the end of the exercise, **Person 1**'s cardiac output = 160 × 77 = 12 320 cm^3 per minute.

Use information from the figure above to complete the following calculation of **Person 2**'s cardiac output at the end of the exercise.

At the end of the exercise:

Person 2's heart rate = _____ beats per minute

Person 2's stroke volume = _____ cm^3

Person 2's cardiac output = _____ cm^3 per minute

(3)

(b) **Person 2** had a much lower cardiac output than **Person 1.**

(i) Use information from the figure above to suggest the **main** reason for the lower cardiac output of **Person 2**.

_____

_____

(1)

(ii) **Person 1** was able to run much faster than **Person 2**.

Use information from the figure above and your own knowledge to explain why.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(Total 9 marks)

4.4.2.3 Metabolism

Metabolism is the sum of all the reactions in a cell or the body

Metabolism	***The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism.***	Conversion of glucose to starch, glycogen and cellulose.
		The formation of lipid molecules from a molecule of glycerol and three molecules of fatty acid.
		The use of glucose and nitrate ions to form amino acids which in turn are used to synthesise proteins.
		Respiration
		Breakdown of excess proteins to form urea for excretion.

One major set of metabolic reactions is respiration.

- The rate of these reactions varies with the amount of activity done.
    - The more activity, the more energy is required by the body.
- Metabolic rate also varies with respect to the proportion of muscle to fat in your body.
    - The higher the proportion of muscle to fat, the higher the metabolic rate.
    - Exercise increases the proportion of muscle to fat.

Exam practice 5

Q1.

Metabolism is the sum of all the chemical reactions in the cells of the body.

One metabolic reaction is the formation of lipids.

(a) Give **one** other metabolic reaction in cells.

_____

_____

(1)

Table 1 shows the mean metabolic rate of humans of different ages.

Table 1

Age in years	Mean metabolic rate in kJ/m²/hour	
	Males	Females
5	53	53
15	45	42
25	39	35
35	37	35
45	36	35

(b) What **two** conclusions can be made from the data in **Table 1**?

Tick **two** boxes.

As age increases, mean metabolic rate of males and females increases.	☐
Males have a higher metabolic rate than females after five years of age.	☐
The mean metabolic rate of females decreases faster than males up to 25 years of age.	☐
The mean metabolic rate of males and females decreases more quickly after the age of 35.	☐
There is no relationship between age and mean metabolic rate.	☐

(2)

(c) Calculate the percentage decrease in the mean metabolic rate of males between 5 years and 45 years of age.

Use the equation:

$$\text{percentage decrease} = \frac{\text{decrease in metabolic rate}}{\text{original metabolic rate}} \times 100$$

Give your answer to 3 significant figures.

_____

_____

_____

_____

Percentage decrease = _____

(3)

Regular exercise can increase metabolic rate.

Two people did five minutes of gentle exercise from rest.

Table 2 shows the effect of the exercise on their heart rates.

Table 2

Time in minutes	Heart rate in beats per minute	
	Person R	Person S
0 (at rest)	60	78
1	76	100
2	85	110
3	91	119
4	99	129
5	99	132

(d) Describe **two** differences in the response of person **R** and person **S** to the exercise.

Use information from **Table 2**.

