4.4 Bioenergetics
Higher

Name: _____

Class: _____

Date: _____

Time: **213 minutes**

Marks: **212 marks**

Comments:

Q1.

Diagram 1 shows the main features of human blood circulation.

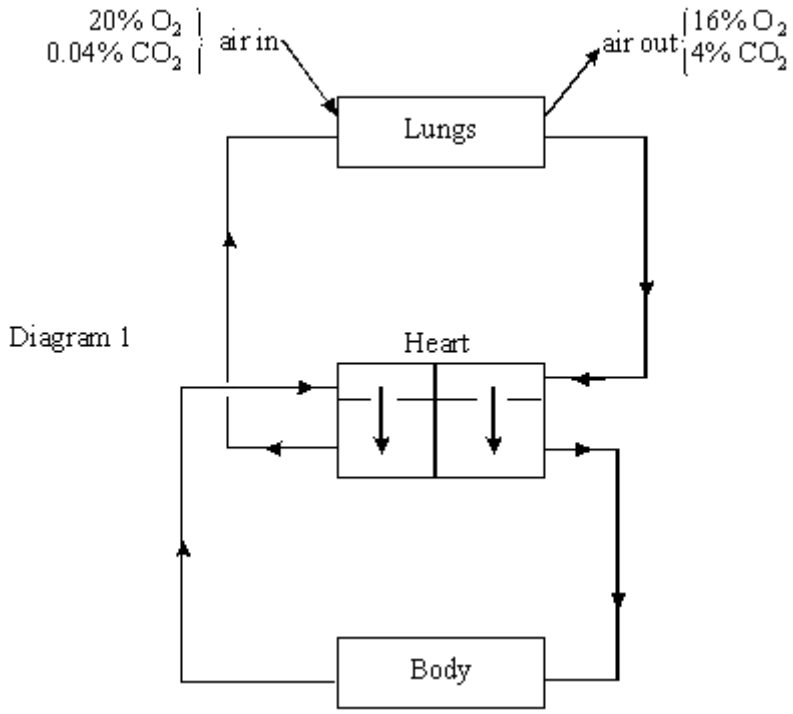


Diagram 1

(a) What changes in the composition of **blood** occur in the lungs?

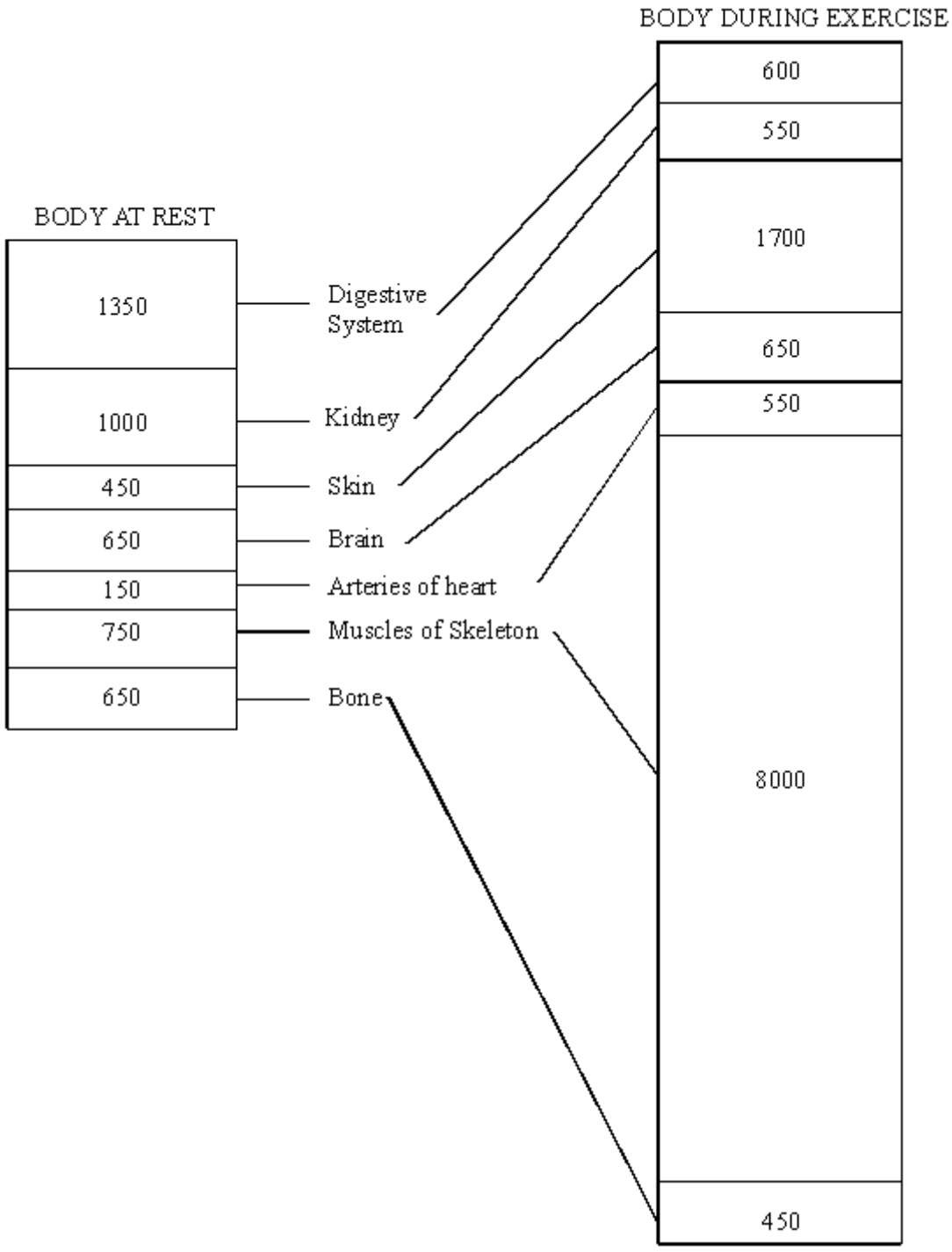
_____

_____

_____

(2)

Diagram 2 shows how the circulation of blood changes between rest and exercise.



Rate of supply of blood to parts of the body (cm^3/min) when at rest and during exercise.

(b) (i) Use the information from Diagram 2 to complete the table below.

Parts of the body to be included:

Digestive System

Skin

Brain

Arteries of Heart

Muscles of Skeleton

Bone

HOW BLOOD SUPPLY CHANGES DURING EXERCISE		
reduced	unchanged	increased
Kidney		

(4)

(ii) What happens to the rate of supply of blood to the whole body with exercise?

(You should make full use of the information provided.)

_____

_____

_____

(3)

(Total 9 marks)

Q2.

In a stable community, the processes that remove carbon are balanced by processes that return carbon.

The figure below shows a woodland community.

Describe how carbon is recycled in a woodland community.

_____

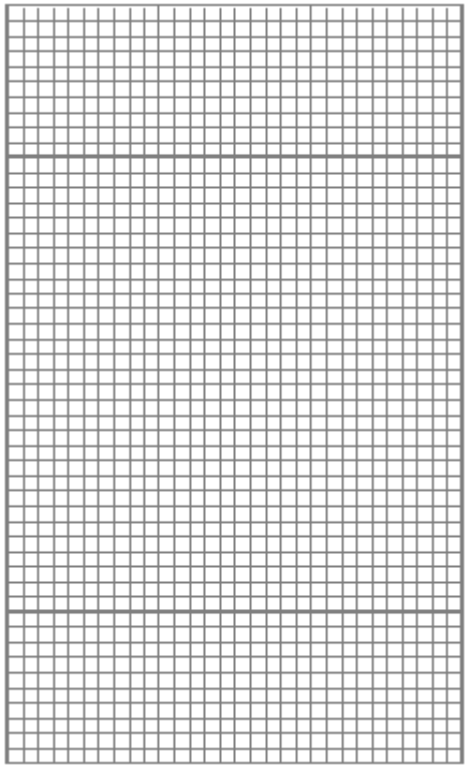
(Total 6 marks)

Q3.

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

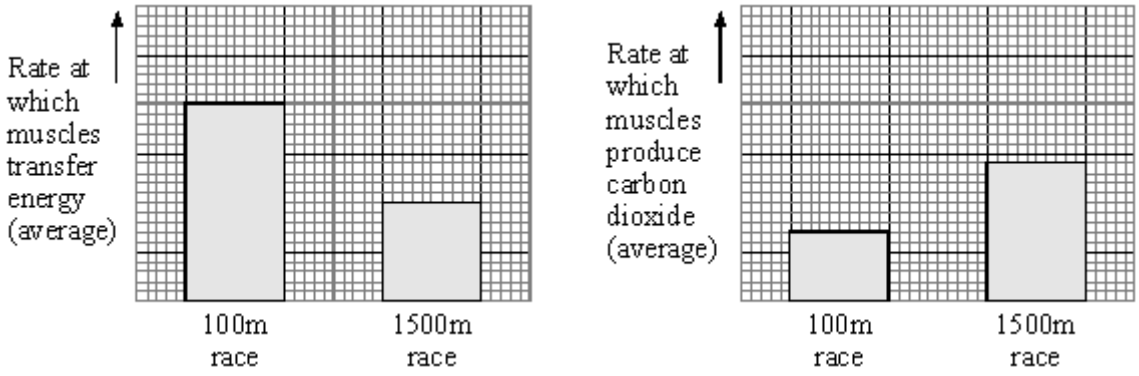
Use the information shown in the table to draw a line graph.

Time after end of race (minutes)	Breathing rate (litres per second)
0	4
1	2
2	1
3	1
4	1
5	1



(3)

(b) 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.

_____

_____

(3)

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

aerobic respiration	glucose + oxygen ⟶	carbon dioxide + water
anaerobic respiration	glucose ⟶	lactic acid

_____

_____

(2)

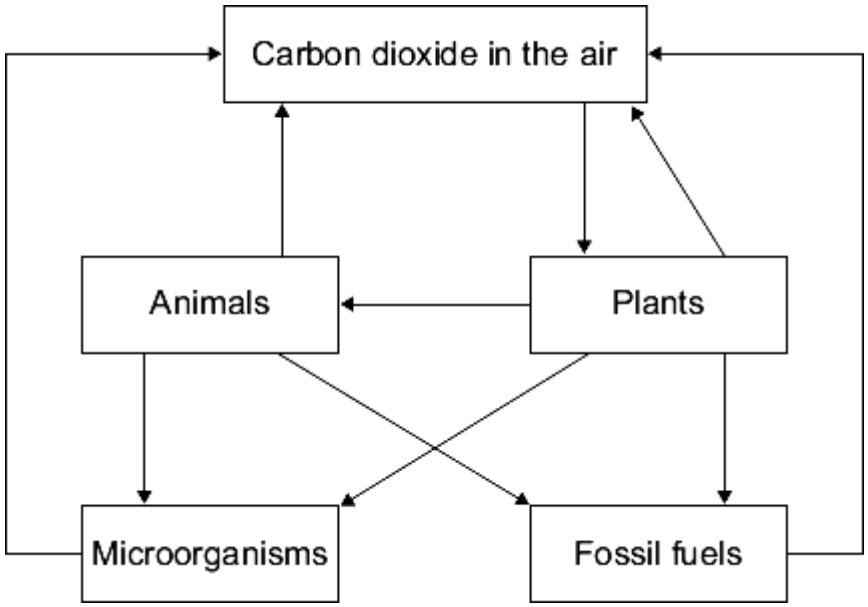
(c) Explain why the athlete breathes at a faster rate than normal for two minutes after finishing a 100 metres race.

(2)

(Total 10 marks)

Q4.

The diagram shows part of the carbon cycle.



Use the information in the diagram and your own knowledge to describe in detail how carbon is cycled between living organisms and the air.

Your answer should include the names of any processes involved.

_____

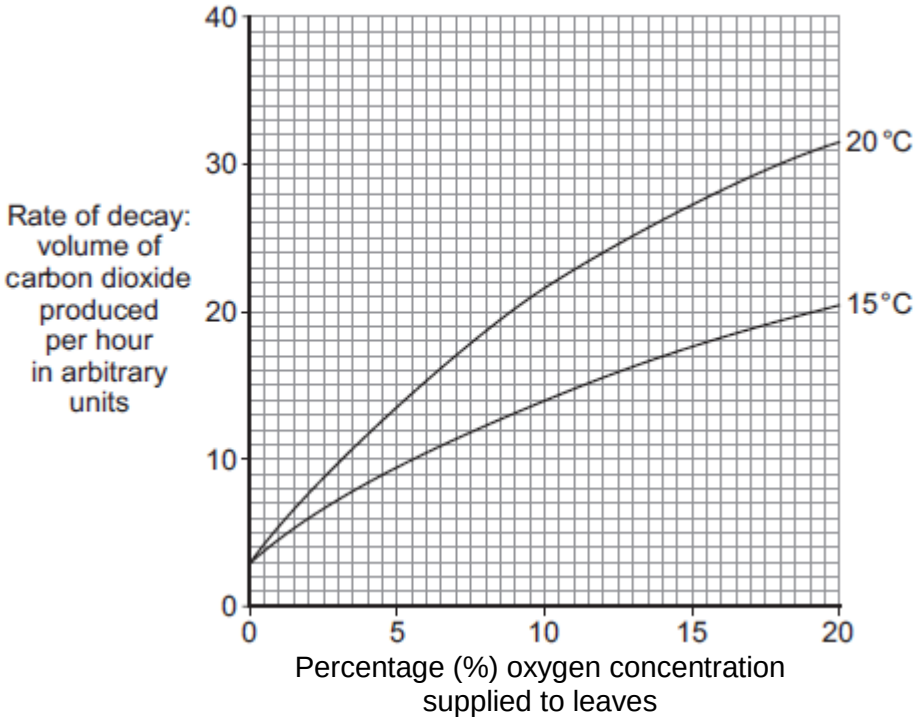
_____

(Total 6 marks)

Q5.

