

Photosynthesis 1

Name: _____

Class: _____

Date: _____

Time: **78 minutes**

Marks: **72 marks**

Comments:

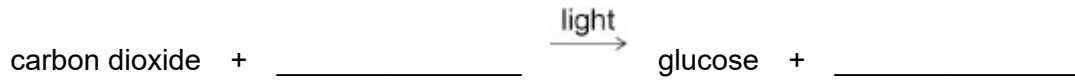
1.

This question is about photosynthesis.

(a) Complete the equation for photosynthesis.

Choose answers from the box.

nitrogen	oxygen	ethanol	water
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(2)

(b) What is the chemical formula for glucose?

Tick (✓) **one** box.



(1)

(c) Give **two** ways plants use the glucose produced by photosynthesis.

1 _____

2 _____

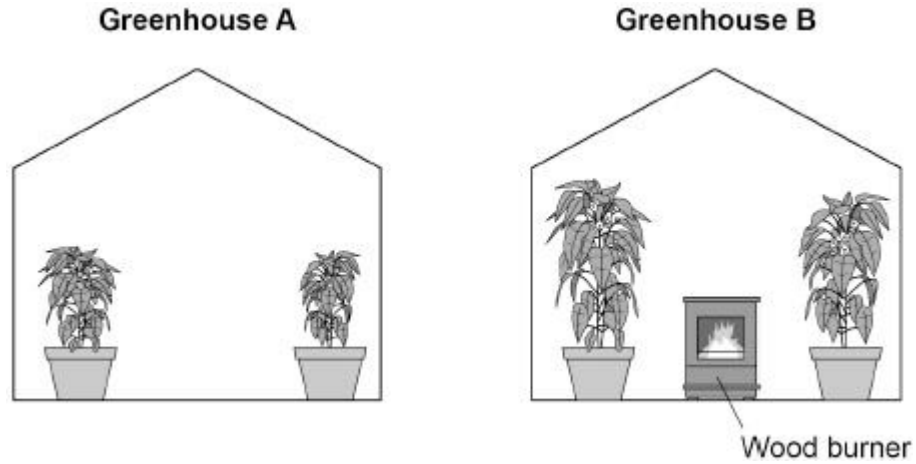
(2)

(d) A person has two greenhouses.

In each greenhouse, the plants:

- are all the same type
- receive the same intensity of light and the same volume of water
- grow in the same type of soil.

The figure below shows the greenhouses.



The person burns logs in the wood burner in greenhouse **B**.

Explain why the plants in greenhouse **B** grow faster than the plants in greenhouse **A**.

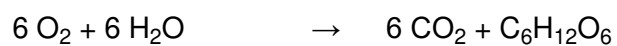
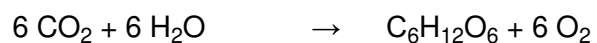
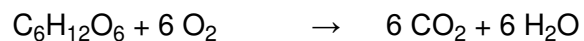
(4)
(Total 9 marks)

2.

This question is about photosynthesis.

(a) What is the symbol equation for photosynthesis?

Tick (✓) **one** box.



(1)

A student investigated the relationship between temperature and the rate of photosynthesis.

The student measured the volume of gas produced by an aquatic plant in 1 hour.

The student collected the gas in a measuring cylinder.

The table below shows the results.

Temperature in °C	Volume of gas produced in 1 hour in cm ³
10	1
15	2
20	4
25	8
30	16
35	16
40	2
45	0

(b) Describe the effect of increasing temperature on the **rate** of photosynthesis.

Use data from the table above.

(3)

(c) Explain why no gas was produced by the plant at 45 °C.

(2)

(d) How could the student increase the accuracy of the results?

Tick (✓) **one** box.

Repeat the investigation, collecting the gas for 24 hours.

Repeat the investigation, measuring the volume of gas to 0.5 cm³.

Repeat the investigation using a different aquatic plant.

Repeat the investigation, using temperatures of 5 °C and 50 °C.

(1)

A person grows tomatoes in a greenhouse.

(e) The mean temperature of the greenhouse is 15 °C.

A heater would keep the temperature of the greenhouse at 25 °C.

Suggest **two** reasons **against** using a heater set at 25 °C in the greenhouse.

Do **not** refer to cost in your answer.

1 _____

2 _____

(2)

(f) The person cut a stem from one of the tomato plants.

The cut stem was placed in soil to grow new roots.

Which tissue in the cut stem will differentiate into new root cells?

Tick (✓) **one** box.

Epidermis

Meristem

Mesophyll

Phloem

(1)

(Total 10 marks)

3.

Plants need water for photosynthesis.

(a) Where do plants obtain water for photosynthesis from?

(1)

Plants lose water from their leaves through small pores called stomata.

(b) What is the evaporation of water from leaves called?

Tick (✓) **one** box.