1. _____

_____

2. _____

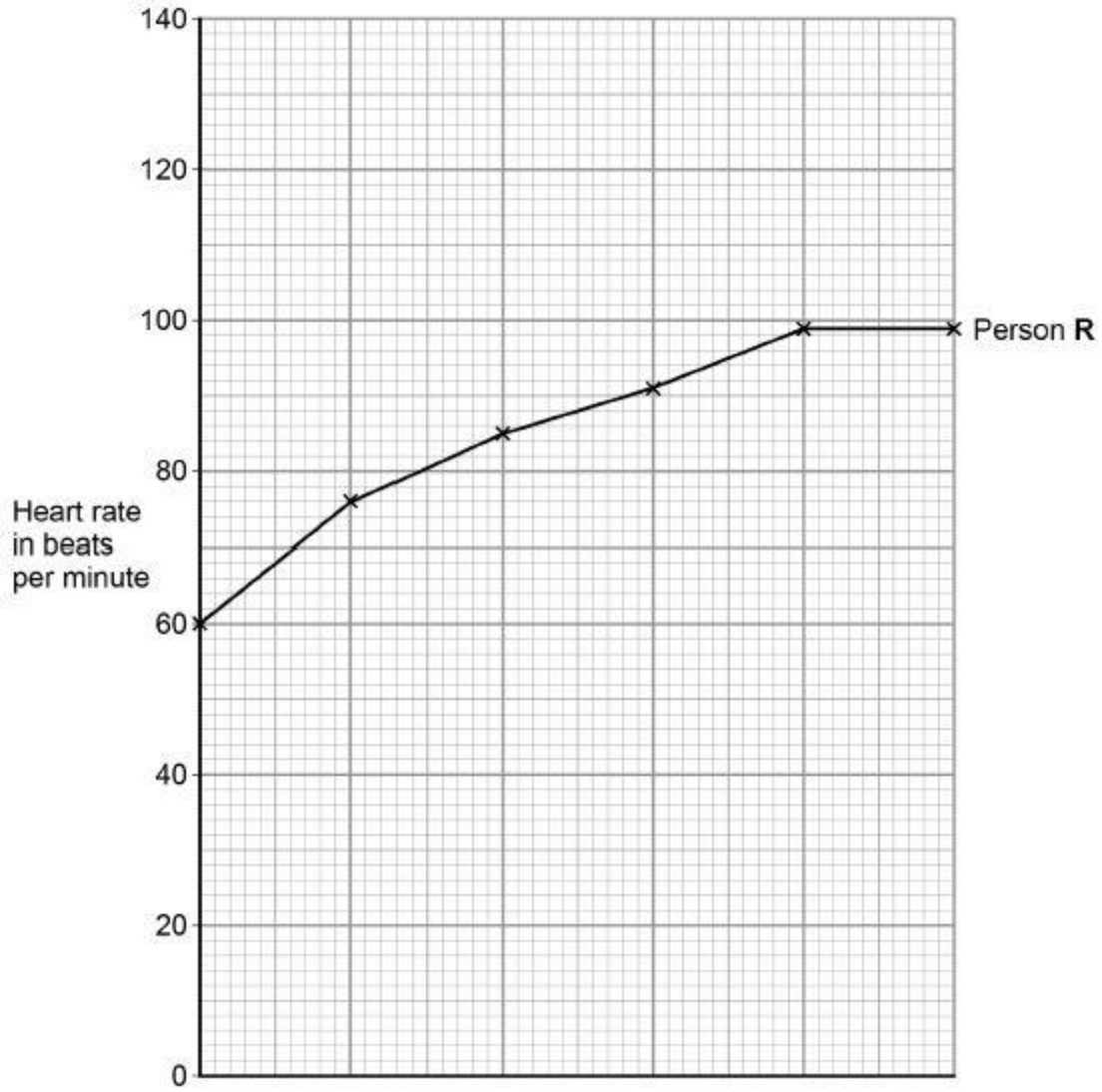
_____

(2)

(e) Complete the line graph below for person **S**.

You should:

- add the scale to the x axis
- label the x axis.



(4)

(f) After five minutes of exercise, the heart rate of person **S** was 132 beats per minute. When person **S** rested, his heart rate decreased steadily at a rate of 12 beats every minute.

Calculate how much time it would take the heart rate of person **S** to return to its resting rate.

_____

_____

_____

Time = _____ minutes

(2)

Q2. One factor that may affect body mass is *metabolic rate*.

(a) (i) What is meant by *metabolic rate* ?

_____

_____

(1)

(ii) Metabolic rate is affected by the amount of activity a person does.

Give **two** other factors that may affect a person's metabolic rate.

1. _____

_____

2. _____

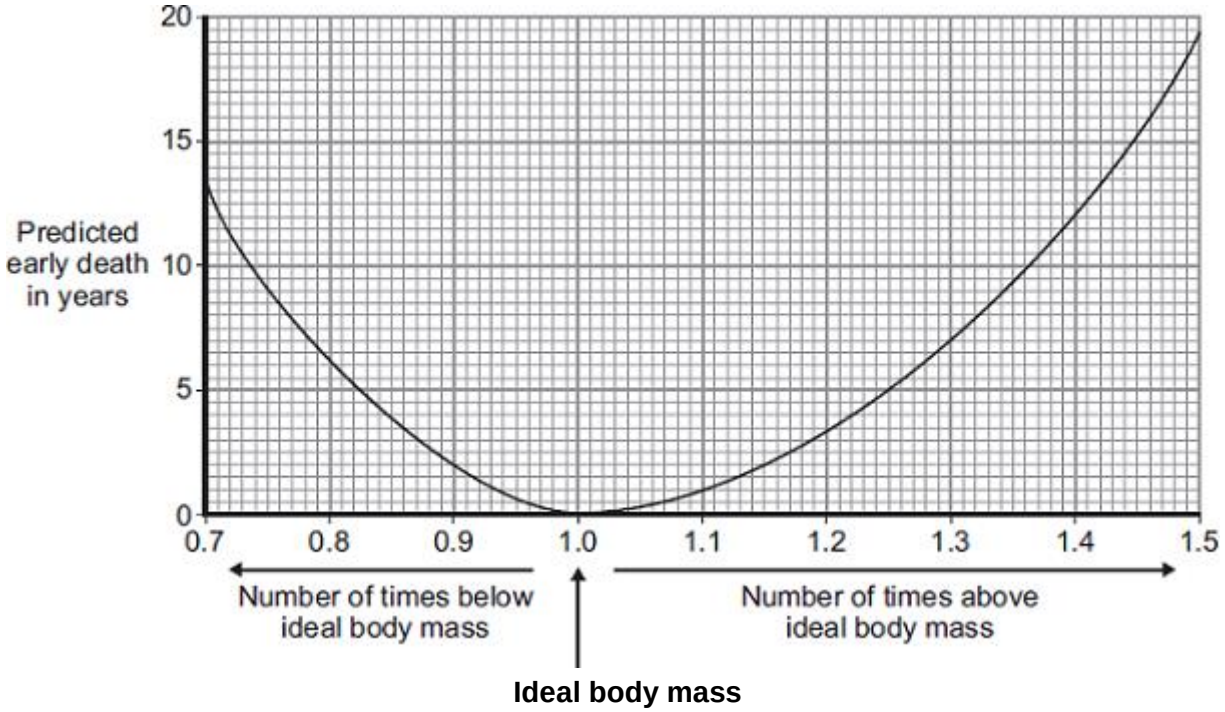
_____

(2)

(b) Predicted early death is the number of years that a person will die before the mean age of death for the whole population. The predicted early death of a person is affected by their body mass.

Scientists have calculated the effect of body mass on predicted early death.

The graph shows the results of the scientists' calculations.



The number of times above or below ideal body mass is given by the equation:

$$\frac{\text{Actual body mass}}{\text{Ideal body mass}}$$

In the UK the mean age of death for women is 82.

A woman has a body mass of 70 kg. The woman's ideal body mass is 56 kg.

(i) Use the information from the graph to predict the age of this woman when she dies.

_____

_____

_____

Age at death = _____ years

(2)

(ii) The woman could live longer by changing her lifestyle.

Give **two** changes she should make.

1. _____

_____

2. _____

_____

(2)

(Total 7 marks)