A scientist investigated the effect of oxygen concentration and temperature on the rate of decay of leaves in a container.

The scientist's results are shown in the graph.



(a) The rate of decay is measured as the volume of carbon dioxide produced per hour.

Explain why carbon dioxide is produced during the process of decay.

_____

_____

_____

_____

_____

_____

_____

(3)

(b) Give **two** conclusions that can be made from the results shown in the graph.

_____

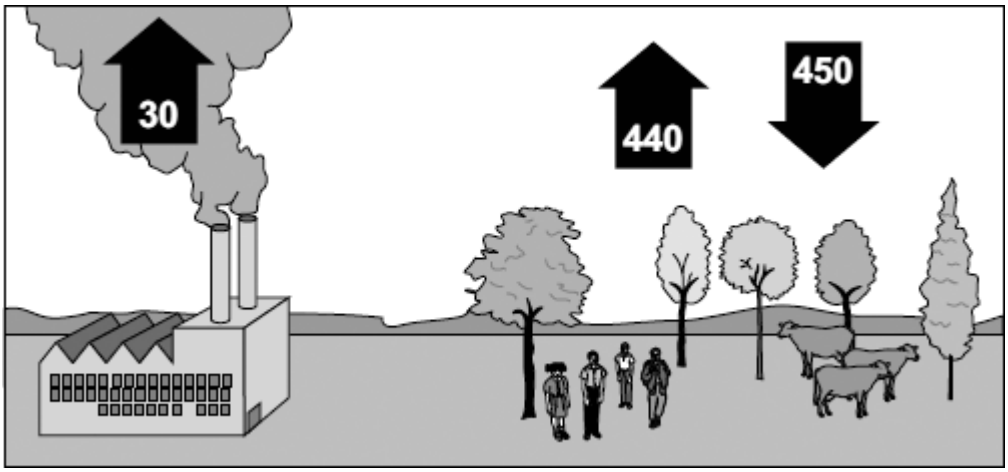
_____

(2)

(Total 5 marks)

Q6.

The diagram shows the mass of carbon dioxide released into and removed from the air each year in billions of tonnes.



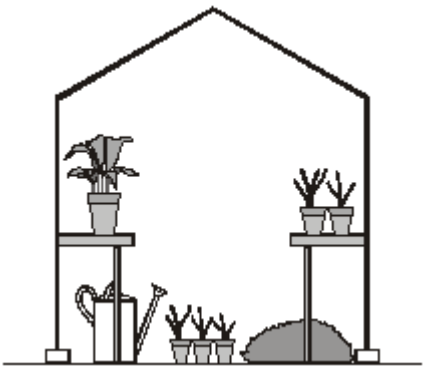
Describe the processes **shown on the diagram** that exchange carbon dioxide with the air.

Explain the overall effect of these processes on the mass of the carbon dioxide in the air.

(Total 6 marks)

Q7.

The diagram shows some plants growing in a greenhouse on a hot summer's day.



Which **one** of the following factors is most likely to limit the rate of photosynthesis at this time?

- carbon dioxide concentration
- light intensity
- temperature

Factor _____

Explain the reason for your answer.

_____

_____

_____

_____

_____

_____

(Total 4 marks)

Q8.

Plants need nitrate ions in order to make proteins.

A plant is growing in soil flooded with water.

Explain why the plant cannot absorb enough nitrate ions.

_____

_____

_____

_____

_____

_____

_____

_____

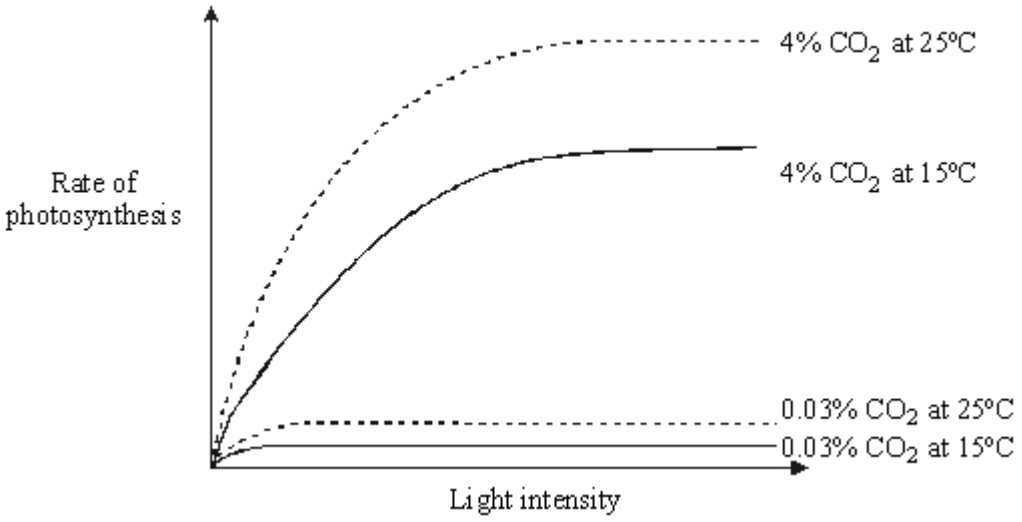
_____

_____

(Total 5 marks)

Q9.

The graph shows how the rate of photosynthesis is affected by different conditions.



(a) What patterns can you find from this graph?

_____

_____

_____

_____

_____

(5)

(b) How useful could this information be to a grower using glasshouses? Give reasons for your answer.

_____

_____

_____

(2)

(Total 7 marks)

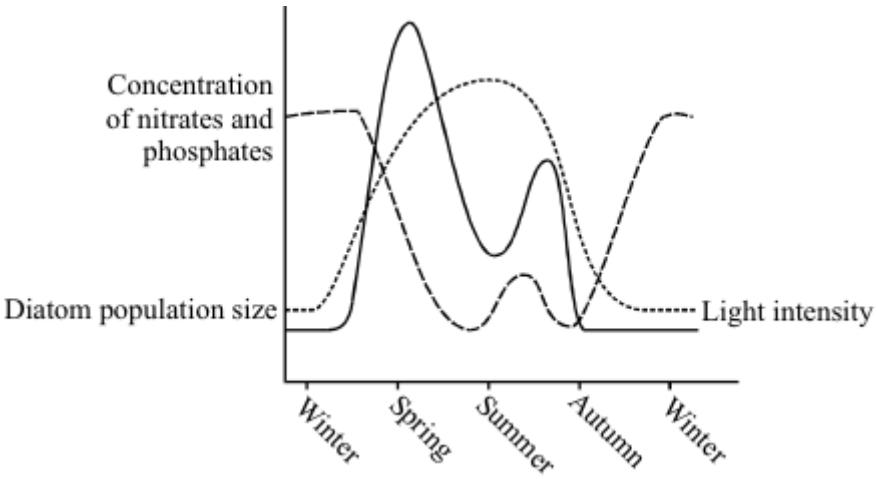
Q10.

A food chain in the North Atlantic Ocean is:

diatoms → small fish → large fish

The graphs show how over a year:

- the population size of diatoms in the North Atlantic varies;
- the light intensity alters;
- the concentration of nitrate and phosphate minerals alters.



(a) Explain why the light intensity is a major factor in controlling the numbers of diatoms.

_____

_____

_____

(2)

(b) (i) Suggest **two** reasons why the population of diatoms decreases between spring and summer.

1. _____

_____

2. _____

_____

(2)

(ii) Give **two** reasons why the population of diatoms decreases in autumn.

1. _____

_____

2. _____

_____

(2)

(c) Use the information on the graph to suggest what change causes the number of diatoms to increase in the late summer. Give a reason for the change.

_____

_____

_____

(2)

(Total 8 marks)

Q11.

Plants need chemical energy for respiration and for active transport.

(i) Write a balanced chemical equation which represents the process of respiration in plants.

_____

(2)

(ii) Describe the process of active transport in the root hair cells of plants.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 5 marks)

Q12.

(a) The concentration of sulfate ions was measured in the roots of barley plants and in the water in the surrounding soil.

The table shows the results.

	Concentration of sulfate ions in mmol per dm^3
Roots of barley plants	1.4
Soil	0.15

Is it possible for the barley roots to take up sulfate ions from the soil by diffusion?

Draw a ring around your answer. **Yes / No**

Explain your answer.

_____

_____

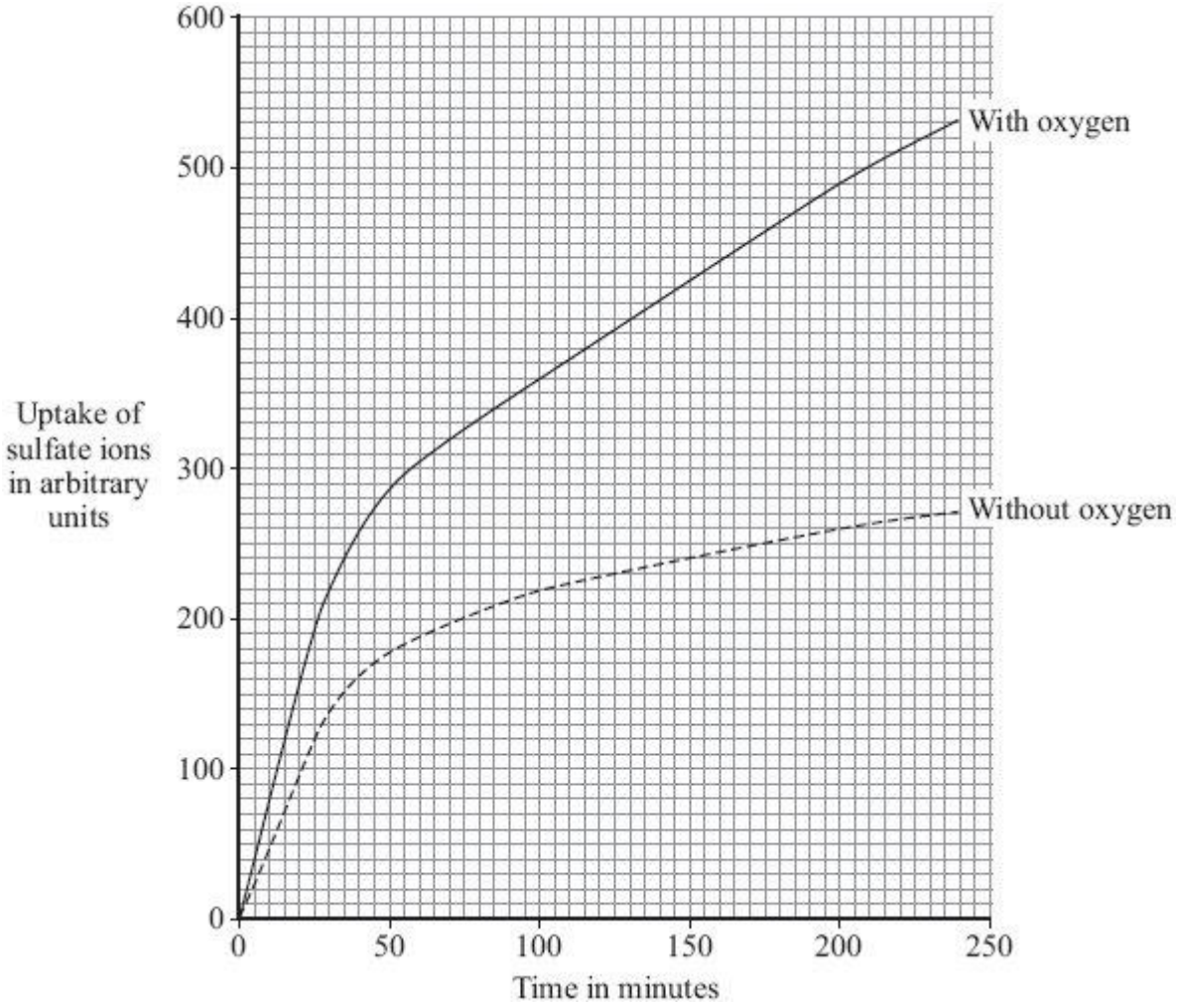
_____

_____

(2)

(b) Some scientists investigated the amounts of sulfate ions taken up by barley roots in the presence of oxygen and when no oxygen was present.