Active transport

Respiration

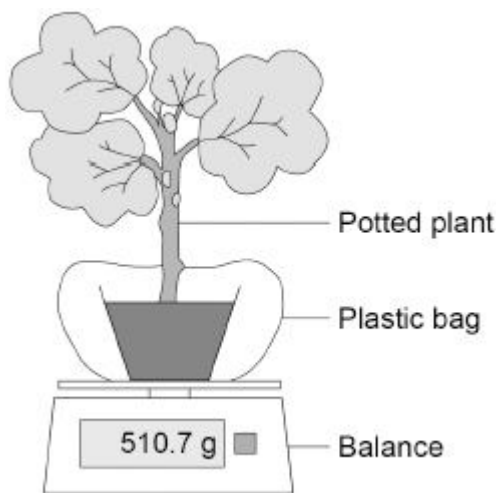
Transpiration

(1)

A student investigated the mass of water lost from a plant.

Figure 1 shows the apparatus.

Figure 1



This is the method used.

1. Seal a plastic bag around the pot of a potted plant.
2. Place the plant on a balance in a room at 20 °C.
3. Record the mass.
4. Record the mass every hour for 5 hours.
5. Calculate the total mass of water lost from the plant after each hour.

The table below shows the results.

Time in hours	Mass in grams	Total mass of water lost in grams
0	510.7	0.0
1	508.9	1.8
2	507.1	3.6
3	505.3	5.4
4	503.5	7.2
5	X	9.0

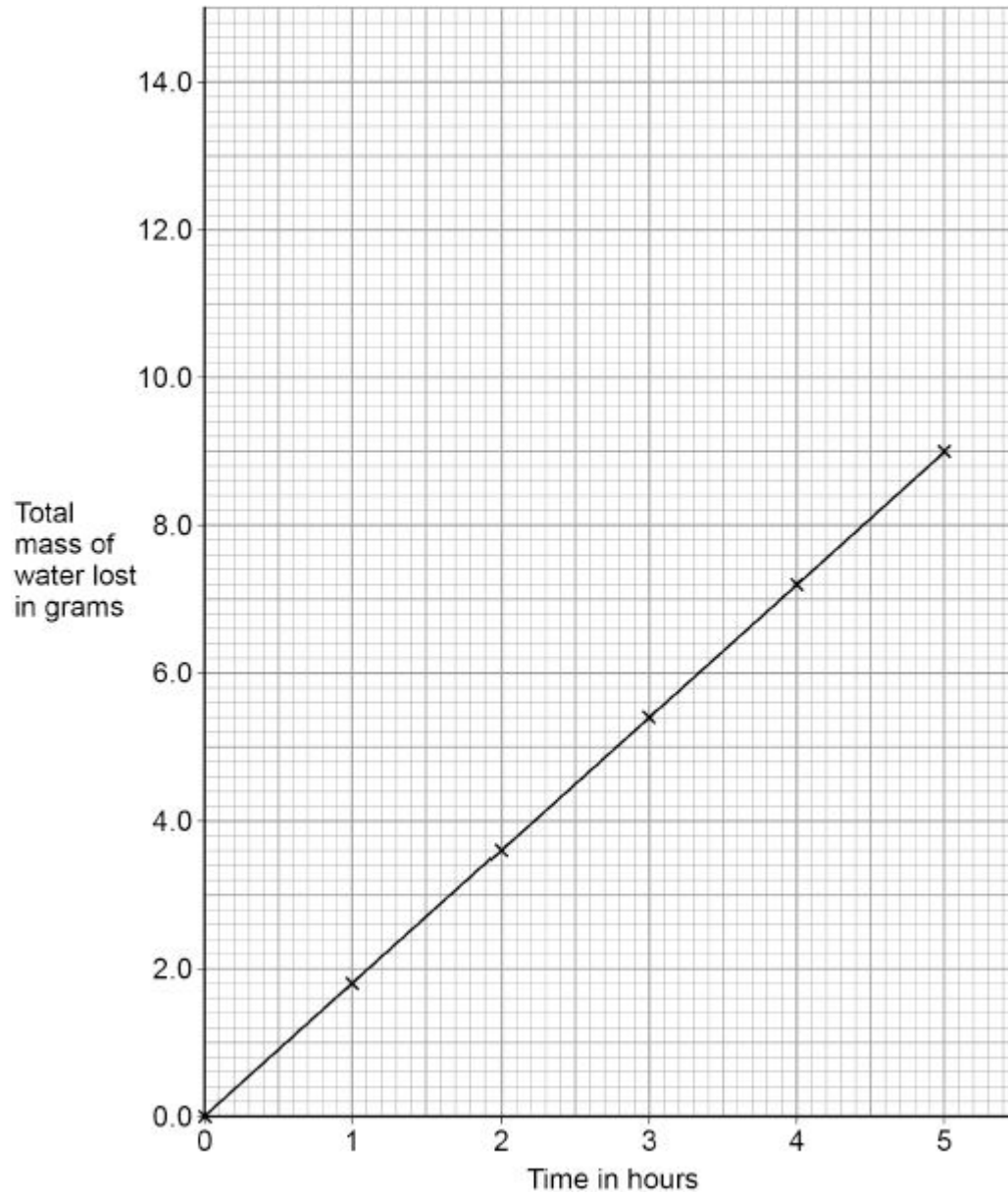
(c) Calculate mass **X** in the table above.

