Photosynthesis 4

Name: _____

Class: _____

Date: _____

Time: **90 minutes**

Marks: **90 marks**

Comments:

1. 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. ☐

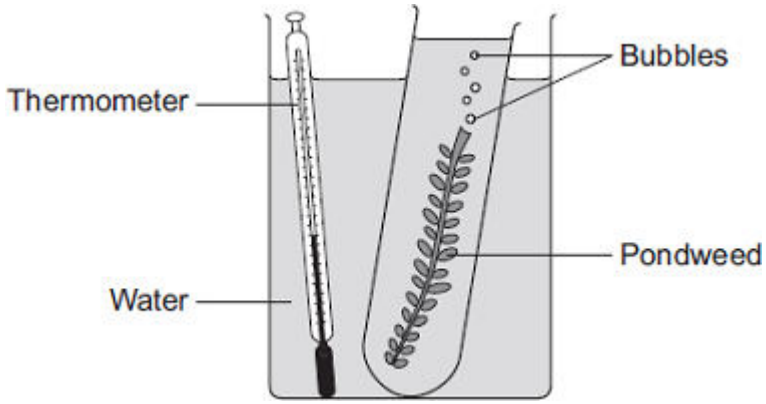
The starch is stored for use later. ☐

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.

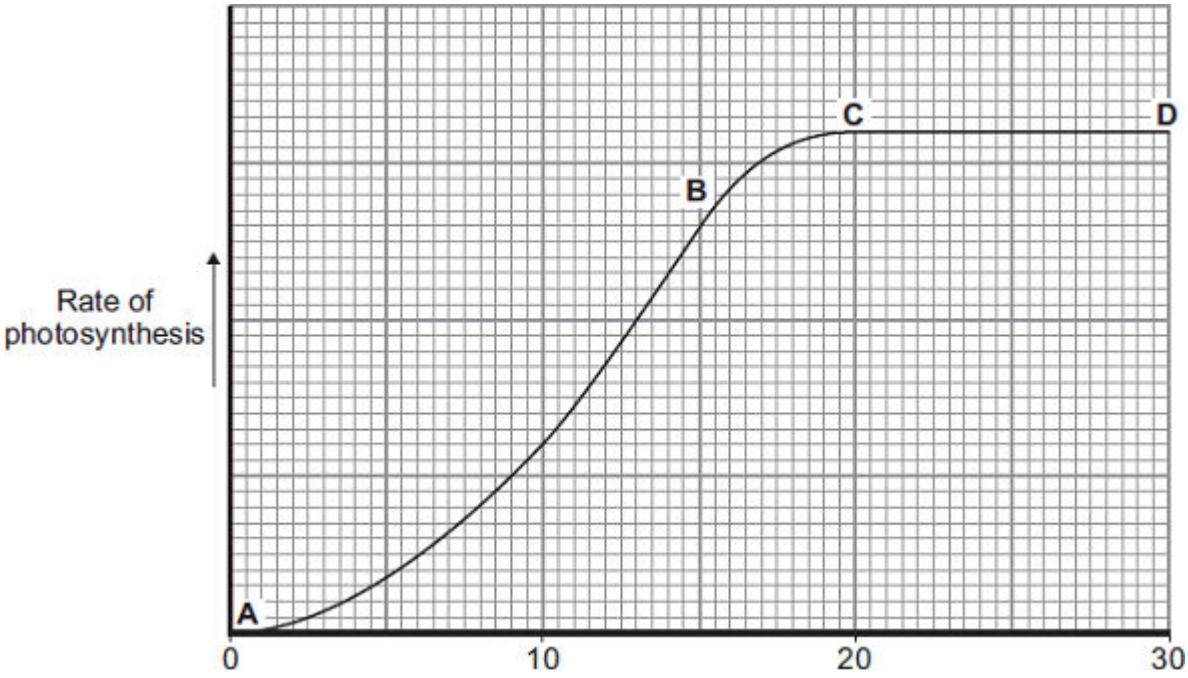
What **two** measurements would the student make to calculate the rate of photosynthesis?

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)

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

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

(1)

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

(i) The energy needed for photosynthesis comes from

light.
osmosis.
respiration.

(1)

(ii) Energy is absorbed by a green pigment called

chloride.
chloroplast.
chlorophyll.

(1)

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

decrease.
increase.
stay the same.

