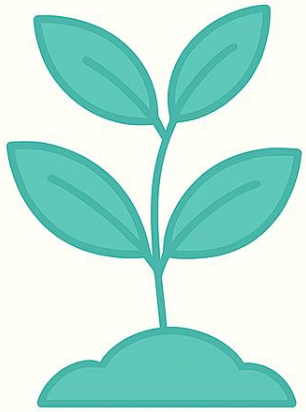
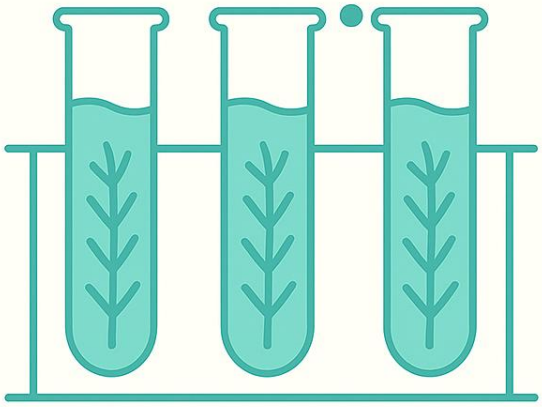
Hickling Hacks

Hack it at home!

Practical Hacks





Photosynthesis

Name: _____

Date: _____

Table of Contents

Exploring Oxygen Production in Spinach Leaves

Objective

Investigate how light intensity and carbon dioxide concentration affect the rate of photosynthesis in spinach leaves

Materials Required

- Fresh spinach leaves
- Sodium bicarbonate (baking soda)
- Water
- Beakers (or any see-through container)
- Desk lamp
- Hole punch
- Stopwatch (you can use the one on your phone!)
- Safety goggles (not essential for this experiment, but makes you feel more sciency!)

Initial Preparation

1. Prepare Leaf Discs

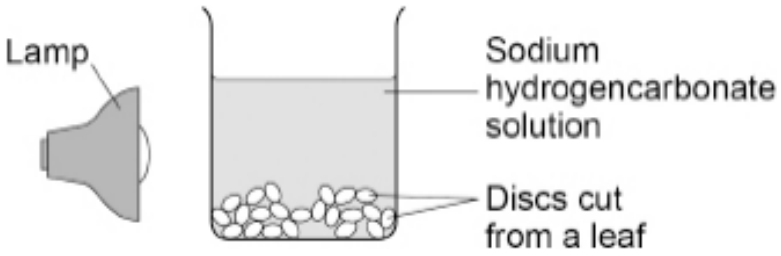
- Use a hole punch to create 40 uniform leaf discs
- Divide discs into four groups of 10 discs

2. Prepare Solution

- Mix 300 ml of water with 1 teaspoon sodium bicarbonate – this will create the 'low' carbon dioxide concentration
- Mix 300 ml of water with 3 teaspoons of sodium bicarbonate – this will create the 'high' carbon dioxide concentration