The graph below shows the results.



(i) The graph shows that the rate of sulfate ion uptake between 100 and 200 minutes, **without** oxygen, was 0.4 arbitrary units per minute.

The rate of sulfate ion uptake between 100 and 200 minutes, **with** oxygen, was greater.

How much greater was it? Show clearly how you work out your answer.

_____

_____

_____

Answer _____ arbitrary units

(2)

(ii) The barley roots were able to take up more sulfate ions with oxygen than without oxygen.

Explain how.

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Q13.

Low light intensity is one factor that limits the yield of a crop.

In Britain, many tomato growers use artificial lights to increase the yield of tomato crops.

The table shows the amount of natural daylight and artificial lamplight received by a tomato crop grown in a greenhouse.

Month	Natural daylight received by tomato plant		Artificial lamplight given to tomato plant		Total light energy received by plant per day in J/cm^2	Percentage increase in growth resulting from artificial light
	Day length in hours	Light energy received by plant per day in J/cm^2	Hours of light given per day	Light energy received by plant per day in J/cm^2		
January	8.1	239	18	492	731	206
February	9.9	492	18	492	984	100
March	11.9	848	12	328	1176	39
April	13.9	1401	2	55	1456	4
May	15.5	1786	0	0	1786	0
June	16.6	1960	0	0	1960	0

July	16.2	1849	0	0	1849	0
August	14.7	1561	0	0	1561	0
September	12.8	1064	2	55	1119	5
October	10.6	614	11	301	915	49
November	8.8	288	18	492	780	171
December	7.6	183	18	492	675	269

(a) Describe the pattern for the amount of light energy received from natural daylight by a tomato plant during the day.

_____

_____

_____

_____

_____

_____

(3)

(b) A tomato plant needs 600 J of light energy per cm^2 each day to grow and produce tomatoes.

Use this information and data from the table to suggest an explanation for the pattern of the artificial light given to the tomato plants.

_____

_____

_____

_____

_____

_____

(2)

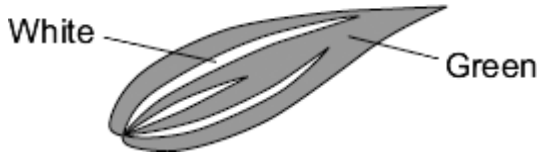
(Total 5 marks)

Q14.

Students investigated the effect of changing the carbon dioxide concentration on the rate of photosynthesis in pieces of leaf.

Diagram 1 shows the type of leaf used by the students.

Diagram 1

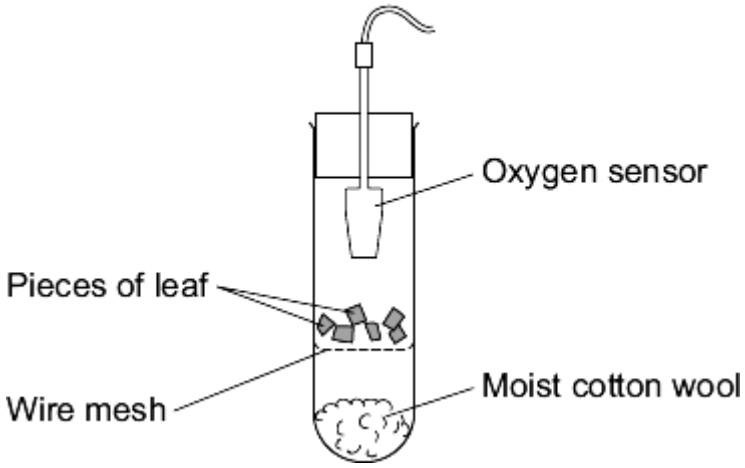


The students:

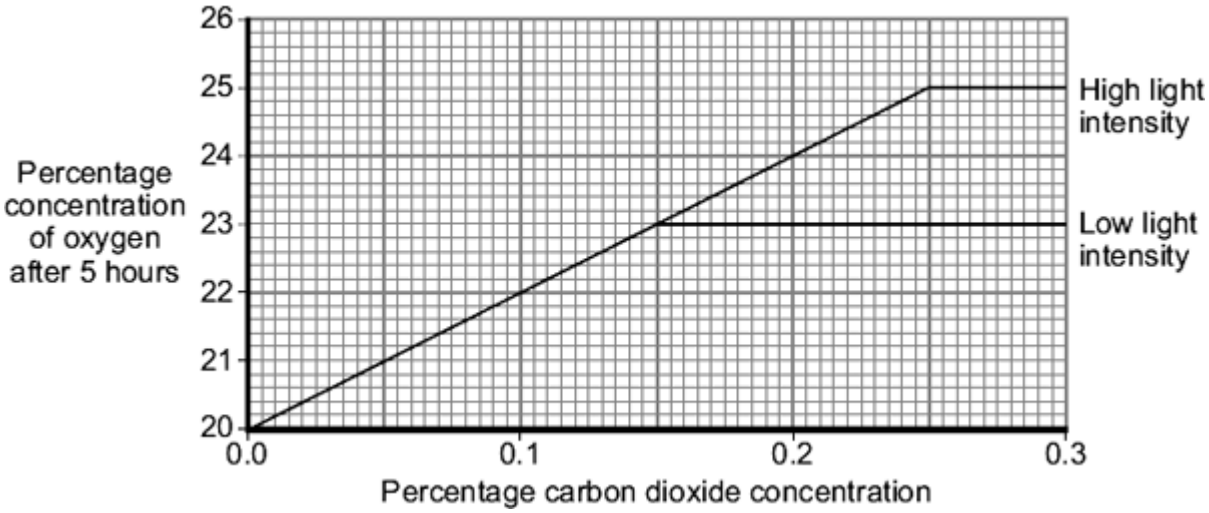
- cut pieces of leaf from the green region
- put the pieces into tubes
- added different concentrations of carbon dioxide to each tube
- shone lights on the tubes with either high or low light intensity
- recorded the concentration of oxygen in the tubes after 5 hours.

Diagram 2 shows how each experiment was set up.

Diagram 2



The graph shows the results of the investigation.



(a) (i) Describe the effect of increasing carbon dioxide concentration on the rate of photosynthesis at low light intensity.

_____

_____

(1)

(ii) Explain the effect that you have described.

In your answer you should refer to limiting factors.

_____

_____

_____

_____

(2)

(b) What would have been the effect on oxygen concentration over the five-hour period if a white region of the leaf had been used, instead of a green region?

Effect _____

Explain your answer.

Explanation _____

_____

_____

(2)

(c) Some people keep indoor plants which have variegated leaves (leaves with green and white regions).

If plants with variegated leaves are kept in dim light conditions the white areas of the leaves start to turn green.

This is an advantage to the plant.

Suggest why.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q15.

Read the passage.

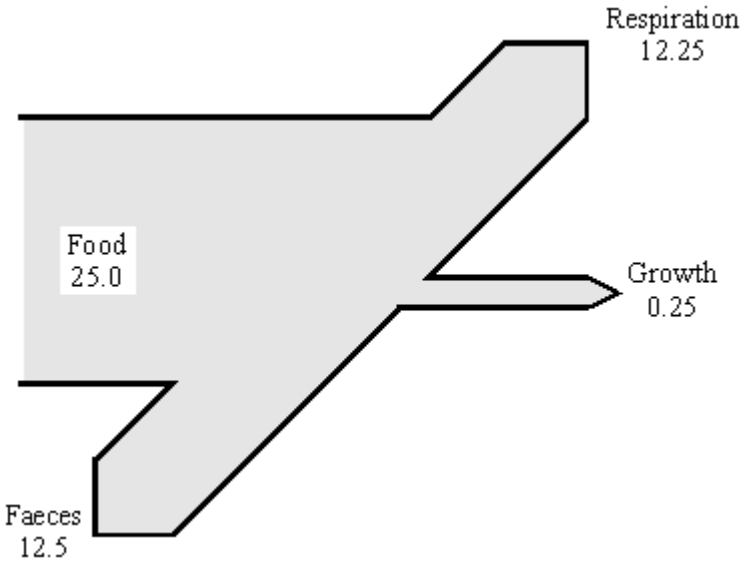
Glutton up a gum tree

Along the banks of the Cygnet River on Kangaroo Island, the branches of the dying gum trees stretch out like accusing fingers. They have no leaves. Birds search in vain for nectar-bearing flowers.

The scene, repeated mile upon mile, is an ecological nightmare. But, for once, the culprit is not human. Instead, it is one of the most appealing mammals on the planet – the koala. If the trees are to survive and provide a food source for the wildlife such as koalas that depend on them, more than 2000 koalas must die. If they are not removed the island's entire koala population will vanish.

Illegal killing has already started. Worried about soil erosion on the island, some farmers have gone for their guns. Why not catch 2000 koalas and take them to the mainland? "Almost impossible," says farmer Andrew Kelly. "Four rangers tried to catch some and in two days they got just six, and these fought, bit and scratched like fury."

The diagram shows the flow of energy through a koala.
The numbers show units of energy.



(i) Calculate the percentage of the food intake which is converted into new tissues for growth. Show your working.

_____ %

(2)

(ii) Give **three** different ways in which the koala uses the energy released in respiration.

1. _____

2. _____

3. _____

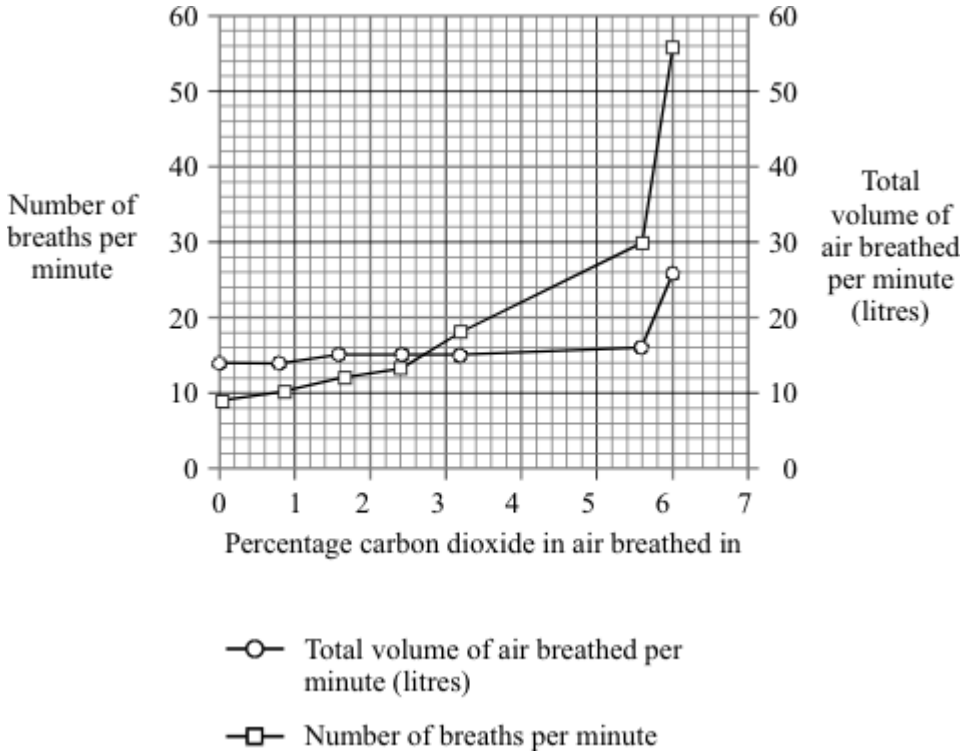
(3)

(Total 5 marks)

Q16.

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.



(i) Describe the effect of increasing the percentage of carbon dioxide in the inhaled air on the total volume of air breathed.

_____

_____

_____

_____

(2)

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

_____

_____

_____

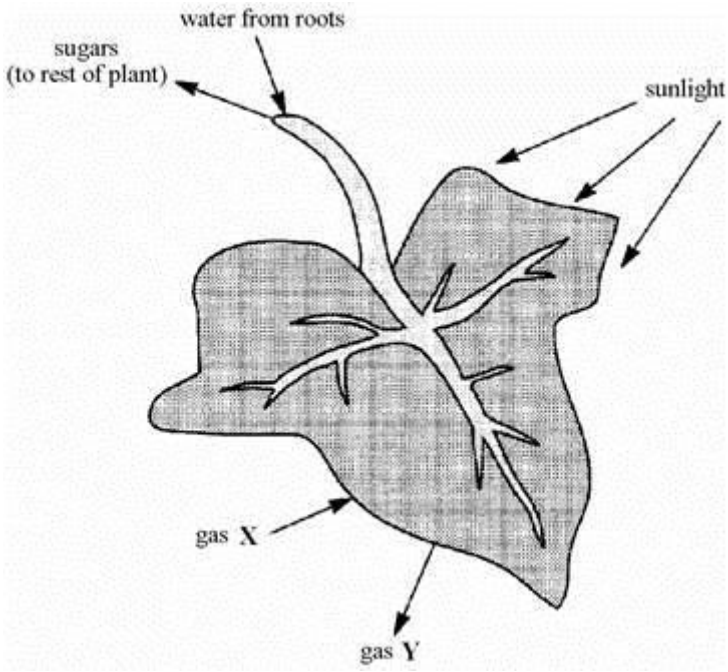
_____

(2)

(Total 4 marks)

Q17.