(1)

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

1. _____

_____

2. _____

_____

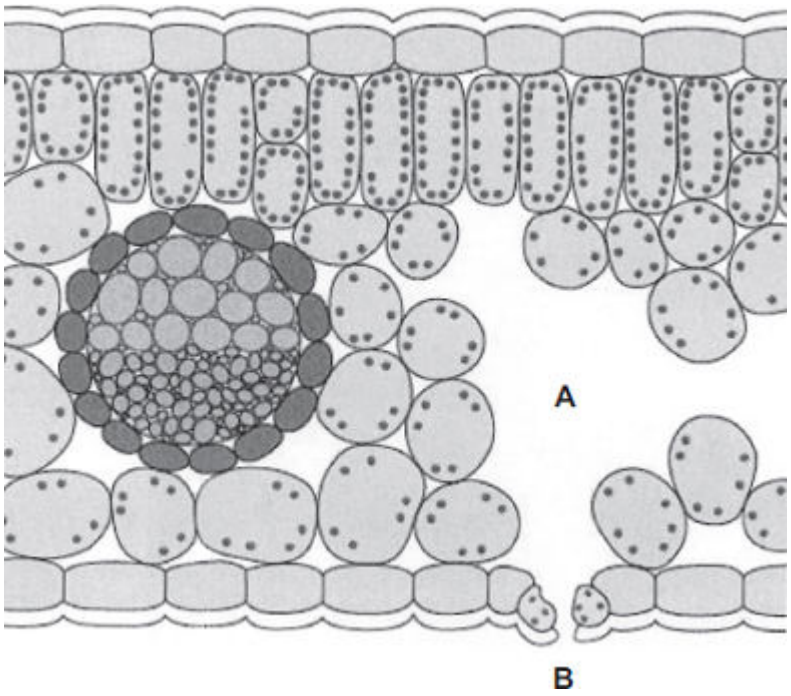
3. _____

_____

(3)

(Total 7 marks)

3. The diagram shows a section through a plant leaf.



(a) Use words from the box to name **two** tissues in the leaf that transport substances around the plant.

epidermis	**mesophyll**	**phloem**	**xylem**

_____ and _____

(1)

(b) Gases *diffuse* between the leaf and the surrounding air.

(i) What is *diffusion*?

_____

_____

_____

_____

(2)

(ii) Name **one** gas that will diffuse from point **A** to point **B** on the diagram on a sunny day.

_____

(1)

(Total 4 marks)

4. (a) Complete the equation for photosynthesis.

_____ + water $\xrightarrow{\text{light energy}}$ _____ + _____

(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)

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

Use words from the box.

chlorophyll	minerals	oxygen	water

carbon dioxide + _____ → glucose + _____

(2)

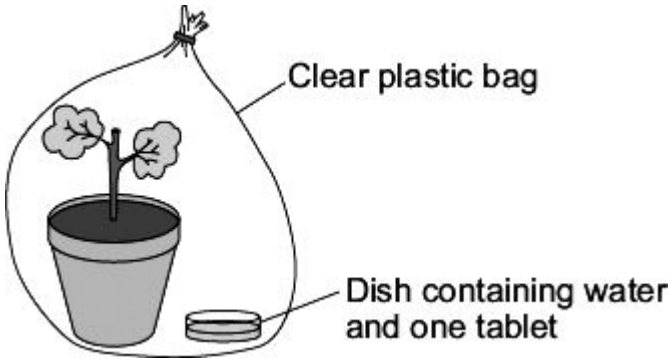
(b) Plants may grow faster if they have more carbon dioxide.

Indigestion tablets dissolve in water to form a solution.
This solution slowly gives off carbon dioxide.

A student set up an investigation to see what concentration of carbon dioxide is best for increasing the growth of geranium plants.

The student:

- put a geranium plant in a clear plastic bag
- put a dish containing water and one tablet in the bag
- sealed the top of the bag.



The student:

- set up 5 more experiments each with water and a different number of tablets
- left all the plants in a well-lit place for four weeks.

The student used a clear plastic bag, not a black plastic bag.

Explain why.

_____

_____

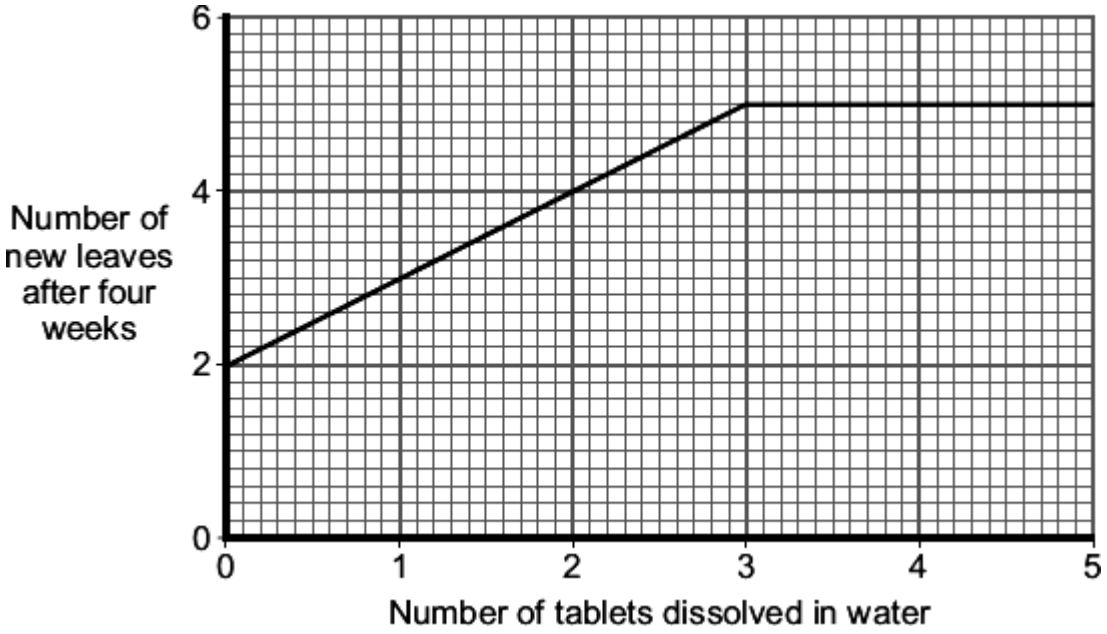
_____

_____

(2)

(c) After four weeks, the student counted the number of new leaves on each plant.