Mass **X** = _____ grams

(2)

Figure 2 shows the results.

Figure 2



(d) What was the rate of water loss from the plant?

Tick (✓) **one** box.

0.9 grams/hour

1.8 grams/hour

9.0 grams/hour

(e) The investigation was repeated at a **lower** temperature.

Draw **one** line on **Figure 2** to show how the results would be different at a **lower** temperature.

(2)

(f) Suggest **one** change to the investigation that would **increase** the rate of water loss from the plant.

Do **not** refer to temperature in your answer.

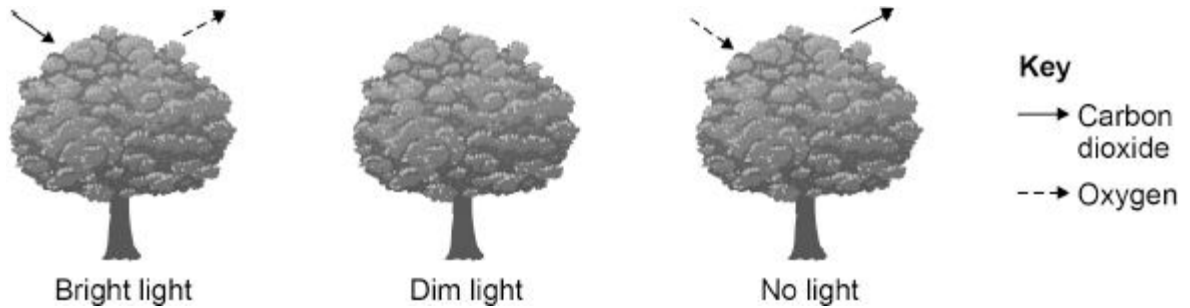
(1)

(Total 8 marks)

4.

Light intensity varies during 24 hours.

The figure below shows the overall exchange of carbon dioxide and oxygen for a tree at three different light intensities.



(b) Gases pass into and out of the leaf through small pores in the surface of the leaf.

What are the small pores labelled **X** called?

Tick (✓) **one** box.

Guard cells

Stomata

Xylem vessels

(1)

(c) A student viewed a section of a leaf using a microscope.

The student measured the length of one of the palisade cells.

The cell image measured 28 mm in length when viewed at a magnification of $\times 400$

Calculate the real length of the palisade cell in millimetres (mm).

Use the equation:

$$\text{real length} = \frac{\text{image length}}{\text{magnification}}$$

Real length = _____ mm

Convert the real length of the cell from millimetres to micrometres (μm).

1 mm = 1000 μm

Real length = _____ μm

(3)

(d) Carbon dioxide can move into and out of cells.

What is the process by which carbon dioxide can move into and out of cells?

Tick (✓) **one** box.

Active transport

Diffusion

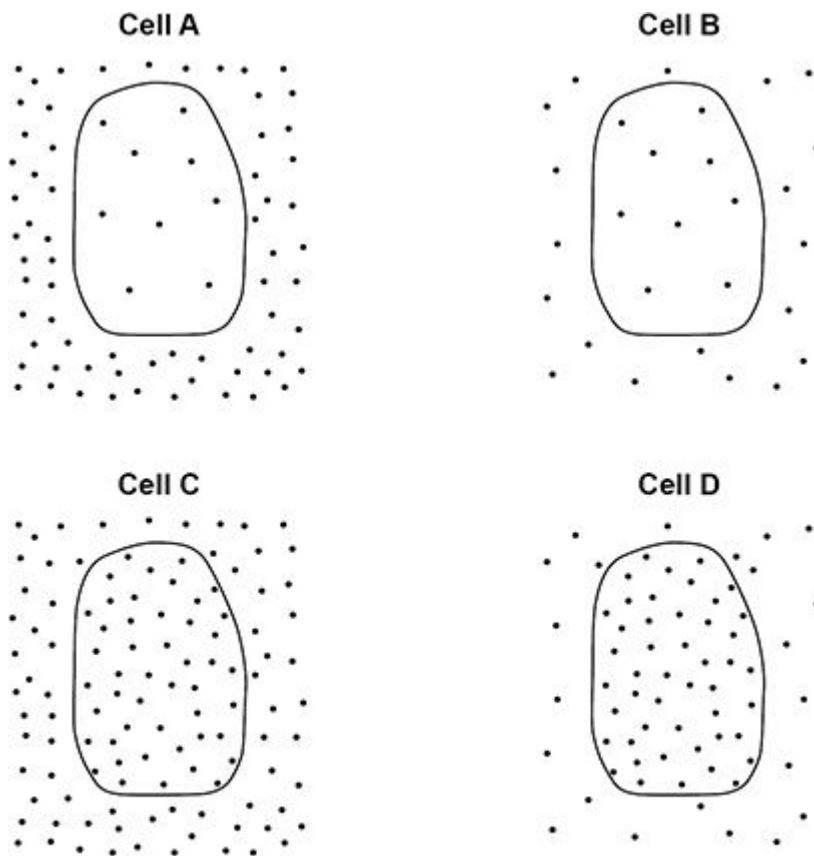
Osmosis

(1)

Figure 2 shows a diagram of four cells.