The diagram shows a plant leaf during photosynthesis.



(a) Name:

(i) gas **X**; _____

(ii) gas **Y**. _____

(2)

(b) Why is sunlight necessary for photosynthesis?

_____

_____

(1)

(c) Some of the sugars produced by photosynthesis are stored as starch in the roots. Explain, as fully as you can, why it is an advantage to the plant to store carbohydrate as starch rather than as sugar.

_____

_____

_____

_____

_____

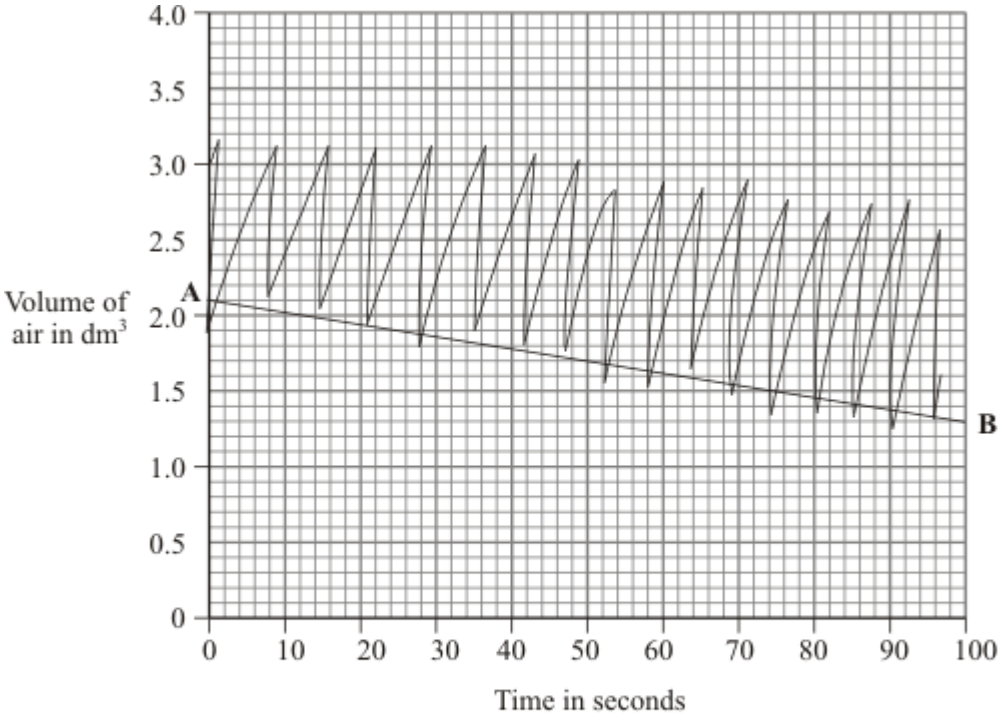
_____

(3)

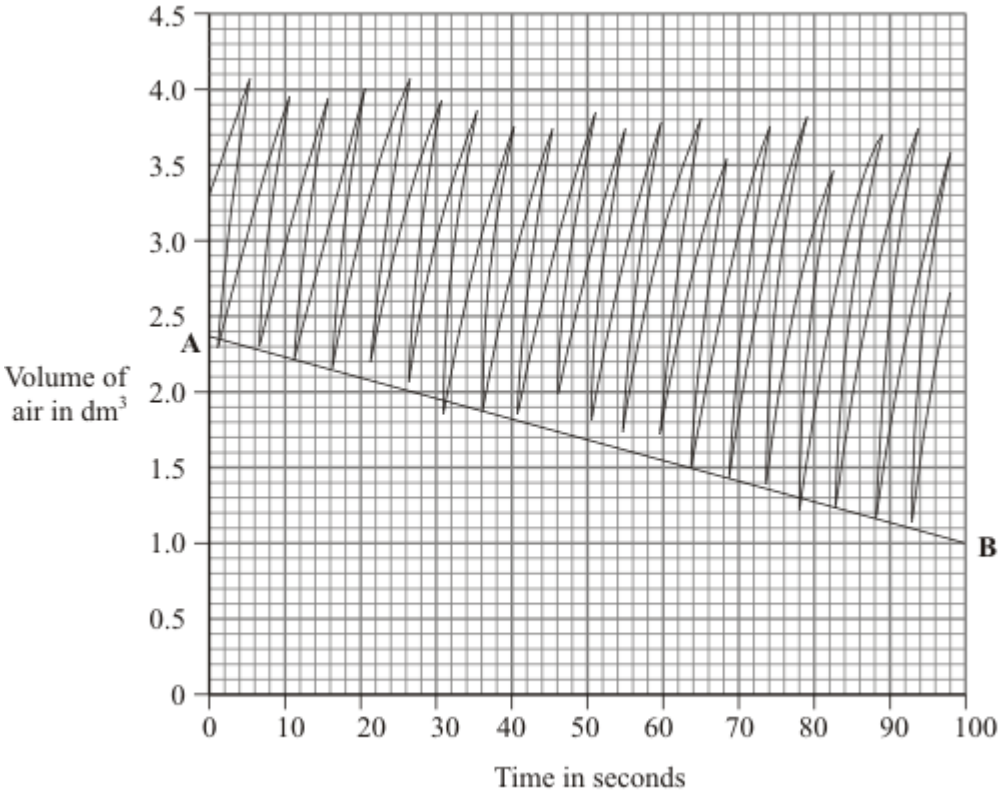
(Total 6 marks)

Q18.

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.



Before exercise



After exercise

(a) How many times did the student breathe in per minute:

before exercise; _____

after exercise? _____

(1)

(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.

Rate of oxygen use after exercise = _____ dm^3 per minute

(2)

(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?

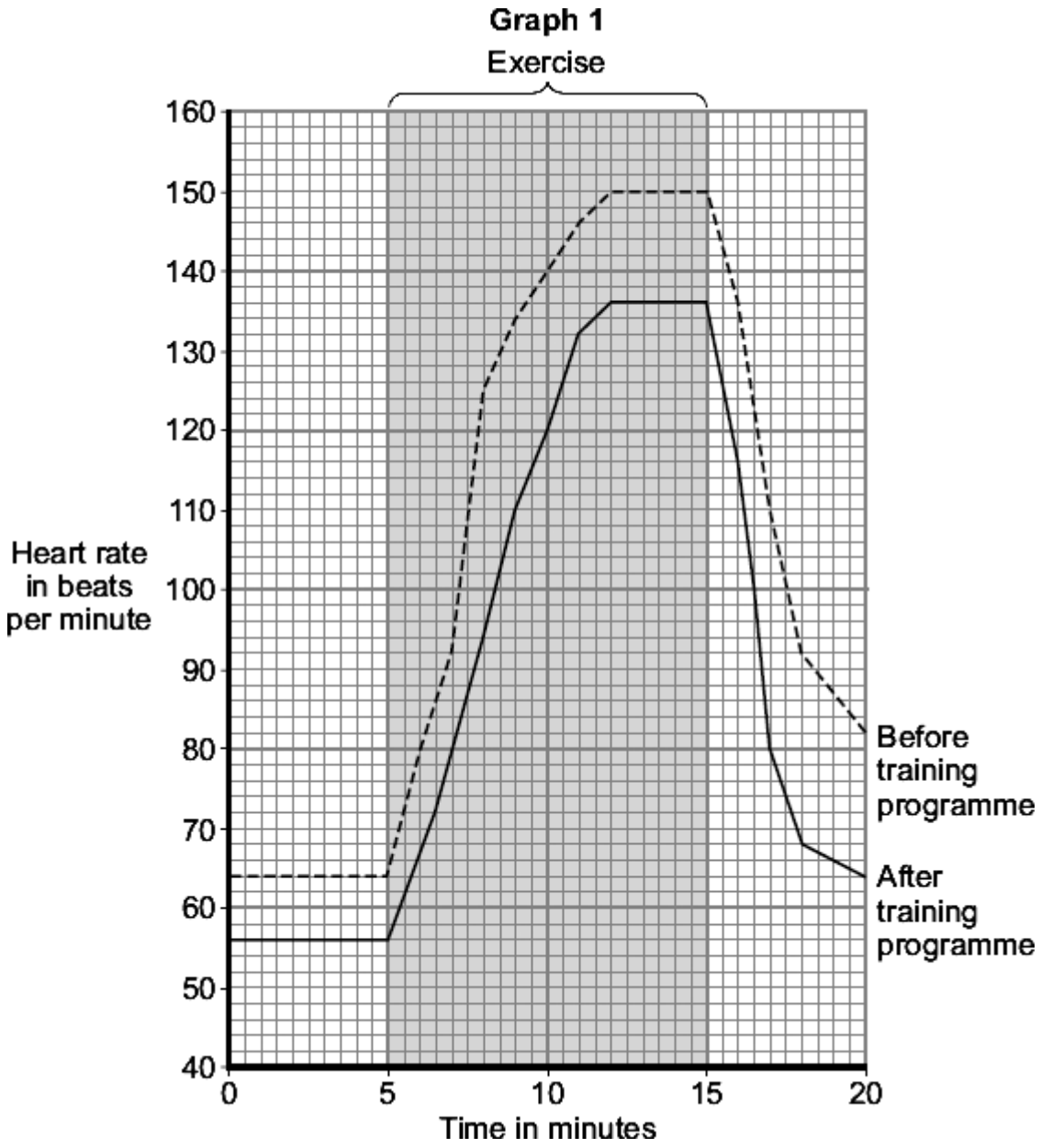
(4)

(Total 7 marks)

Q19.

An athlete carried out a 6-month training programme.

Graph 1 shows the effect of the same amount of exercise on his heart rate before and after the training programme.



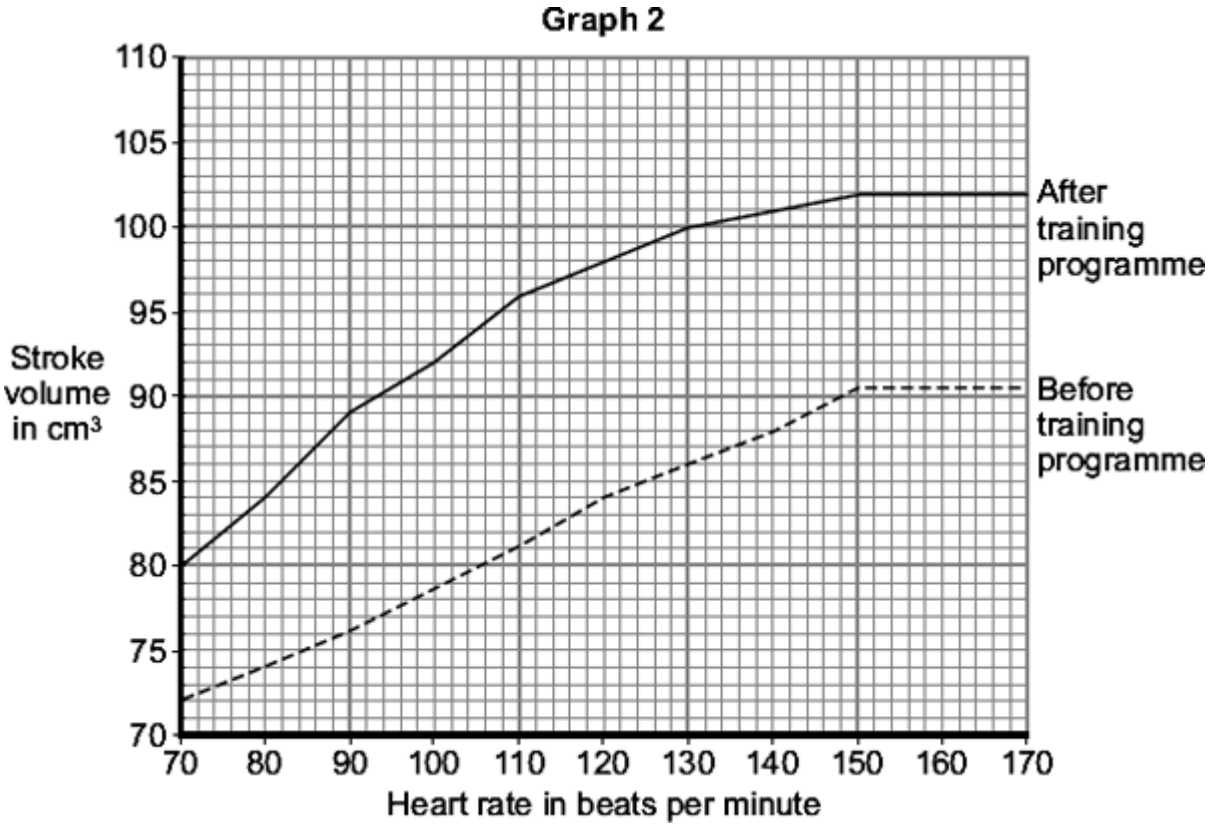
(a) (i) Use **Graph 1** to find the heart rate of the **trained** athlete 5 minutes after the start of the exercise.