The graph shows his results.



Describe the effect of increasing the number of tablets dissolved in water on the number of new leaves that grew in four weeks.

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

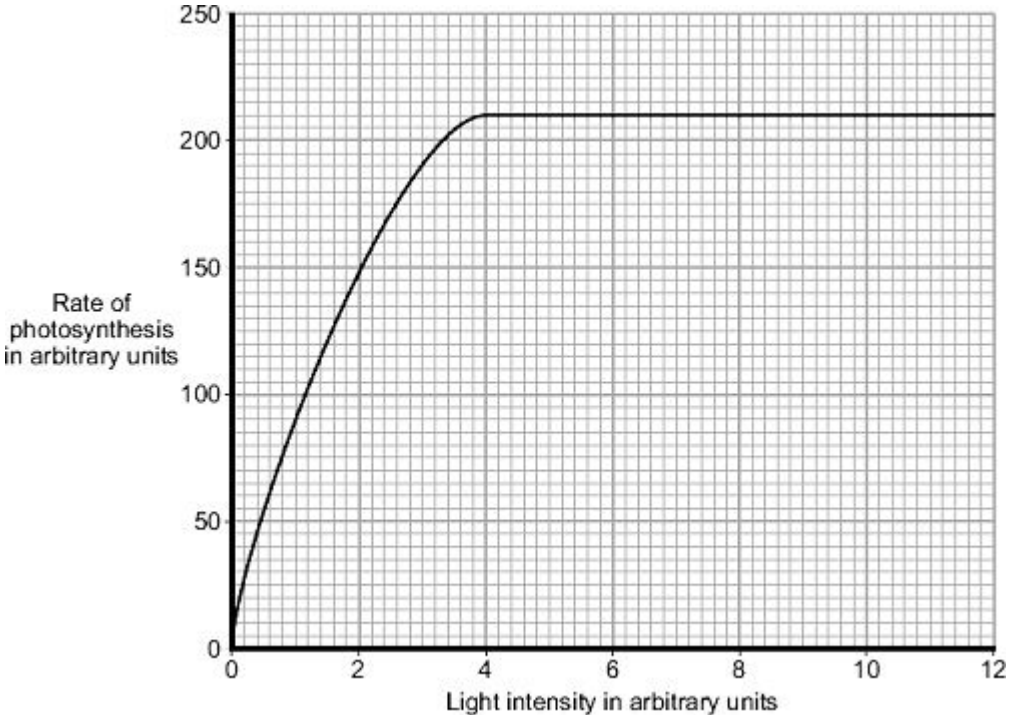
6. (a) Complete the equation for photosynthesis.

Carbon dioxide + _____ $\xrightarrow{\text{light energy}}$ _____ + oxygen

(2)

(b) A farmer grew tomato plants in a greenhouse.

The graph shows the effect of light intensity on the rate of photosynthesis in the tomato plants growing in the greenhouse.



(i) At which light intensity was light a limiting factor for photosynthesis?

Tick (✓) **one** box.

1 arbitrary unit ☐

4 arbitrary units ☐

10 arbitrary units ☐

(1)

(ii) What was the highest rate of photosynthesis?

_____ arbitrary units

(1)

(iii) The farmer wants to increase the rate of photosynthesis in his tomato plants.