Each cell is surrounded by carbon dioxide molecules.

Figure 2



Key

• Carbon dioxide molecule

(e) Which cell will carbon dioxide move into at the fastest rate?

Give a reason for your answer.

Tick (✓) **one** box.

A

B

C

D

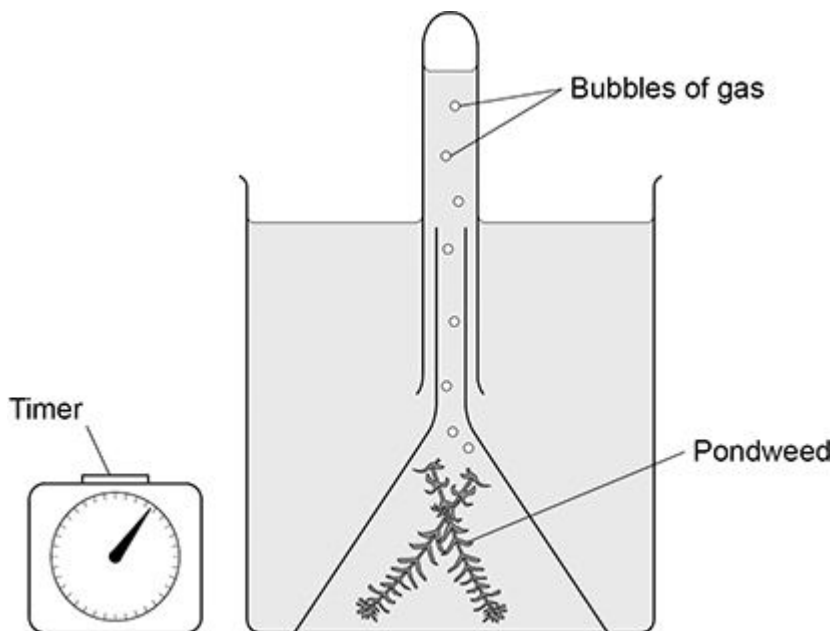
Reason _____

(2)

A student investigated the effect of different colours of light on the rate of photosynthesis.

Figure 3 shows some of the apparatus the student used.

Figure 3



The student placed the apparatus in blue light, then in green light and then in red light.

The student measured the rate of photosynthesis in each colour of light.

(f) What **two** measurements should the student make to calculate the **rate** of photosynthesis?

1 _____

2 _____

(2)

(g) Give **two** variables the student should keep the same in this investigation.

1 _____

2 _____

(2)

The table below shows the results.

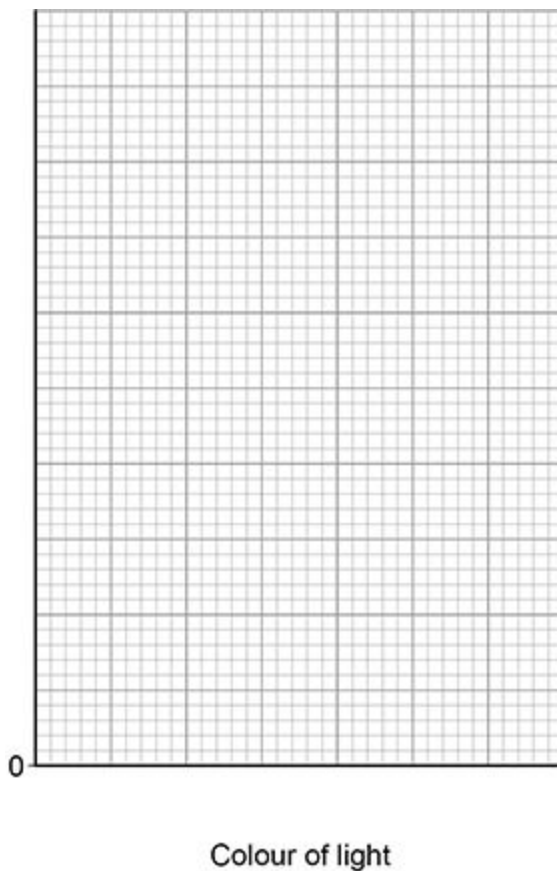
Colour of light	Rate of photosynthesis in arbitrary units
Blue	9
Green	1
Red	8

(h) Complete **Figure 4**.