Experimental Setup

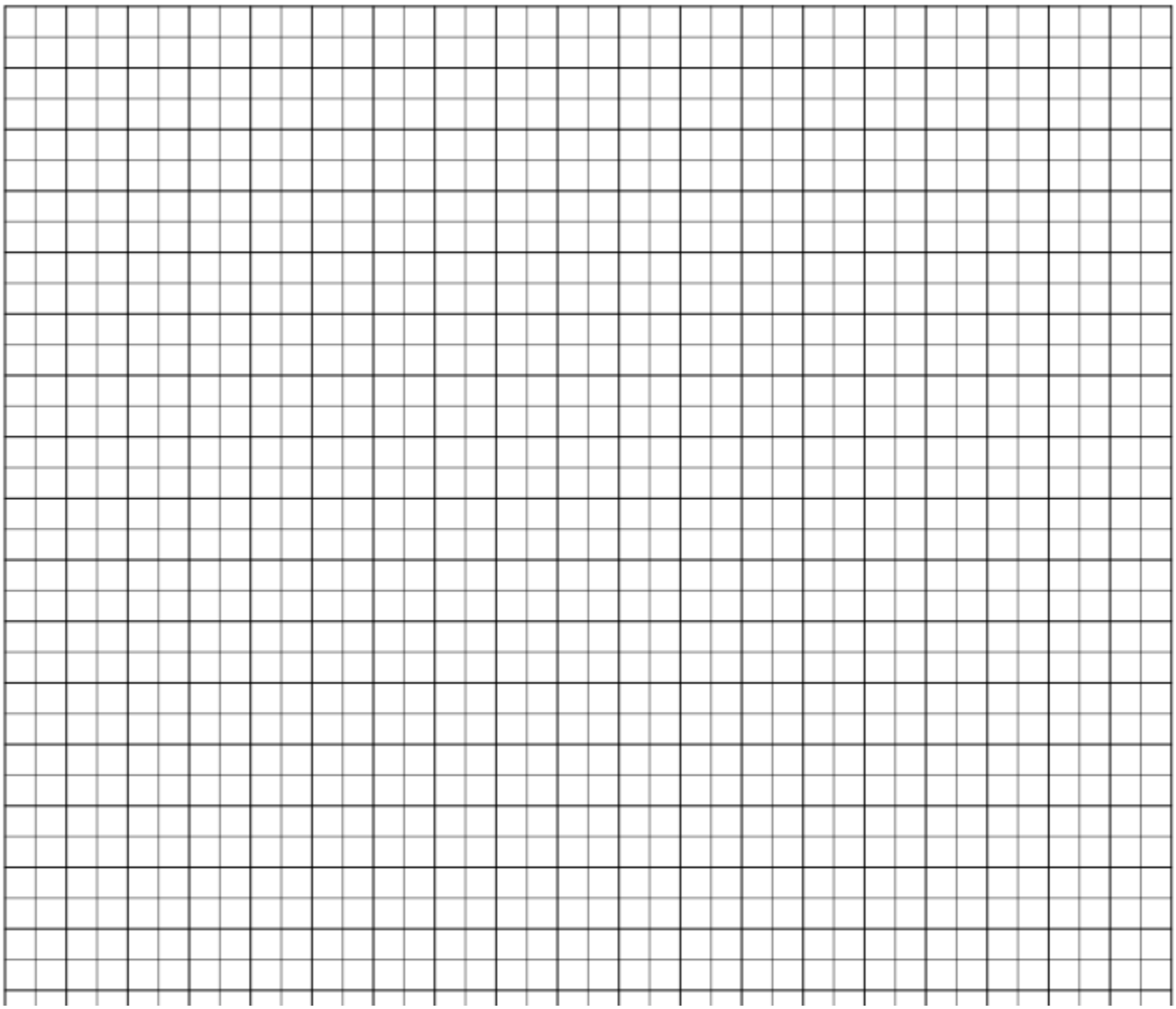
- Use a fresh 150 ml sample of your sodium bicarbonate solution each time
- For high light intensity, put the lamp as close as possible to the beaker, for low light put the lamp at least 30 cm away, or use natural light only.
- Time how long 5 out if the 10 discs take to float – this is to reduce any anomalies that may occur due to where in the leaf the disc was cut, and so you can see results faster!



Results Table

Condition	Light Intensity	CO_2 Concentration	Time taken for 5 out of 10 discs to float (s)
1	High (lamp close)	Low	
2	High (lamp close)	High	
3	Low (lamp far away)	Low	
4	Low (lamp far away)	High	

Results Graph



Take it Further:

Here are some ideas to improve or vary this experiment – can you think of any more?

- Repeat each condition three times, then calculate a mean – this helps to control anomalies
- Change the colour of the light – you can do this by making a filter out of used sweet wrappers – are some colours better than others?
- Count oxygen bubbles produced in 5 minutes – is this easier or harder?
- Vary the light intensity by moving the light back by 10 cm each time.