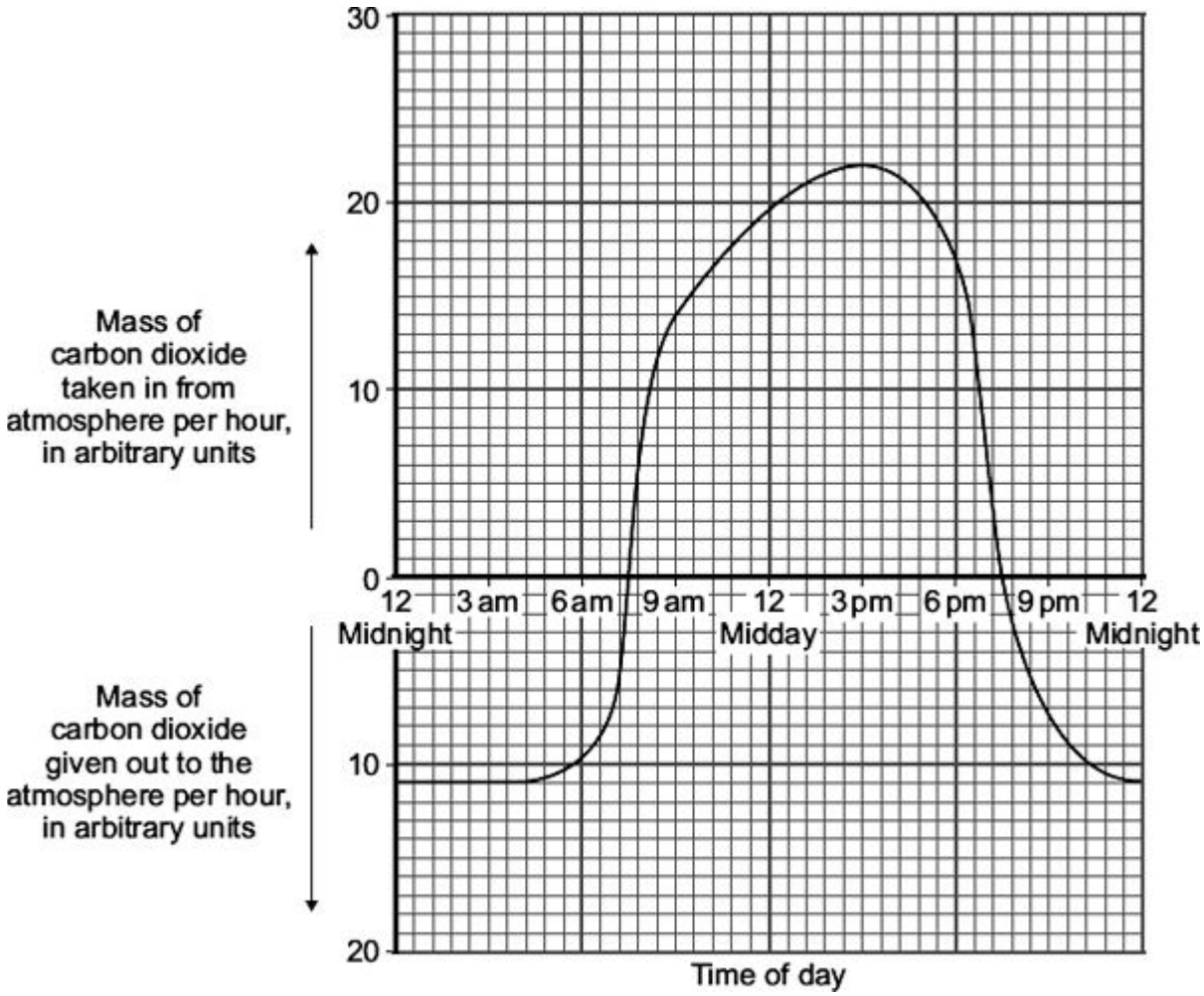
Apart from light intensity, name **one** factor that the farmer could change to increase the rate of photosynthesis in his tomato plants.

_____

(1)

(Total 5 marks)

7. 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. _____ 2. _____

(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)

8. (a) Complete the equation for photosynthesis.

$$\text{\_\_\_\_\_} + \text{\_\_\_\_\_} \xrightarrow{\text{light energy}} \text{\_\_\_\_\_} + \text{oxygen}$$

(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.

_____

_____

_____

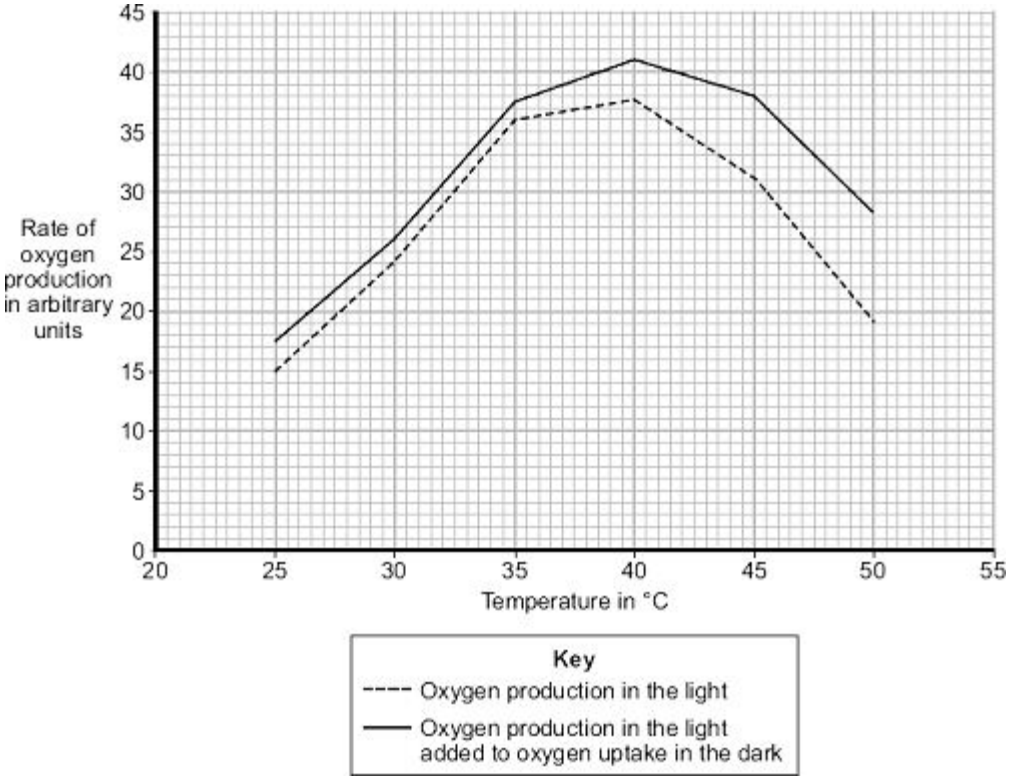
_____

(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)