You should:

- label the y-axis
- use a suitable scale
- plot the data from the table above as a bar chart
- label each bar.

Figure 4



(4)

(i) Look at the table above.

What colour of light should be used to grow plants in a greenhouse?

Tick (✓) **one** box.

Blue

Green

Red

(1)

(Total 17 marks)

6.

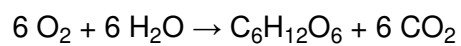
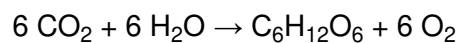
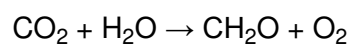
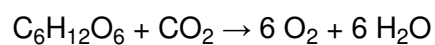
Photosynthesis is an important chemical reaction in plants.

(a) Why is light needed for photosynthesis?

(1)

(b) What is the equation for photosynthesis?

Tick (✓) **one** box.



(1)

(c) A student investigated the effect of different colours of light on the rate of photosynthesis at room temperature.

The student used pondweed in water.

A piece of pondweed was placed in red light, then in blue light and then in green light.

Each colour of light was the same intensity.

Describe how the student should make accurate measurements to obtain valid results for the rate of photosynthesis.

(4)

A scientist investigated the effect of different wavelengths of light on the rate of photosynthesis.

The wavelength of light determines the colour of the light.

Figure 1 shows the student's results.

Figure 2 shows the scientist's results.

Figure 1

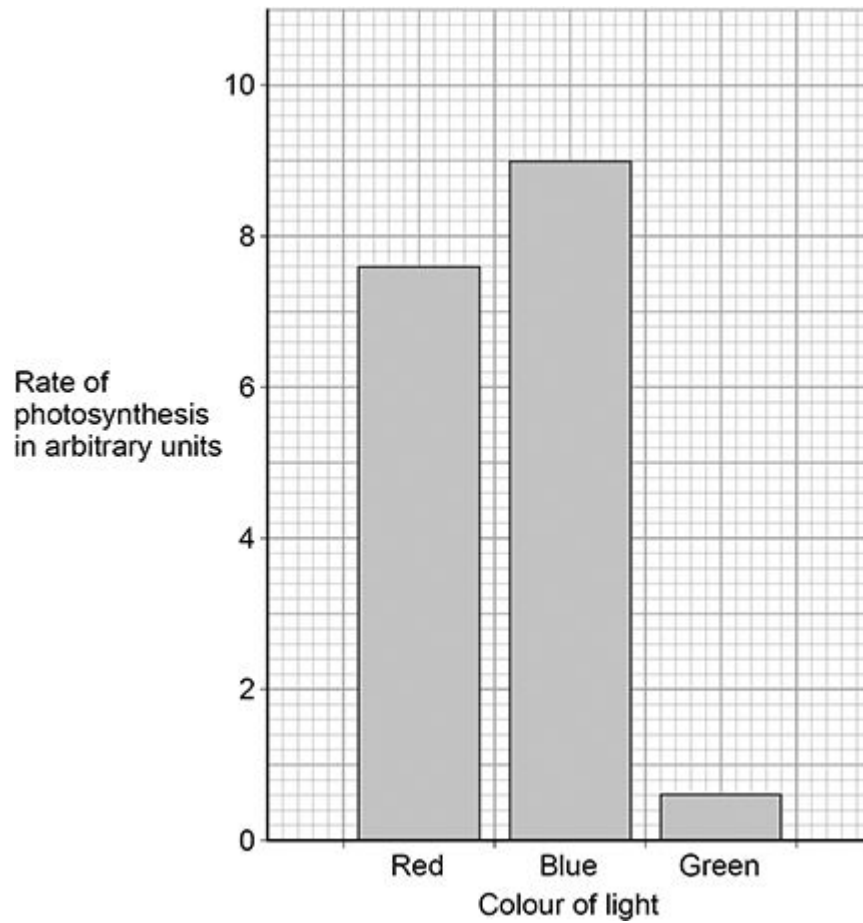
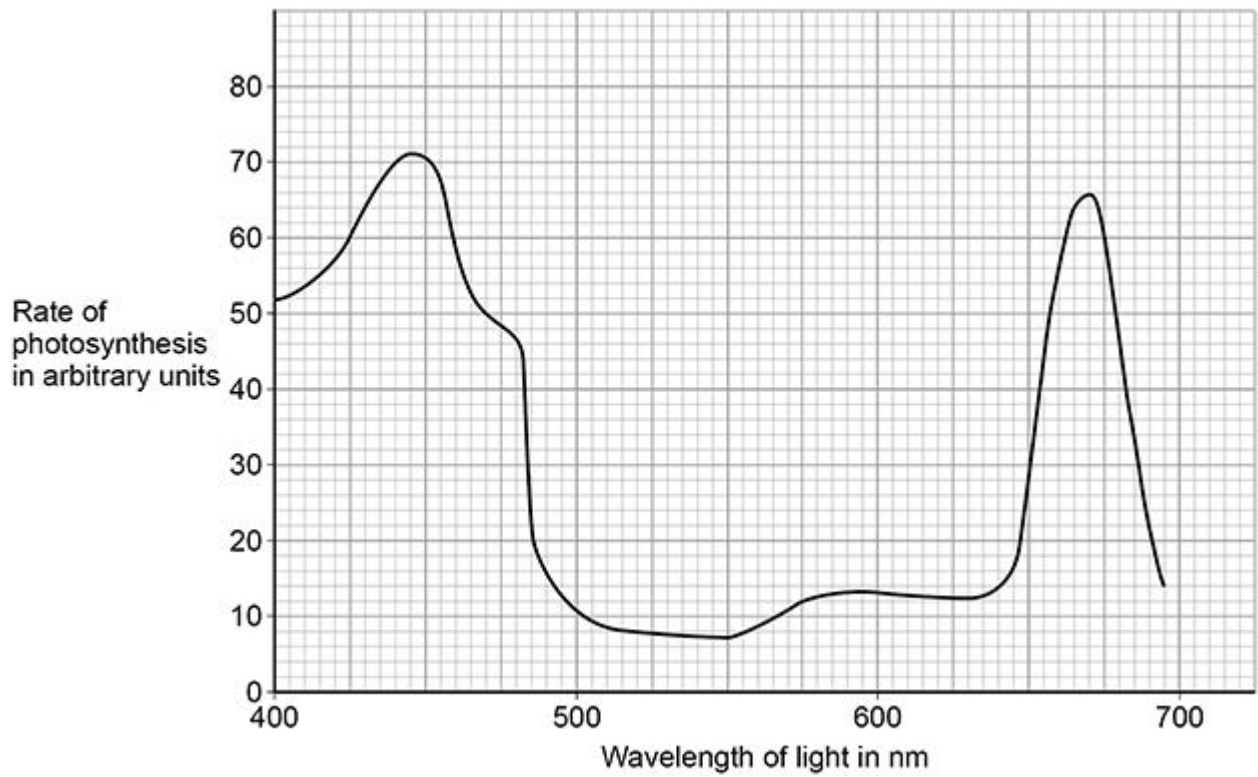