Heart rate = _____ beats per minute

(1)

The stroke volume of the heart is the volume of blood pumped out of the left side of the heart in one heart beat.

Graph 2 shows the relationship between the stroke volume and the heart rate before and after the athlete did the training programme.



(ii) The *cardiac output* is defined as

cardiac output = heart rate × stroke volume

Calculate the cardiac output of the **trained** athlete 5 minutes after the start of the exercise. Use your answer to part (a)(i), and information from **Graph 2**.

Show clearly how you work out your answer.

_____

_____

Cardiac output = _____ cm^3 blood per minute

(2)

(b) **Graph 1** shows that, for the same amount of exercise, the heart of the trained athlete was beating more slowly than it did before the training programme.

Use information from **Graph 2** to explain why.

_____

_____

_____

_____

(2)

(c) An increased cardiac output will provide more oxygen and more glucose to the working muscles.

Explain how this helps the athlete during exercise.

(4)

(Total 9 marks)

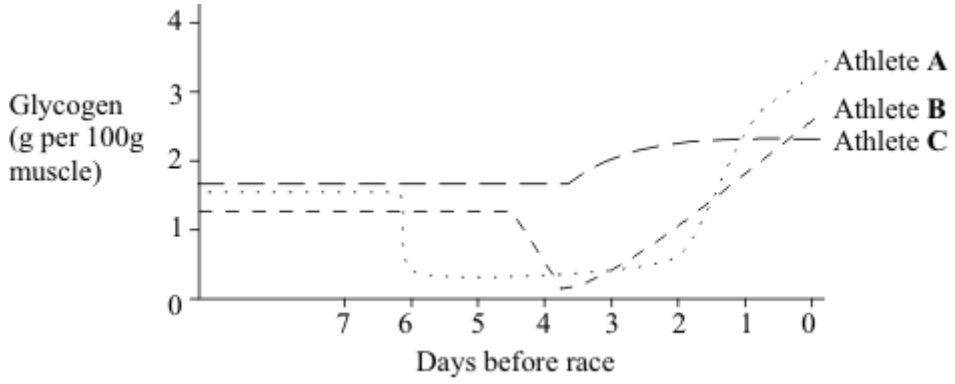
Q20.

Marathon runners are recommended to have a high carbohydrate diet prior to a race. Three athletes tried out three dietary regimes prior to a marathon race.

These three dietry regimes were as follows.

Athlete A	Up to 7 days before the race	-	Normal mixed diet
	7 days before the race	-	Prolonged extreme physical activity
	6-3 days before the race	-	Protein and fat diet; no carbohydrate
	2 and 1 days before the race	-	Large carbohydrate intake
Athlete B	Up to 5 days before race	-	Normal mixed diet
	5 days before the race	-	Prolonged extreme physical activity
	4-1 days before the race	-	Large carbohydrate intake
Athlete C	Up to 4 days before the race	-	Normal mixed diet
	4-1 days before the race	-	Large carbohydrate intake

The graph below shows the effect of each of these dietary regimes on glycogen levels in the athletes' muscles



(a) (i) What is the immediate effect of extreme physical activity on the glycogen

content of muscles?

(1)

(ii) Describe how this effect occurs.

(3)

(b) (i) Evaluate the three regimes as preparation for a marathon race.

(3)

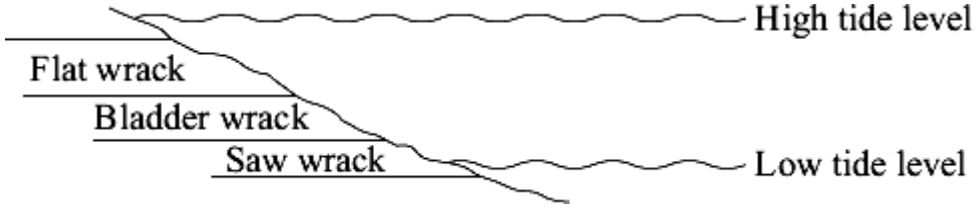
(ii) Suggest a possible explanation for the different effects of the three regimes.

(2)

(Total 9 marks)

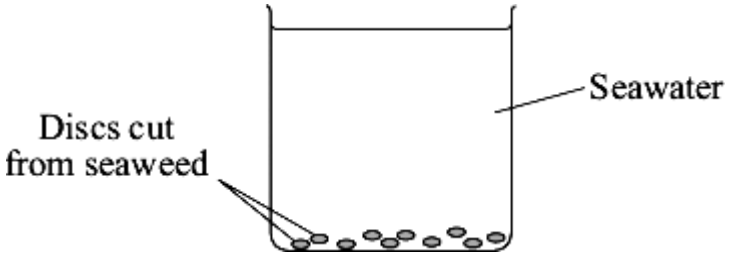
Q21.

The diagram shows where three seaweeds live on a seashore.
As the tide moves in and out, these seaweeds are covered with seawater for different lengths of time.



Some students investigated the rate of photosynthesis in these seaweeds.

- They cut ten small discs from one seaweed.
- They dropped the discs into seawater in a beaker.
- They recorded the time taken for the fifth disc to float to the surface.
- They repeated this experiment with the other two seaweeds.



(a) (i) Suggest why the discs floated to the surface.

_____

_____

(1)

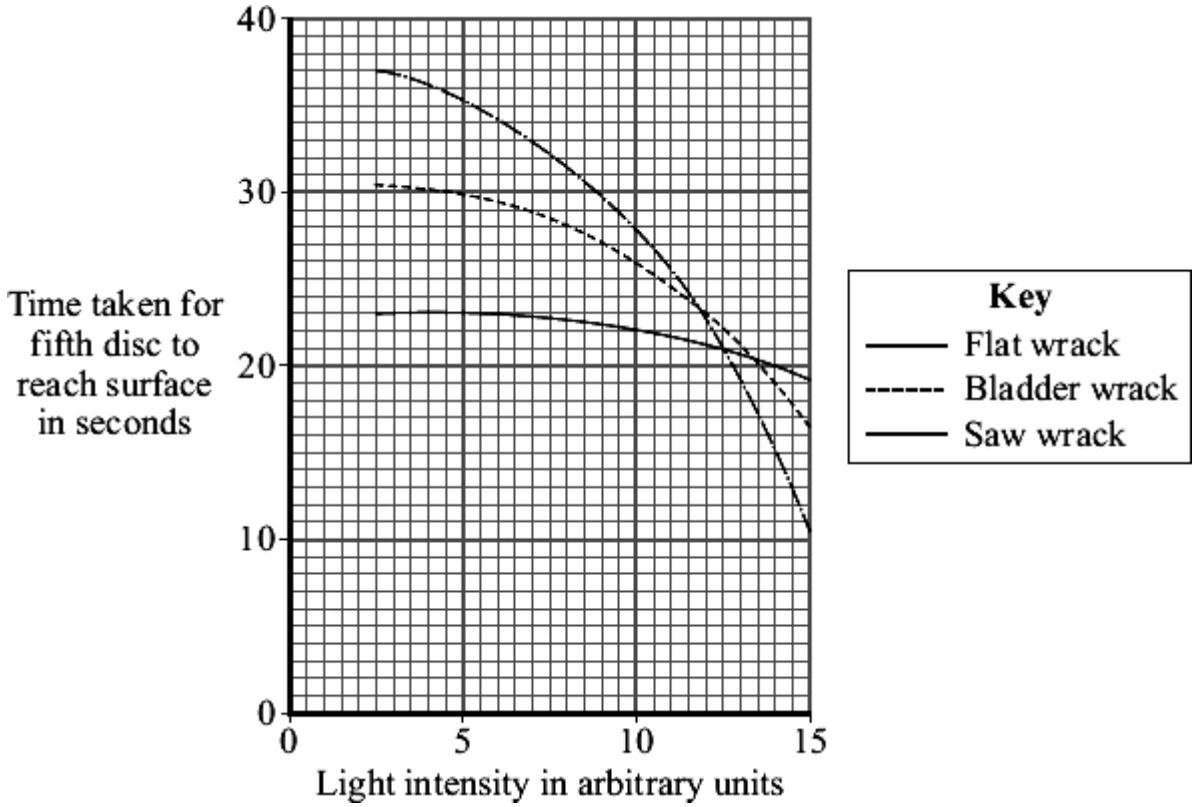
(ii) Suggest the advantage of recording the time taken for the fifth disc to reach the surface, rather than for the tenth disc.

_____

_____

(1)

(b) The students carried out their experiments at different light intensities.
The graph shows the results they collected.



(i) Compare the rate of photosynthesis for flat wrack with the rate for saw wrack at different light intensities.

_____

_____

_____

_____

(2)

(ii) Seawater absorbs light.

The growth rate of saw wrack is less than the growth rate of bladder wrack.

Suggest why.

_____

_____

_____

_____

(2)

(Total 6 marks)

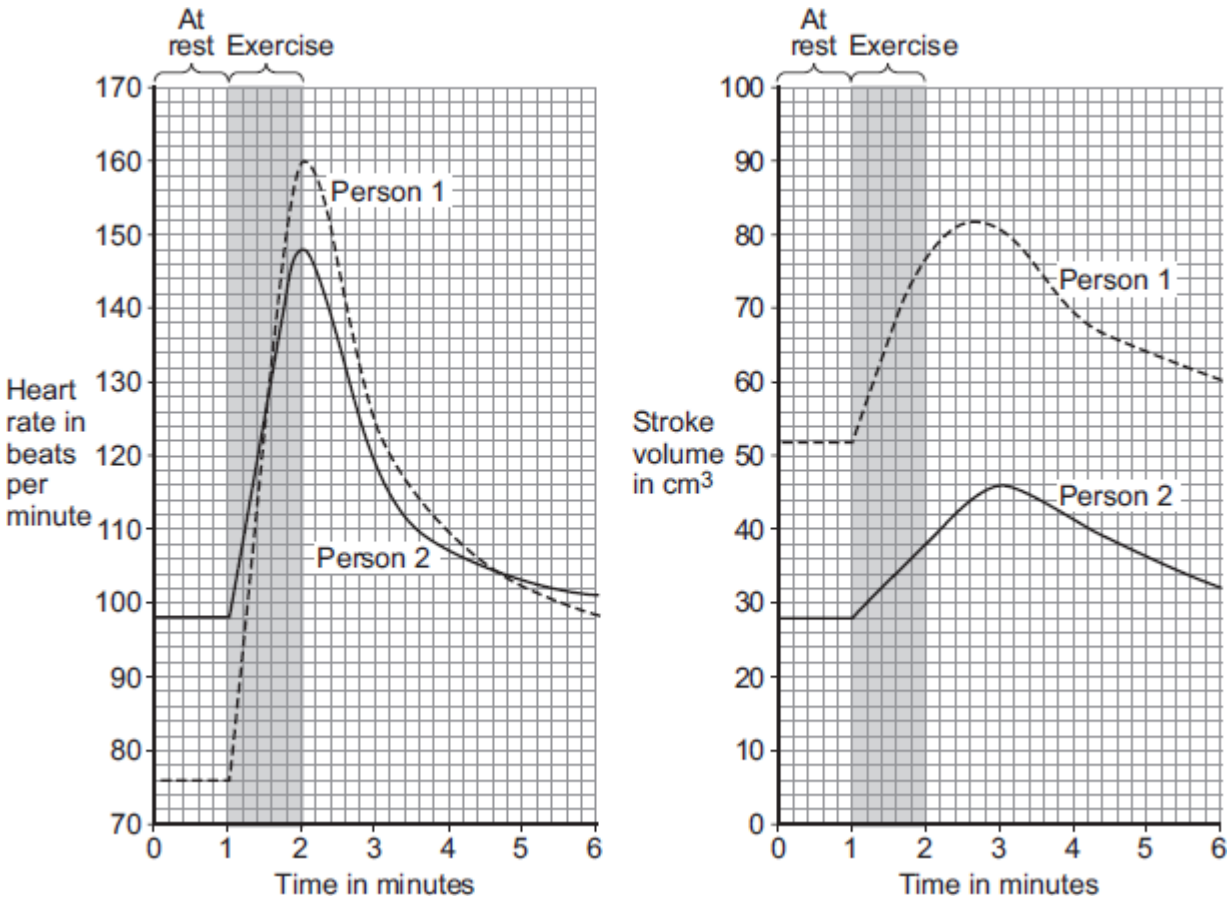
Q22.