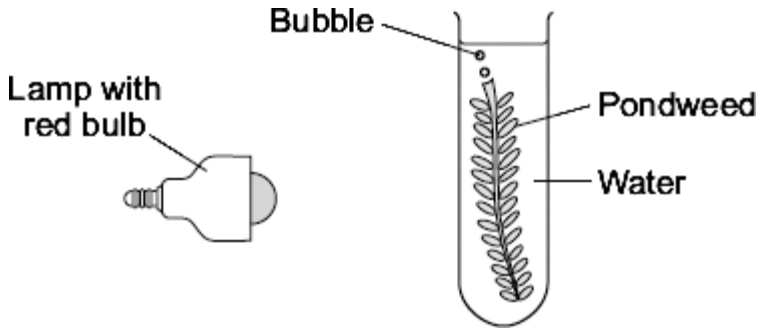
(Total 12 marks)

9. A group of pupils investigated the way in which the colour of light affects photosynthesis.

The pupils:

- put a piece of pondweed into a test tube of water
- shone light from a lamp with a red light bulb onto the pondweed
- counted the bubbles of gas produced by the pondweed every minute for three minutes.

The diagram shows the experiment.



The pupils repeated their experiment using a yellow light bulb, a green light bulb and a blue light bulb.

(a) (i) What was the independent variable in the investigation?

_____

(1)

(ii) To make the investigation fair the pupils needed to control some variables.

Suggest **one** variable that the pupils should have controlled during their investigation.

_____

(1)

(iii) It is better to count the bubbles every minute for three minutes than to count all the bubbles in three minutes.

Why?

_____

_____

(1)

(b) The table shows the pupils' results.

Colour of bulb	**Number of bubbles produced in one minute**			
	1st minute	**2nd minute**	**3rd minute**	**Mean**
Red	24	19	21	21
Yellow	18	14	15	16
Green	6	4	3	4
Blue	32	34	32	33

Algae are tiny organisms that photosynthesise.
In natural light algae grow very quickly on the sides of a fish tank.
The algae make it difficult to see the fish.

(i) What would be the best colour of light bulb to illuminate the fish tank to reduce the growth of algae?

Use the results in the table to help you to decide.

Draw a ring around **one** answer.

red **yellow** **green** **blue**

(1)

(ii) Explain why the colour you have chosen is the best.

_____

_____

_____

_____

(2)

(Total 6 marks)

10. 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?

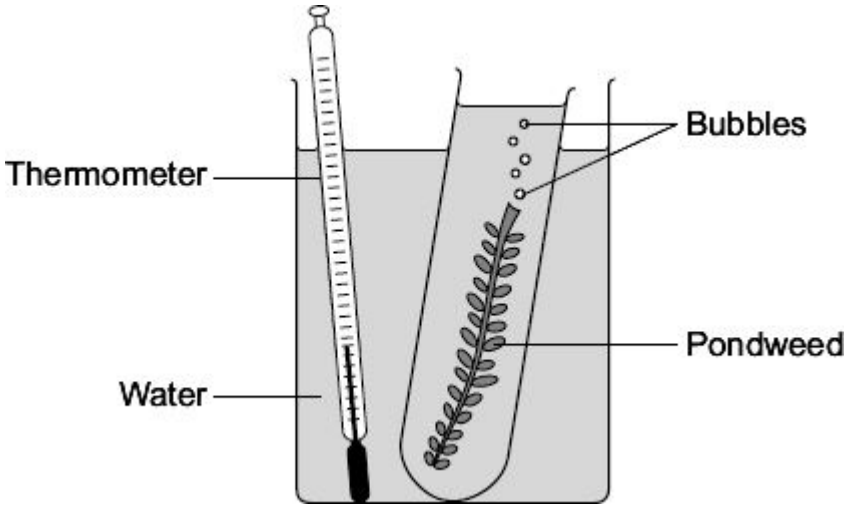
Tick (✓) **one** box.

The starch is converted into oxygen.	☐
The starch is stored for later use.	☐
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** of these variables.