Figure 2



(d) Why are the results for the two investigations presented differently?

(2)

(e) Suggest the range in wavelength of green light.

Use **Figure 1** and **Figure 2**.

Range in wavelength of green light = from _____ nm to _____ nm

(1)

(Total 9 marks)

7.

This question is about plant transport systems.

(a) Which **organ** in a plant absorbs water from the soil?

(1)

- (b) The concentration of nitrate ions in the soil is lower than the concentration of nitrate ions inside a plant.

How would the nitrate ions move from the soil into the cells of this plant?

Tick (✓) **one** box.

By active transport

By diffusion

By osmosis

(1)

Dissolved sugars are transported in the phloem.

- (c) What is the name of the process that moves dissolved sugars through the phloem?

Tick (✓) **one** box.

Evaporation

Osmosis

Translocation

(1)

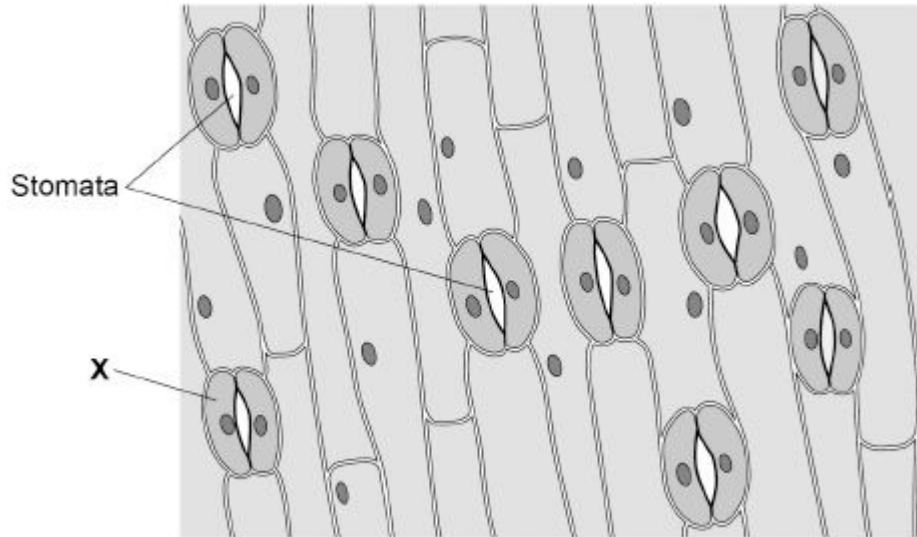
(d) Give **one** use of sugars in a plant.