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 **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 **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 **Figure above** and your own knowledge to explain why.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(Total 9 marks)

Q23.

Lactic acid production during exercise affects an athlete's performance.

Explain why lactic acid is produced during exercise.

_____

_____

_____

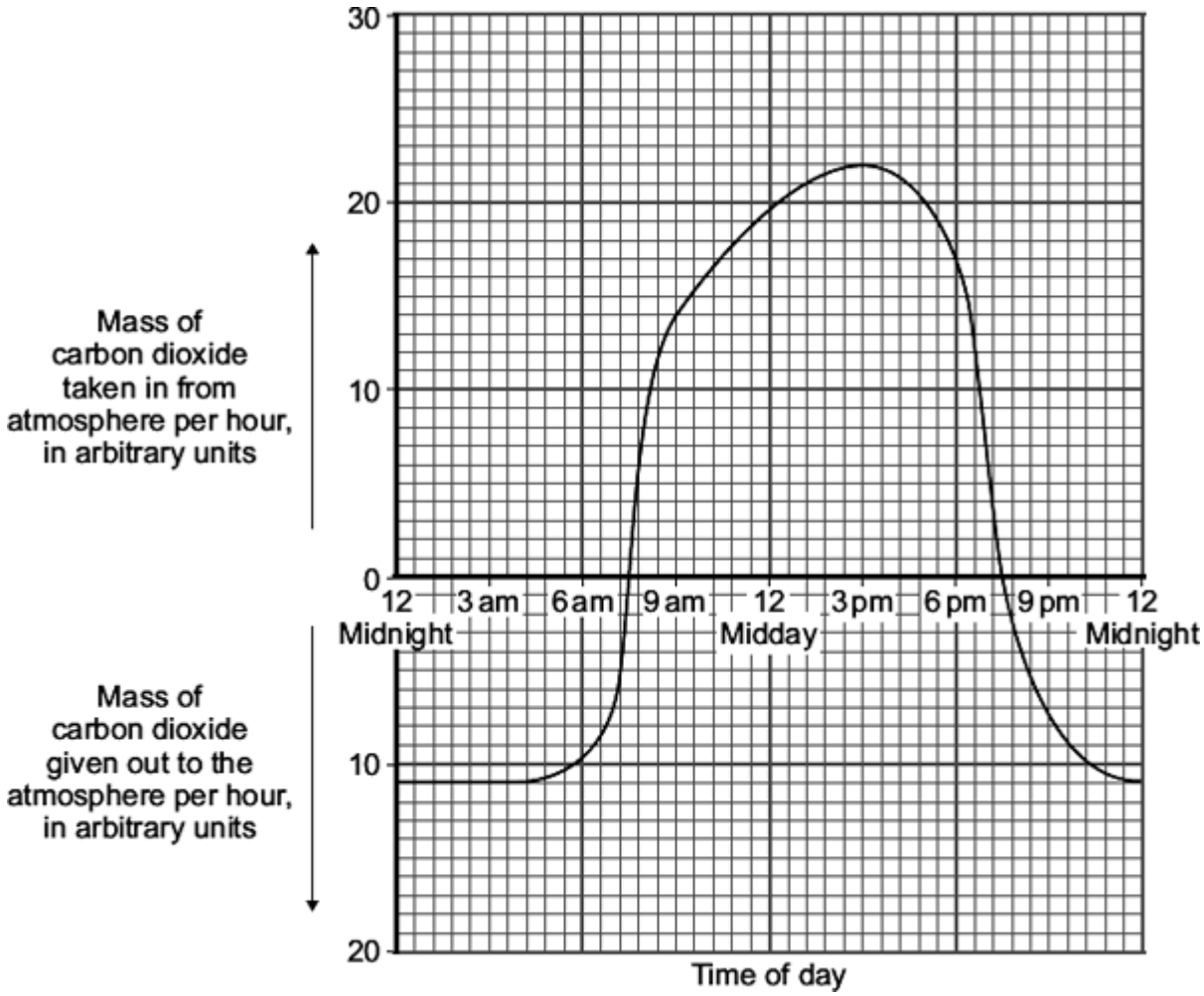
_____

_____

(Total 2 marks)

Q24.

The graph shows the uptake of carbon dioxide and the release of carbon dioxide by a bean plant on a hot summer's day.



(a) At which **two** times in the day did the rate of photosynthesis exactly match the rate of respiration in the bean plant?

1. _____

(1)

(b) The bean plant respires at the same rate all through the 24 hour period.

(i) How much carbon dioxide is released each hour during respiration?

_____ arbitrary units

(1)

(ii) How much carbon dioxide is used by photosynthesis in the hour beginning at 3 pm?

_____

_____

Answer = _____ arbitrary units

(1)

(c) Over the 24 hour period, the total amount of carbon dioxide taken in by the bean plant was greater than the total amount of carbon dioxide given out by the bean plant.

Explain, in detail, why this was important for the bean plant.

_____

_____

_____

_____

_____

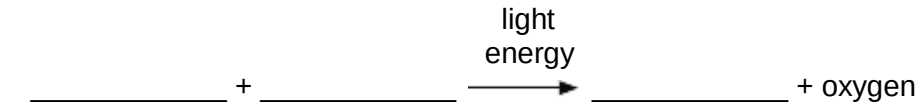
_____

(2)

(Total 5 marks)

Q25.

(a) Complete the equation for photosynthesis.



(2)

(b) Scientists investigated how temperature affects the rate of photosynthesis.
The scientists grew some orange trees in a greenhouse.
They used discs cut from the leaves of the young orange trees.

The scientists used the rate of oxygen production by the leaf discs to show the rate of photosynthesis.

(i) The leaf discs did not produce any oxygen in the dark.

Why?

_____

_____

(1)

(ii) The leaf discs took in oxygen in the dark.

Explain why.

_____

_____

_____

_____

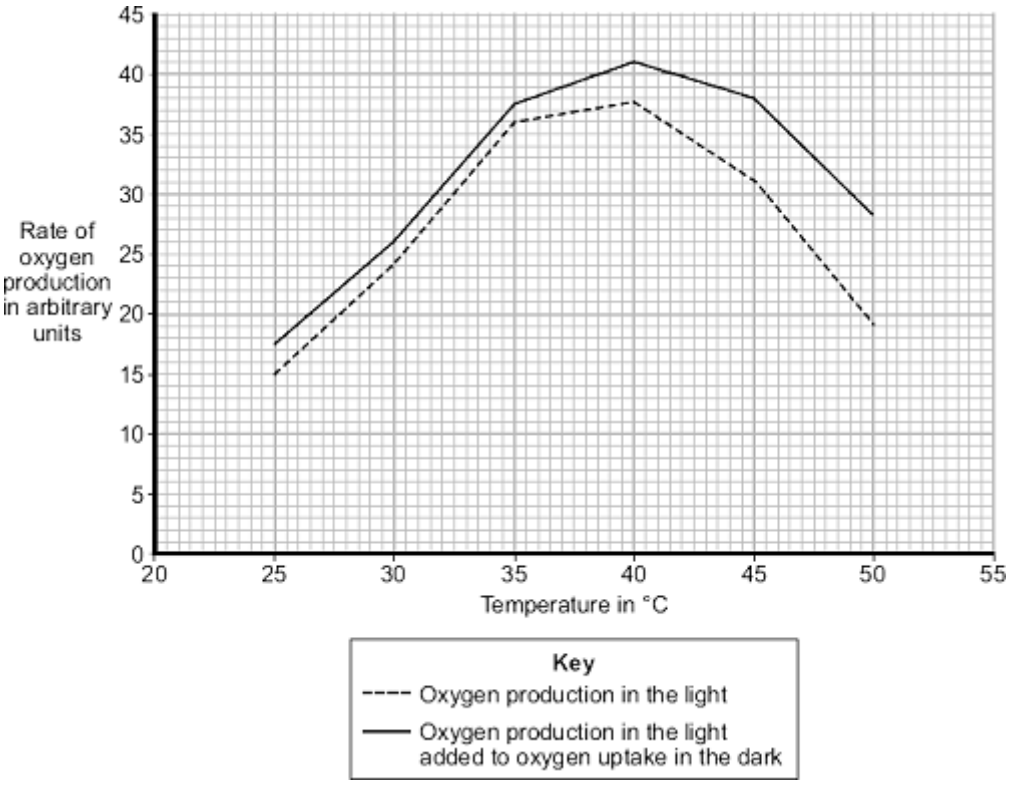
(2)

(c) In their investigation, the scientists measured the rate of oxygen release by the leaf discs in the light. The scientists then measured the rate of oxygen uptake by the leaf discs in the dark.

The graph shows the effect of temperature on

- oxygen production in the light

- oxygen production in the light added to oxygen uptake in the dark.



Use the information from the graph to answer each of the following questions.

(i) Describe the effect of temperature on oxygen production in the light.

_____

_____

_____

_____

(2)

(ii) Explain the effect of temperature on oxygen production in the light when the temperature is increased:

from 25 °C to 35 °C

_____

_____

_____

from 40 °C to 50 °C.

_____

_____

_____

(2)

(d) A farmer in the UK wants to grow orange trees in a greenhouse. He wants to sell the

oranges he produces at a local market.
He decides to heat the greenhouse to 35 °C.

Explain why he should **not** heat the greenhouse to a temperature higher than 35 °C.
Use information from the graph in your answer.

(3)

(Total 12 marks)

Q26.

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

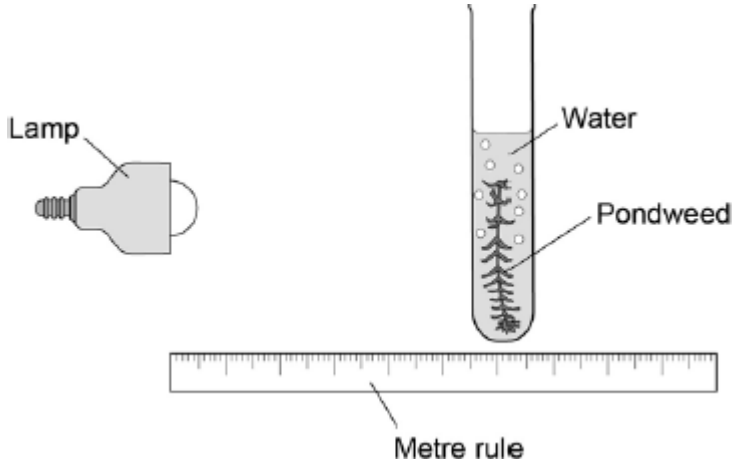
(a) The formula for glucose is $C_6H_{12}O_6$

Use the formula for glucose to write the balanced symbol equation for photosynthesis.

(2)

(b) **Figure 1** shows the apparatus the student used.

Figure 1



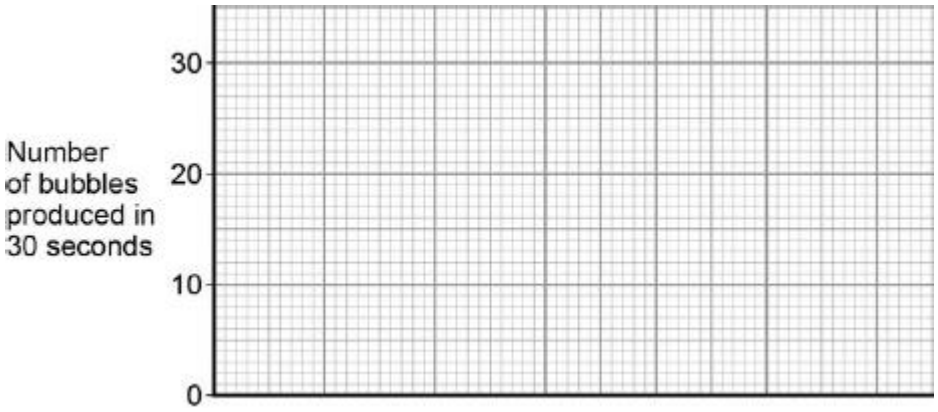
The student altered the distance of the lamp from the pondweed and counted the number of bubbles produced in 30 seconds for each distance.

The table below shows the student's results.

Distance in cm	Number of bubbles produced in 30 seconds
10	27
20	23
30	16
40	7
50	2

Use the data in the table above to complete the graph on **Figure 2**.

Figure 2



(3)

(c) The student concluded that the rate of photosynthesis is inversely proportional to the distance of the lamp from the pondweed.

Does the student's data support this conclusion?

Use data from **Figure 2** to justify your answer.

_____

_____

_____

_____

_____

_____

(3)

(d) The volume of one bubble can be calculated using the equation:

$$V = 4 / 3 \pi r^3$$

The radius of one bubble is 0.1 cm.

The value for π is 3.14

Use data from the table above and the information above to calculate the rate of gas production at a distance of 40 cm.

Give your answer in standard form to three significant figures.

_____

_____

_____

_____

_____

_____

_____

Rate of reaction = _____ cm^3 per minute

(5)

(Total 13 marks)

Q27.