1. _____

2. _____

(2)

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

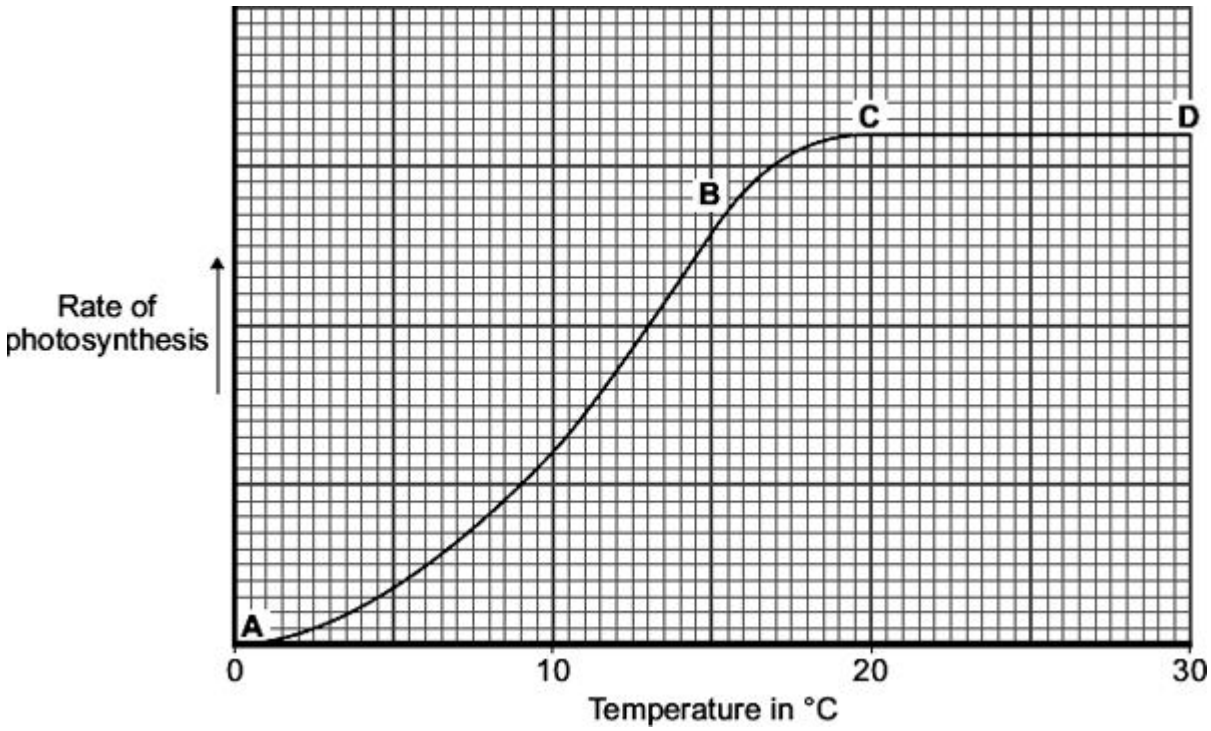
What **two** measurements would the student make to calculate the rate of photosynthesis?

1. _____

2. _____

(2)

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



(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)

11. Photosynthesis takes place the leaves of green plants.

(a) Write a balanced chemical equation for the formation of glucose by photosynthesis.

_____

(3)

(b) Describe **two** ways that the rate of photosynthesis can be decreased without lowering the temperature.

_____

_____

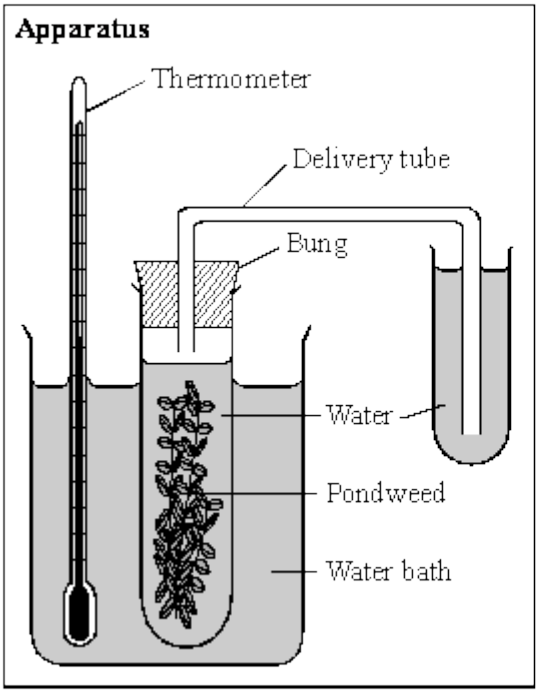
_____

_____

_____

(2)