(1)

Stomata are openings on the surface of a leaf.

Stomata allow gases to move into and out of a leaf.

The figure below shows the surface of a leaf.



(e) What is cell **X**?

Tick (✓) **one** box.

Guard cell

Meristem cell

Palisade cell

(1)

(f) Why do the stomata open during the day?

Tick (✓) **one** box.

To allow carbon dioxide in

To allow nitrogen in

To allow oxygen in

(1)

(g) The area of the leaf shown in the figure above is 0.25 mm².

Calculate the number of stomata per mm² for the leaf in the figure above.

Use the equation:

$$\text{number of stomata per mm}^2 = \frac{\text{number of stomata}}{\text{area in mm}^2}$$

Number of stomata per mm² = _____

(2)

A student investigated the number of stomata per mm^2 on the upper and lower surfaces of leaves.

The leaves were taken from the same plant.

The table below shows the results.

Leaf	Number of stomata per mm^2	
	Upper surface	Lower surface
1	0	37
2	1	36
3	2	30
4	1	32
5	1	35
Mean	1	X

(h) Calculate mean value **X** in the table above.

X = _____

(2)

(i) Water vapour is lost through stomata.

Explain the difference in the number of stomata on the upper and lower surfaces of the leaves.

Use the table above.

(3)

(Total 13 marks)

Mark schemes

- 1.** (a) (reactants)
water
allow H₂O 1
- (products)
oxygen
allow O₂ 1
- (b) C₆H₁₂O₆ 1
- (c) any **two** from:
• respiration
allow energy (source)
do not accept energy produced / made / created
do not accept energy for respiration
• to convert to starch
allow produce / store starch
• to produce / store fat / oil
• to produce cellulose
• to produce amino acids **or** to produce protein
ignore used for growth of the plant 2
- (d) higher / increase in temperature
allow warmer
or
more carbon dioxide
allow combustion / burning releases carbon dioxide 1
- (so) more photosynthesis
allow faster photosynthesis 1
- (so) more glucose / sugar made 1
- (so) more protein / cellulose made 1
- 2.** (a) $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ 1

[9]

- (b) (as temperature increases) the rate of photosynthesis increases **then** (the rate of photosynthesis) decreases

ignore references to volume unqualified

1

fastest rate between 30 °C **and** 35 °C

allow a fastest rate at a temperature above 30 °C and below 35 °C

allow reaches an optimum temperature between 30 °C and 35 °C

1

up to 30 °C the rate doubles every 5 °C increase

allow up to 30 °C the rate increases at an increasing rate

allow up to 30 °C the rate increases exponentially

1

- (c) enzymes (in the plant / chloroplast) become destroyed

allow enzymes become denatured

*do **not** accept enzymes are killed*

*do **not** accept cells / plants are denatured*

1

(because) active site changes shape

OR

the active site changes shape (1)

(so) the substrate no longer fits / binds (1)

OR

enzymes (in the plant / chloroplast) become destroyed (1)

allow enzymes become denatured

*do **not** accept enzymes are killed*

*do **not** accept cells / plants are denatured*

(so) the substrate no longer fits / binds (1)

ignore the plant is killed / dead

1

- (d) repeat the investigation, measuring the volume of gas to 0.5 cm³

1

- (e) any **two** from:
- may have too many tomatoes to eat / sell
allow the idea of a glut or all ripen at the same time
 - other factors could limit photosynthesis
allow other named limiting factor could limit photosynthesis
allow factors could limit tomato production
 - the optimum temperature might be above / below 25 °C
 - greenhouses are poorly insulated
 - pollution from the heater
allow increase carbon dioxide emissions
allow increase global warming
 - increase the rate of transpiration
allow increase the water loss from the plant
 - increased spread of plant disease(s)
if no other mark awarded allow it is a fire hazard for 1 mark

2

(f) meristem

1

[10]

3.

(a) soil

allow ground
ignore air
ignore rain
ignore roots

1

(b) transpiration

1

(c) 510.7 - 9(.0)
or
503.5 - 1.8

1

501.7 (grams)

1

(d) 1.8 grams/hour

1

(e) straight line drawn from 0,0 to 5 hours
ignore any extrapolations

1

at a less steep gradient below the line on **Figure 2**

1

- (f) any **one** from:
- increase air movement
 - increase light intensity
 - decrease humidity

ignore references to temperature

ignore references to the bag

allow descriptions of how changes could be achieved

experimentally eg use a fan

1

[8]

4.

Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.