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

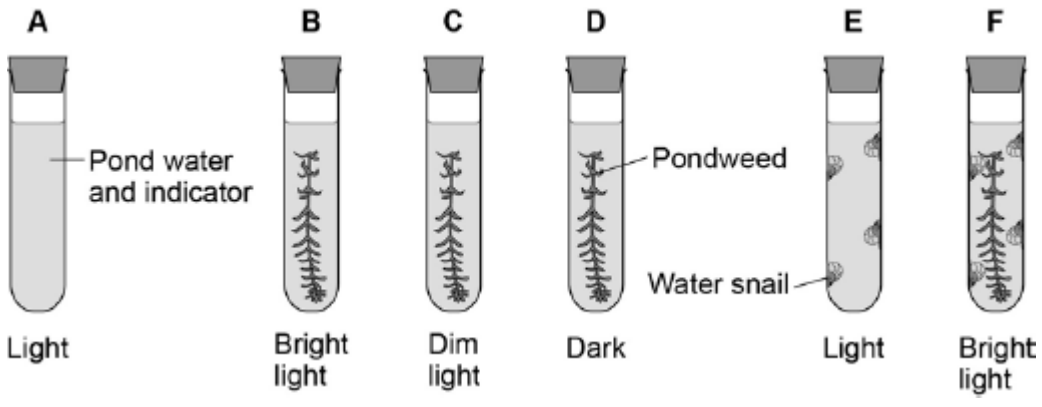
The student set up six boiling tubes as shown in the figure below.

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.

_____

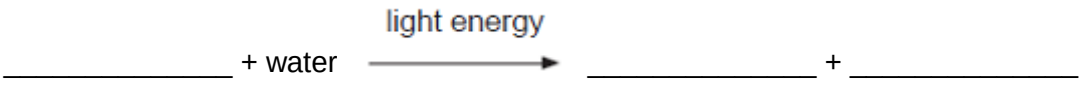
_____

(1)

(Total 6 marks)

Q28.

(a) Complete the equation for photosynthesis.



(3)

(b) The rate of photosynthesis in a plant depends on several factors in the environment.
These factors include light intensity and the availability of water.

Describe and explain the effects of **two other** factors that affect the rate of photosynthesis.

You may include one or more sketch graphs in your answer.

(5)
(Total 8 marks)

Q29.

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.

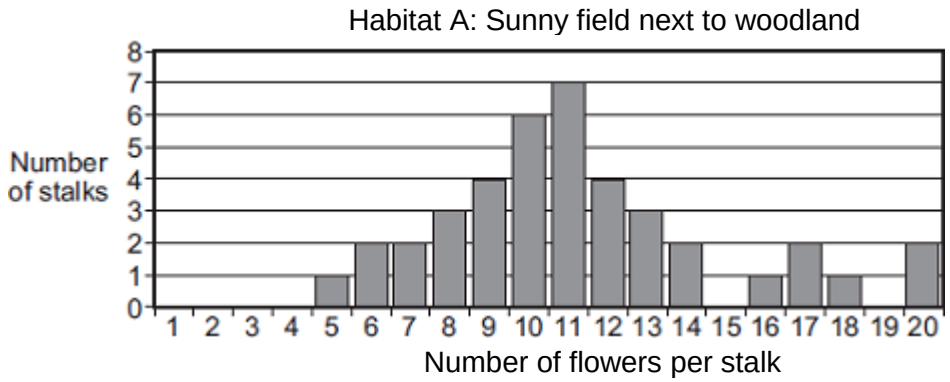
(4)
(Total 6 marks)

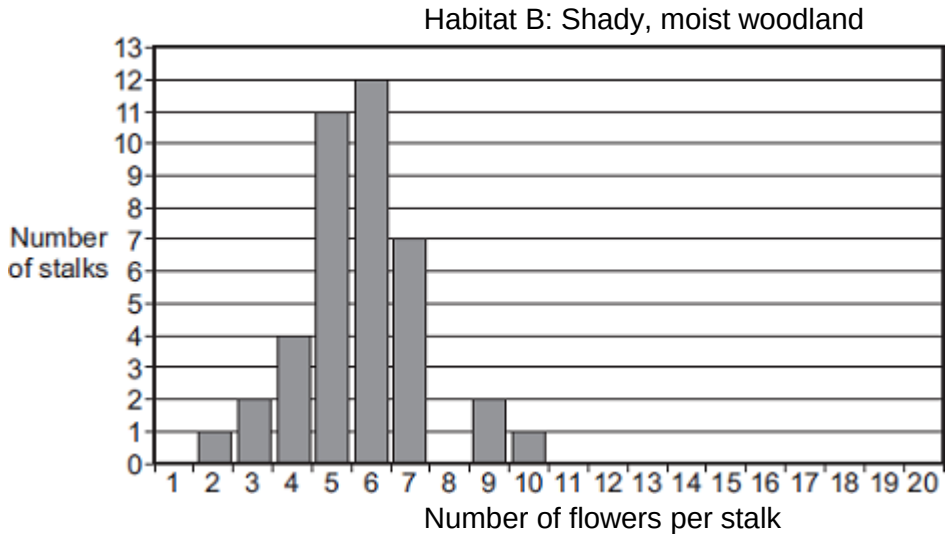
Q30.

Some students studied bluebell plants growing in two different habitats.

Habitat **A** was a sunny field next to woodland.
Habitat **B** was a shady, moist woodland.

A bluebell plant can have several flowers on one flower stalk. The students counted the number of flowers on each of 40 bluebell flower stalks growing in each habitat.
The bar charts show the results.





(a) The students wanted to collect valid data.
Describe how the students should have sampled the bluebell plants at each habitat to collect valid data.

(2)

(b) (i) The students used the bar charts to find the mode for the number of flowers per stalk in the two habitats.

The mode for the number of flowers per stalk in habitat **A** was 11.

What was the mode for the number of flowers per stalk in habitat **B**?

Mode = _____

(1)

(ii) The students suggested the following hypothesis:

'The difference in the modes is due to the plants receiving different amounts of sunlight.'

Suggest why.

_____

_____

_____

_____

(2)

(iii) Suggest how the students could test their hypothesis for the two habitats.

_____

_____

_____

_____

(2)

(c) Suggest how receiving more sunlight could result in the plants producing more flowers per stalk.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q31.

The UK contains large areas of peat bogs that have been present for thousands of years.

(a) Peat is removed from peat bogs.

The peat can be mixed with air and added to garden compost.

The release of carbon dioxide from peat is a problem.

Give **two other** reasons why gardeners should use less peat-based compost in the future.

1. _____

_____

2. _____

_____

(2)

(b) Explain why mixing peat with air leads to the release of carbon dioxide.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 6 marks)

Mark schemes

Q1.

(a) *idea*
O_2 increases
CO_2 decreases
for 1 mark each

2

(b) (i)

reduced	unchanged	increased
digestive system	brain	skin
bone		muscles
		heart and arteries

All (6) correct gains 4
5 correct gains 3
4 correct gains 2
2/3 correct gains 1

Correct wording not needed if unambiguous. No mark if organ repeated.

4

(ii) more/higher/quicker/faster
gains 1 mark

but
7500 more/from 5,000 to 12,500 more
gains 2 marks

but
7500 cm^3/min more
gains 3 marks

or 2½ times more

3

[9]

Q2.

any **six** from:

*only credit release of carbon dioxide **once** when linked to a correct process*

ignore references to burning

- (plants) photosynthesise
- *(plants)* take in carbon dioxide
- *(plants)* produce carbohydrates / fats / proteins
  accept produce glucose
- (carbon compounds transferred by) feeding
- respiration
- breaks down carbon compounds / carbohydrates
  accept glucose
- releases carbon dioxide
- organisms die / produce wastes / *excrete*
- (which are) decomposed / decayed by microorganisms

allow broken down

allow bacteria / fungi / microbes / decomposers

- (which) release carbon dioxide

[6]

Q3.

(a)
- appropriate scales (> halfway along each axis)
- all points correctly plotted to better than ½ a square
- lines carefully drawn

(*allow* point to point in this case)

N.B.

- no mark available for labelling axes
- *allow* either orientation

for 1 mark each

3

(b) (i) *ideas that*

- energy transferred faster in 100m race

(*not* more energy transferred)

- carbon dioxide produced faster during 1500m race

for 1 mark each

(*allow* more carbon dioxide produced)

correct reference to twice / half as fast in either / both cases

for 1 further mark

3

(ii)
- respiration during 100m race (mainly) anaerobic
- respiration during 1500m race aerobic
- aerobic respiration produces carbon dioxide
- anaerobic respiration doesn't produce carbon dioxide / produces lactic acid

any two for 1 mark each

2

(c) *ideas that*

- there is an oxygen debt / more than normal oxygen needed
- lactic acid needs to be oxidised / combined with oxygen

for 1 mark each

2

[10]

Q4.

plants absorb CO_2 for photosynthesis

ignore carbon

1

all organisms / any named organism respire(s) and release(s) CO_2

ignore breathing

ignore carbon

1

any **four** from:

- carbon compounds / named compound made by plants
- plants eaten by animals
- dead organisms / faeces are decomposed / decayed

  allow broken down
- by bacteria / microorganisms
- dead plants and animals (may) form fossil fuels
- when (fossil) fuels are burnt they release CO_2 into the air

4

[6]

Q5.

(a) microorganisms / bacteria / fungi

allow correct named organisms

allow detritus feeders / decomposers / worms

1

break down / digest / feed on (dead organisms)

accept use carbohydrates / glucose

allow decomposes

ignore decay / rot

1

(and release carbon dioxide when they) <u>respire</u>

*do **not** allow respiration if linked to leaves / dead organisms*

1

(b) any **two** from:

- the higher the temperature the faster the rate of decay

  allow faster / more carbon dioxide for faster rate of decay
- the higher the oxygen concentration the faster the rate of decay

  allow faster / more carbon dioxide for faster rate of decay
- the rate increases faster (with increasing oxygen concentration) at 20 °C (than 15 °C)

2

[5]

Q6.

read 'the gas' or 'it' as carbon dioxide

(plants) photosynthesise

1

(plants) absorb <u>carbon dioxide / CO_2</u> (from the air)

allow take in / use <u>carbon dioxide / CO_2</u> (from the air)

1

(overall) <u>more carbon dioxide / CO_2</u> is being released into the air than is being removed

*allow 470 (billion tonnes) released **but / and** 450 (billion tonnes) taken in*

1

(by) <u>respiration</u> (by all organisms / any named organism)

ignore breathing

ignore carbon

1

(and) combustion / burning

ignore carbon

1

(so) amount of <u>carbon dioxide / CO_2</u> in air is increasing

allow 20 (billion tonnes) of <u>carbon dioxide / CO_2</u> added to air each year

1

[6]

Q7.

carbon dioxide concentration

1

since atmospheric concentration very low / value give e.g. 0.03%

allow carbon dioxide used up

1

temperature high

allow if light chosen as a factor

1

light intensity high

allow If temperature chosen as a factor

1

[4]

Q8.

(nitrate) ions are absorbed by active transport

1

(active transport) is the movement of ions against the concentration gradient

allow (active transport) is the movement of ions from a dilute to a more concentrated solution

1

(active transport) requires energy from respiration

1

(respiration) requires oxygen

1

no / little oxygen / air in water-logged soil

1

[5]

Q9.

(a) + light = + photosynthesis
+ light = + photosynthesis to a limit
limit depends on temp/CO_2 levels
+ CO_2 = + photosynthesis
+ temp = + photosynthesis

each for 1 mark

5

(b) need to raise optimum levels
when one other raised
to get max/economic yield

each for 1 mark

2

[7]

Q10.

(a) diatoms photosynthesise **or** are producers

1

the amount of growth depends upon the energy **or** light they get

accept more light means more growth
or *they multiply more in more light*
do not accept they need light

1

(b) (i) eaten by small fish

do not accept eaten by fish

1

minerals **or** nitrate **or** phosphates
or nutrients **or** food supply used up
or reduced

1

(ii) any **two** from

gets colder
light decreases
end of their life span **or** die

accept more being eaten than being formed

eaten by small fish

do not accept a decrease in nitrates
or *phosphates*

1

(c) increased minerals **or** nitrates **or** phosphates

1

any **one** from

due to death **or** decay of diatoms **or** fish

do not accept death of large fish

1

influx of minerals in an ocean current

*do not accept extraneous pollution **or** dumping by a ship*

1

[8]

Q11.

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

energy is neutral

1

formulae all correct

with no omissions / deletions

correctly balanced

credit 1 mark if the answer is the exact reverse of an incorrect answer for (a)

1

(ii) and **three** from

take up of (soluble) substances / ions against the concentration gradient

***or** when the concentration (of the substance / ions) is greater inside the cell / cytoplasm than outside it*

through the (semi-permeable) (cell) membrane energy from mitochondria

***or** energy from respiration*
not just energy

3

[5]

Q12.