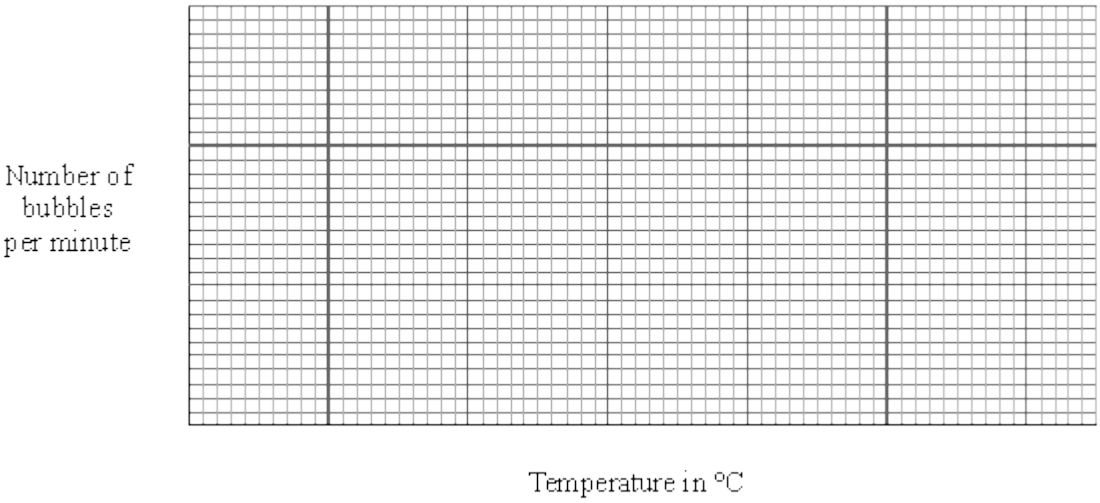
(c) Some students decided to investigate the effect of temperature on the rate of photosynthesis in pond weed. They set up the apparatus and altered the temperature using ice and hot water. The counted the number of bubbles given off in a minute at different temperatures. They obtained the following results.



Results

Temperature in °C	Number of bubbles per minute
10	6
20	15
30	21
40	23
50	19

(i) Plot the points on the graph.



(3)

(ii) Use your graph to predict the number of bubbles per minute at 25 °C.

_____

(1)

(iii) Suggest a reason why the rate of photosynthesis seems to decrease in this pondweed after 40 °C.

_____

_____

(1)

(Total 10 marks)

12. (a) Photosynthesis is a process that takes place in green plants.

(i) What type of energy is needed for this process?

_____

(1)

(ii) What substance in the plant absorbs this energy?

_____

(1)

(iii) In which part of the plant cell does photosynthesis take place?

_____

(1)

(iv) Write a balanced chemical equation for photosynthesis.

_____ → _____

(3)

(b) Describe **two** ways you could speed up photosynthesis.

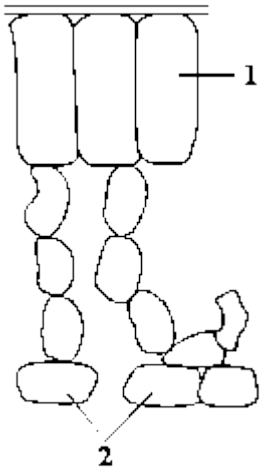
_____

_____

_____

(2)

(c) The diagram shows the outline of a cross-section of a leaf. Name cells **1** and **2** and describe how they are involved in photosynthesis.



_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 12 marks)

Mark schemes

1.

(a) The starch is stored for use later

no mark if more than one box is ticked

1

(b) (i) any **two** from:

*do **not** accept temperature*

apply list principle

ignore reference to time

- carbon dioxide (concentration)
- light intensity
- light colour / wavelength

*allow **1** mark for light if neither intensity or colour are awarded*

- pH
- size / amount of pondweed / plant
- same / species / type pondweed
- amount of water <u>in the tube</u>

ignore amount of water alone

2

(ii) number / amount of bubbles **or** amount of gas / oxygen

allow volume of bubbles (together)

ignore 'the bubbles' unqualified

1

(relevant reference to) time / named time interval

allow how long it bubbles for

*do **not** accept time bubbles start / stop*

ignore speed / rate of bubbling

ignore instruments

*do **not** accept other factors eg temperature*

*accept how many bubbles per minute for **2** marks*

1

(c) (i) temperature

allow heat / cold / °C

1

(ii) carbon dioxide / CO_2

allow CO2

*do **not** accept CO^2*

1

[7]

2. (a) oxygen

allow O_2 / O2

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

1

(b) (i) light

1

(ii) chlorophyll

1

(iii) decrease

1

(c) any **three** from:

- for respiration / energy

  *do **not** accept use energy for photosynthesis*
- to make cellulose / starch

  accept named carbohydrate other than glucose
- to make lipid / fat / oil

  accept fatty acid / glycerol
- to make protein

  accept named protein / amino acid / named amino acid
- to build big molecules from small molecules / metabolism

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

3

[7]

3. (a) xylem **and** phloem

either order

allow words ringed in box

allow mis-spelling if unambiguous

1

(b) (i) movement / spreading out of particles / molecules / ions / atoms

ignore names of substances / 'gases'

1

from high to low concentration

accept down concentration gradient

ignore 'along' / 'across' gradient

ignore 'with' gradient

1

(ii) oxygen / water (vapour)

allow O_2 / O2

ignore O^2/ O

allow H_2O / H2O

ignore H^2O

1

[4]

4. (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
  2nd or 3rd mark can be gained from correct description and explanation

5

[8]

5. (a) water

1

oxygen

in this order only
accept correct chemical symbols
allow H_2O / OH_2

1

(b) allow light (in / through) / need light

*do **not** accept attracts light*

ignore heat / moisture / carbon dioxide

ignore so the plants can be seen

accept the converse, ie the black plastic bag would not let light in (1)