5-6

Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3-4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1-2

No relevant content

0

Indicative content

Bright light:

- rate of photosynthesis is high due to high light intensity
- (extra) carbon dioxide is absorbed from the air
- (so) oxygen is released into the air
- carbon dioxide produced in respiration is used for photosynthesis
- (so) no carbon dioxide released from plant **or** into the air
- sufficient oxygen for respiration is produced by photosynthesis
- (so) no extra oxygen absorbed from the air
- rate of photosynthesis is greater than rate of respiration

Dim light:

- no net / overall flow / exchange of carbon dioxide or oxygen with the air
- (because) rate of respiration equals rate of photosynthesis
- carbon dioxide produced in respiration is used for photosynthesis
- no (extra) carbon dioxide is absorbed from the air
- oxygen produced by photosynthesis is used in respiration
- no (extra) oxygen is absorbed from the air

No light:

- no photosynthesis occurs as no light
- (so) no carbon dioxide is absorbed and no oxygen released / produced
- plant respire so takes in oxygen and releases carbon dioxide into the air

General points:

- plants photosynthesise when there is light using carbon dioxide and producing oxygen
- rate of photosynthesis depends on light intensity
- respiration occurs at all times of the day
- respiration uses oxygen and produces carbon dioxide

Level 3 response must include explanation at all three light intensities, demonstrating a good understanding of both photosynthesis **and** respiration.

For **Level 2** correct reference to **both** processes **and** to **both** gases

[6]

5.

- (a) cells contain (many) chloroplasts

allow positioned nearest to the light

or

at the top of the leaf

allow cells are closely packed

or

no gaps between cells

allow chlorophyll for chloroplast

1

- (b) stomata

1

- (c) (real length) = $\frac{28}{400}$

1

(real length in mm =) 0.07

1

(real length in μm =) 70

allow answer given for length in mm correctly multiplied by 1000

1

- (d) diffusion

1

- (e) A
- no marks if wrong cell chosen*
- 1
- Reason any **one** from:
- steeper (diffusion) gradient
 - bigger difference in concentration of carbon dioxide inside and outside the cell
- allow higher concentration of carbon dioxide outside the cell than inside the cell*
- allow particles / molecules for carbon dioxide*
- 1
- (f) (number / amount of) bubbles
- allow volume of gas / oxygen*
- 1
- time
- allow suitable time eg 1 / 5 / 10 minutes*
- 1
- (g) any **two** from:
- temperature (of water)
 - light intensity
- allow amount of light*
- ignore light unqualified*
- or**
- distance of light (from pondweed)
 - concentration of carbon dioxide (in water)
- allow amount / mass of sodium hydrogen carbonate (in water)*
- allow type / size of plant*
- ignore volume of water / solution*
- do **not** accept colour of light*
- ignore time*
- 2
- (h) y-axis labelled: rate of photosynthesis in arbitrary units
- 1
- suitable scale
- 1
- all **bars** plotted correctly
- allow $\pm \frac{1}{2}$ a small square the bars can be in any order*
- 1
- all bars labelled correctly
- 1
- (i) blue
- 1

6.

- (a) to transfer energy

allow idea that light is the source of energy (for the reaction)

*do **not** accept to produce / make / create / use energy*

or

photosynthesis is an endothermic reaction

1

- (b) $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$

1

- (c) allow the pondweed to equilibrate in the light

allow leave the pondweed in the light (for a few minutes) before taking measurements

allow use the same concentration of sodium hydrogen carbonate solution

ignore control carbon dioxide concentration unless method described

ignore use same intensity / distance of light

ignore control temperature

ignore use same pondweed

1

use a gas syringe

or

use a (measuring) cylinder to measure / collect the oxygen / gas produced

*do **not** accept carbon dioxide*

ignore references to counting bubbles

1

measure time oxygen / gas is collected for using a timer / stopwatch / stopclock

1

repeat the measurements **and** calculate a mean

*allow repeat the measurements (several) **and** discard anomalies*

1

- (d) independent variable in student's investigation is categoric / discrete

allow colour of light is a categoric / discrete variable

ignore discontinuous

1

independent variable in scientist's investigation is continuous

allow wavelength is a continuous variable

1

ignore answers relating to the scale on the y-axis

- (e) 492 to 577 (nm)
*allow answers in range 475 to 525 **and** 575 to 650 (nm)*

1

[9]

- 7.** (a) root

*do **not** accept root hair (cells)*

1

- (b) by active transport

1

- (c) translocation

1

- (d) any **one** from:

- respiration

allow to release energy

*do **not** accept to produce / make / create energy*

allow for growth

- (used) to produce starch
- (used) to produce fat / oil
- (used) to produce cellulose
- (used) to produce amino acids / protein

1

- (e) guard cell

1

- (f) to allow carbon dioxide in

1

- (g) $\frac{9}{0.25}$

1

36

*do **not** accept if a unit is given allow correct calculation using*

$$\frac{9}{25}$$

1

- (h) $\frac{37 + 36 + 30 + 32 + 35}{5}$
allow $\frac{170}{5}$

1

34

1

- (i) there are fewer stomata on the upper surface of the leaves
allow converse statements a comparative term is required

1

(conditions on upper surface will:) any **one** from:

- be warmer
- be drier
- be more exposed to wind
- have more light

1

(so) less water will be lost

1

[13]