(a) No

no mark
if yes max 1 for correct statement

diffusion is down the concentration gradient

accept by diffusion ions would leave the root

1

to enter must go up / against the concentration gradient
or concentration higher in the root
or concentration lower in the soil

1

(b) (i) 0.9 **or** 3.25

for correct answer with or without working
*if answer incorrect 1.3 **or** their rate – 0.4 gains 1 mark*
***or** 130 – 40 **or** 90 gains 1 mark*

2

(ii) (uptake) by active transport

1

requires energy

more energy from aerobic respiration

1

or

more energy when oxygen is present

1

[7]

Q13.

(a) low in winter / named months /when the days are short

accept increases in spring / Dec – June

1

high in summer / named month(s) / (when days are long

decreases in autumn / June – December

1

reasonable quantitative statement

accept any reasonable calculated / translated quantitative statement

higher in summer than in winter for 2 marks
comparative statements may be worth 2 marks
but
8/11 times higher in summer than in winter for 3 marks

1

(b) no artificial light given in summer / light only given in winter

since natural light greatly exceeds minimum / 600 J (required to produce tomatoes)

accept day length if linked to light energy

OR

light only given in winter

as natural light less than the minimum needed (to grow them) or 600 J

OR

for 2 marks:
percentage increase in growth from artificial] light only significant in winter

2

[5]

Q14.

(a) (i) increase (and then level off) **and** max / up to at 0.15 (%) (carbon dioxide)

ignore references to oxygen concentration only

ignore mention of 23

1

(ii) $\underline{CO_2}$ is limiting at low CO_2 / at first

ignore specific numbers

1

light is limiting at high CO_2 / at end

1

(b) ***mark both parts together***

effect: (oxygen) falls

1

explanation: (oxygen) used for respiration

if no other marks *awarded allow (effect) no change* ***and*** *(explanation) no photosynthesis for* ***1*** *mark*

1

(c) more chlorophyll / chloroplasts

1

allows more photosynthesis / description

for both marks must refer to more at least once

1

[7]

Q15.

(i) 0.25 × 100 / 25

gains 1 mark

but

1%

gains 2 *marks*

2

(ii) muscle contraction / limb movement / moving around / chewing
heartbeat / breathing / internal muscle activity
maintaining body temperature / keeps body warm
active uptake synthesising substances (*reject* growth)

any three for 1 mark each

3

[5]

Q16.

(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

2

(ii) *idea that*
depth of breathing changes at low % carbon dioxide, in crease in % CO_2 results in volume of each breath increasing without increase / little increase in number of breaths

each for 1 mark

2

[4]

Q17.

(a) (i) carbon dioxide / CO_2 (*reject* CO)

(ii) oxygen / O_2 / O (water vapour neutral)

for 1 mark each

2

(b) (provides) energy

for one mark

1

(c) starch insoluble therefore water not taken in by osmosis

or

sugar is soluble / has small molecules may diffuse out therefore lost

*(*ignore *ref. to cells bursting)*

or

starch has large molecules

cannot diffuse therefore retained

for 1 mark each

3

[6]

Q18.

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

***both** correct*

1

(b) 0.75 to 0.90

ignore working or lack of working

eg. 2.35 – 1.55 ***or*** $\frac{(2.35-1.0)\times 60}{100}$ ***or*** *other suitable figures*

*for **1** mark*

2

(c) any **four** from:

still need to remove <u>extra</u> 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]

Q19.

(a) (i) 120

1

(ii) 11 760 **or**
correct answer from candidate's answer to (a)(i)
correct answer with or without working
if answer incorrect
120 × 98 ***or***
candidate's answer to (a)(i) × corresponding SV gains ***1*** *mark*
if candidate uses dotted line / might have used dotted line(bod) in (a)(i) ***and*** *(a)(ii) no marks for (a)(i) but allow full ecf in (a)(ii) eg 140 x 88 = 12320 gains* ***2*** *marks*

2

(b) trained athlete has higher stroke volume / more blood per beat

1

same volume blood expelled with fewer beats

or for same heart rate more blood is expelled

1

(c) increased aerobic respiration

or

decreased anaerobic respiration
allow correct equation for aerobic respiration
accept don't have to respire anaerobically

1

increased energy supply / need

1

less lactic acid formed

or to breakdown lactic acid **or** less O_2-debt

1

can do more work **or** can work harder / faster / longer
accept muscle contraction for work

or less fatigue / cramp / pain

1

[9]

Q20.

(a) (i) reduced sharply
for 1 mark

1

(ii) converted to glucose which is respired to produce energy
(allow answers in terms of glucagon)
gains 3 marks

3

(b) (i) athlete A's was most effective
since resulted in highest muscle glycogen level on day of race
for energy release during race

for 1 mark each

3

(ii) e.g. excess carbohydrate stored as glycogen rather than fat in short term
particularly if glycogen stores depleted

for 1 mark each

2

[9]

Q21.

(a) (i) oxygen produced

1

(ii) any **one** from:

- average / mean / median
  ignore reliable / precise / accurate
- some may be anomalous
  allow some may not float

1

(b) (i) *do **not** allow answers in terms of time only*
*if candidate answers in terms of comparing rate of change then the rate of change of photosynthesis must be in the correct direction for **1** mark*

any **two** from:

- low intensity / below 12.5 / 2.5 - 12.5 (units of light) flat wrack /it, rate of photosynthesis faster **or** saw wrack rate of photosynthesis slower
  allow any value in range
- high intensity / above 12.5 / 12.5 - 15 (units of light) flat wrack / it,rate of photosynthesis slower **or** saw wrack rate of photosynthesis faster
  allow any value in range
- same (rate) at 12.5 units

2

(ii) any **two** from:

- saw wrack receives less light
  accept converse if clear reference to bladder wrack
- less photosynthesis
  if first and second responses, 'less' needed only once

  or
  less carbohydrate / sugar / starch production
- when tide is in **or** at high tide **or** any tide above low tide
  accept saw wrack covered by water / submerged longer /

more

reference to position on shore is insufficient

2

[6]

Q22.

(a) 5624

***allow 2 marks** for:*

- *correct HR = 148 **and** correct SV = 38 plus wrong answer / no answer*

or

- *only one value correct **and** ecf for answer*

***allow 1 mark** for:*

- *incorrect values **and** ecf for answer*

or

- *only one value correct*

3

(b) (i) **Person 2** has low(er) stroke volume / SV / described

*eg **Person 2** pumps out smaller volume each beat*

*do **not** allow **Person 2** has lower heart rate*

1

(ii) **Person 1** sends <u>more blood</u> (to muscles / body / lungs)

1

(which) supplies (more) oxygen

1

(and) supplies (more) glucose

1

(faster rate of) respiration **or** transfers (more) energy for use

ignore aerobic / anaerobic

allow (more) energy release

allow aerobic respiration transfers / releases more energy (than anaerobic)

*do **not** allow makes (more) energy*

1

removes (more) CO_2 / lactic acid / heat

allow less oxygen debt

or less lactic acid made

or (more) muscle contraction / less muscle fatigue

if no other mark awarded,

allow person 1 is fitter (than person 2) for max 1 mark

1

[9]

Q23.

insufficient / no oxygen available

1

for (just) aerobic <u>respiration</u>

or
<u>respires</u> anaerobically

1

[2]

Q24.

(a) 7.15 to 7.45 <u>am</u> **and** 7.15 to 7.45 <u>pm</u>

both *required, either order*
accept in 24 hr clock mode

1

(b) (i) 11

1

(ii) 32.5 to 33

allow answer to (b)(i) + 21.5 to 22

1

(c) any **two** from:

- more photosynthesis than respiration
- more biomass / carbohydrate made than used
  allow more food made than used
- so plant able to grow / flower
  accept plant able to store food

2

[5]

Q25.

(a) LHS: carbon dioxide **AND** water

in either order
accept CO_2 ***and*** H_2O
allow CO2 and H2O
if names given ignore symbols
do ***not*** *accept* CO^2 / H^2O / *Co / CO*
ignore balancing

1

RHS: sugar(s) / glucose / starch / carbohydrate(s)

accept $C_6H_{12}O_6$
allow C6H12O6
do ***not*** *accept* $C^6H^{12}O^6$

1

(b) (i) light is needed for photosynthesis

or

no photosynthesis occurred (so no oxygen produced)

1

(ii) oxygen is needed / used for (aerobic) respiration

full statement

*respiration occurs **or** oxygen is needed for anaerobic respiration gains **1** mark*

2

(c) (i) (with increasing temperature) rise then fall in rate

1

use of figures, ie

max. production at 40 °C
or maximum rate of 37.5 to 38

1

(ii) <u>25 – 35 °C</u>

either faster movement of particles / molecules / more collisions
or particles have more energy / enzymes have more energy

1

or temperature is a limiting factor over this range

<u>40 – 50 °C</u>

denaturation of proteins / enzymes

ignore denaturation of cells
ignore stomata

1

(d) above 35 °C (to 40 °C) – little increase in rate
or > 40 °C – causes decrease in rate

1

so waste of money **or** less profit / expensive

1

because respiration rate is higher at > 35 °C
or
respiration reduces the effect of photosynthesis

1

[12]

Q26.

(a) $6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

correct reactants

1

correct products

1

(b) correct scale and label on x axis

1

all 5 plots correct

tolerance ±½ small square
*allow 2 or 3 plots correct for **1** mark*

2

(c) no

no mark

although as distance increases, rate decreases

1

the line curves **or** line should be straight

1

suitable data quoted

examples:

- *supports conclusion between 20–40 (cm)*
- *does not support conclusion between 10–20 (cm)*

1

(d) volume of 1 bubble = $4 / 3 \times 3.14 \times (0.1)^3$

1

= 0.00419

1

at 40 cm there are 7 bubbles

1

vol at 40 cm = 0.02933

allow ecf from incorrect value taken from table

1

Rate per minute = × 2

= 5.86×10^{-2} (cm^3 per min)

*allow 5.86×10^{-2} with no working shown for **5** marks*

1

*answer not given in standard form or to incorrect number of sig. figs max **4** marks*

[13]

Q27.

(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]

Q28.

(a) LHS – carbon dioxide / CO_2

allow CO2

ignore CO^2

1

RHS

in either order

glucose / carbohydrate / sugar

allow starch

allow $C_6H_{12}O_6$ / C6H12O6

ignore $C^6H^{12}O^6$

1

oxygen

allow O_2 / O2

ignore O^2 / O

1

(b) any **five** from:

- factor 1: CO^2 (concentration)
- effect - as CO_2 increases so does rate and then it levels off or shown in a graph
- explanation:
  (graph increases) because CO_2 is the raw material or <u>used</u> in photosynthesis / converted to organic substance / named eg
  or
  (graph levels off) when another factor limits the rate.

  accept points made via an annotated / labelled graph
- factor 2: temperature

  allow warmth / heat
- effect – as temperature increases, so does the rate and then it decreases or shown in a graph

  allow 'it peaks' for description of both phases
- explanation:
  (rise in temp) increases rate of chemical reactions / more kinetic energy

  allow molecules move faster / more collisions

  or
  (decreases) because the enzyme is denatured.

  context must be clear = high temperature

  allow other factor plus effect plus explanation:

  eg light wavelength / colour / pigments / chlorophyll / pH / minerals / ions / nutrients / size of leaves

  2^{nd} or 3^{rd} mark can be gained from correct description and explanation

5

[8]

Q29.

(a) light is trapped / absorbed / used

extra answers cancel mark

ignore solar / sunshine

1

by chlorophyll / chloroplasts

if no other marks awarded, allow 1 mark for photosynthesis / equation for photosynthesis

1

(b) (to make) starch (for storage)

ignore 'for growth' unqualified

ignore respiration

1

(to make) fat / oil (for storage)

1

(to make) amino acids / proteins / enzymes

1

(to make) cellulose / cell walls

allow for active transport

allow any other correct, named organic substances (eg DNA / ATP / chlorophyll / hormone)

*if no named examples, allow 'to make **named** cell structures' for max. 1 mark*

1

[6]

Q30.

(a) use of quadrat / point frame

allow description

1

randomly placed / random sampling

ignore reference to transects

1

(b) (i) 6

1

(ii) more light in A / in field / where sunny

ignore sun

1

more / better / faster photosynthesis in A / with more light

allow converse

1

(iii) use light meter / measure light intensity in both habitats

1

take many measurements at same time of the day

1

or

laboratory / field investigation with 2 batches high light and low light (1)

count or number of flowers in each (1)

counting point is dependent on investigation point

(c) more glucose / energy available

allow other named product eg protein

allow if more energy produced

1

for growth

dependent on 1st mark

1

[9]

Q31.

(a) reduces biodiversity

1

peat is being used faster than it forms

allow peat is non-renewable

1

(b) decay / decomposition / rotting of peat

1

by microorganisms / bacteria / microbes / fungi / decomposers introduced when peat is mixed with air

1

that respire using substances in peat as reactant

1

and using oxygen that is introduced when peat is mixed with air

1

[6]