1

for photosynthesis / make sugar / glucose

so there would be no photosynthesis (1)

*do **not** allow make food unqualified*

1

(c) Increase (in leaves / new leaves)

ignore growth unqualified

1

(then) level off **or** number of (new) leaves (then) stays the same

1

numerical statement eg max at 3 tablets / 5 (new) leaves

should refer to one of the first two marking points

*for every extra tablet get 1 extra leaf = **2** marks*

*for every extra tablet get 1 extra leaf then it levels off = **3** marks*

1

[7]

6. (a) (LHS) water / H_2O

allow H2O

*do **not** accept H^2O*

1

(RHS) glucose / sugar / $C_6H_{12}O_6$

allow starch / carbohydrate

allow C6H12O6

*do **not** accept $C^6H^{12}O^6$*

1

(b) (i) 1 arbitrary unit

extra box ticked – cancel

1

(ii) 210

1

(iii) carbon dioxide / CO_2 / CO2

or

temperature / heat / warmth

*do **not** accept CO^2*
ignore mineral ions
ignore water

1

[5]

7. (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]

8. (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]

9. (a) (i) colour of light / bulb / lamp

allow wavelength for colour

allow bulb alone

*do **not** accept light / colour unqualified*

1

(ii) any **one** from eg

- temperature
  allow heat
- light intensity **or** distance between lamp and plant / tube
  allow amount / brightness of light
  ignore light unqualified
- carbon dioxide
  allow symbols
- other light in room
  allow use a dark room
- mass / size / amount / age / type of pondweed
  allow same piece of pondweed
  ignore pondweed unqualified
- volume / amount of water
  ignore reference to time

1

(iii) improved reliability
*allow for reliability **or** less likely to lose count*

or

can spot anomalies / changes
allow reference to calculating a mean / average
ignore reference to accuracy / precision / fair

1

(b) (i) green

1

(ii) any **two** from:
ignore references to colour

- least / less bubbles / gas / oxygen / mean
  *reference to least / less needed only once, in context, for **2** marks*
- least / less photosynthesis
- least / less glucose / sugar / carbohydrate / food made
  only penalise no once, ie
  *no bubbles = **0** mark*
  *no bubbles so no photosynthesis = **1** mark*
  allow most / more green light reflected (by chloroplasts)

2

[6]

10. (a) the starch is stored for later use.

1

(b) (i) any **two** from:

*do **not** accept temperature-apply list principle*

ignore reference to time

- carbon dioxide (concentration)
- light intensity

  *allow **one** mark for light if neither intensity or colour are awarded*
- light colour / wavelength
- pH
- size / amount plant
- same / species / type plant

  allow 'the plant'
- amount of water <u>in the tube</u>

  ignore amount of water alone

2

(ii) number / amount of bubbles **or** amount of gas / oxygen

allow volume of bubbles (together)

ignore 'the bubbles' unqualified

1

(relevant reference to) time / named time interval

allow how long it bubbles for

*do **not** accept time bubbles start / stop*

ignore speed / rate bubbles

ignore instruments

*do **not** accept other factors eg temperature*

*accept how many bubbles per minute for **2** marks*

1

(c) (i) temperature

allow heat / °C / cold

1

(ii) carbon dioxide / CO_2

CO2 / CO^2 / Co_2 / Co^2 / co_2 / co^2

*do **not** accept CO / 2CO*

1

[7]

11. (a) reactants: $CO_2 + H_2O$

1

products: $C_6H_{12}O_6 + O_2$

1

balance:

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

1

(b) **1** mark each for any of the following ideas:

lower CO_2 concentration

lower light intensity

decrease water availability

alter light wavelength **or** colour

accept more green light

2

(c) (i) scales correctly constructed

i.e. equal intervals along each axis

1

points plotted correctly

1

appropriate line correctly drawn

*accept dot to dot **or** line of best fit*

cancel if line extends through zero or beyond 50°C

1

(ii) 18 – 19 (bubbles per minute)

1

(iii) heat denatures enzymes **or** destroys membranes **or** ruptures cells **or** destroys cells

do not accept kills enzymes

1

[10]

12. (a) (i) light **or** solar

*do **not** credit sun's energy*

*do **not** credit radiant*

1

(ii) chlorophyll

1

(iii) chloroplast

1

(iv) CO_2 **+** H_2O

reactants identified (accept words)

1

$C_6H_{12}O_6 + O_2$

products identified (accept words)

1

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

balanced equation

1

(b) any **two** from:

increased CO_2 concentration

increased water supply

increased temperature (up to a point)
increased light intensity

*do **not** accept heat or warmth*

altered light quality by less green **or**
increasing other colours

2

(c) any **four** points

- palisade (mesophyll)
- lots of chloroplasts **or** chlorophyll
  or main site for photosynthesis
  or absorb maximum amount of light
- guard cells
- CO_2 in **or** O_2 out **or** water vapour out
- controls size of stoma **or** pores in leaf

***allow** stomata*

4

[12]