Worksheet Questions

Here are some worksheet style questions to help you to revisit your knowledge of photosynthesis

1. Fill in the blanks (Foundation Tier) [5 marks]

Complete the sentences using the following words:

sunlight, carbon dioxide, oxygen, glucose, chloroplasts

a) Photosynthesis happens in the _____ of plant cells.

b) Plants use energy from _____ to carry out photosynthesis.

c) The gas taken in by plants during photosynthesis is _____.

d) The gas released by plants during photosynthesis is _____.

e) The sugar made by photosynthesis is called _____.

2. Match the key word to the definition (Foundation Tier) [3 marks]

Draw lines to match.

Key Word	Definition
Chlorophyll	The sugar produced in photosynthesis
Glucose	The green pigment that absorbs sunlight
Stomata	The openings in leaves where gases move in and out

3. Label the equation (Crossover Tier) [4 marks]

Write the names of the substances next to the correct part of the equation:

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

Reactants: _____ and _____

Products: _____ and _____

4. Describe the limiting factors (Higher Tier)

Name three factors that can limit the rate of photosynthesis. [3 marks]

_____

_____

_____

Explain how one of them affects the rate. [2 marks]

_____

_____

_____

_____

_____

_____

5. Apply your knowledge (Higher Tier)

A student sets up an experiment to investigate how light intensity affects the rate of photosynthesis using pondweed.

a) What gas is collected during the experiment? [1 mark]

_____

b) Describe one way to make the experiment more accurate. [1 mark]

_____

_____

_____

c) Sketch a basic line graph to show what you'd expect to happen as light intensity increases (label both axes). [3 marks]

Exam Style Questions

Here are some past exam questions to try:

A student investigated the effect of colour of light on the rate of photosynthesis in leaves.

Figure 2 shows how the investigation was set up.

Figure 2

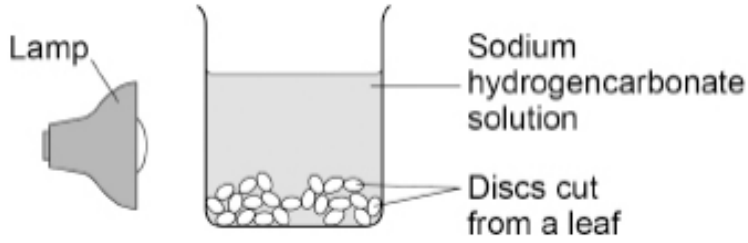


Table 1 shows the results.

Table 1

Colour of light	Time taken for 10 leaf discs to reach the surface of the solution in seconds
Blue	115
Green	831
Red	397

(c) Give **one** way the student could change the colour of the light shining on the leaf discs.

_____

_____

(1)

(d) Give the independent variable and the dependent variable in this investigation.

Independent variable _____

_____

Dependent variable _____

_____

(2)

(e) All of the air had to be removed from the leaf discs before placing them in the beaker.

Suggest **one** reason why.

_____

_____

(1)

(f) The leaf discs were placed in a beaker of sodium hydrogencarbonate ($NaHCO_3$) solution.

Explain why sodium hydrogencarbonate solution was used instead of water.

_____

_____

_____

_____

(2)

(g) Explain why the leaf discs moved to the surface of the solution during the investigation.

_____

_____

_____

_____

(2)

Answers

Worksheet answers

Total Marks: 22

1. Fill in the blanks (5 marks) (1 mark each)

a) chloroplasts
b) sunlight
c) carbon dioxide
d) oxygen
e) glucose

2. Match the key word to the definition (3 marks) (1 mark each)

Chlorophyll → The green pigment that absorbs sunlight
Glucose → The sugar produced in photosynthesis
Stomata → The openings in leaves where gases move in and out

3. Label the equation (4 marks) (1 mark each)

Equation:

$$6CO_2 \text{ (carbon dioxide)} + 6H_2O \text{ (water)} \rightarrow C_6H_{12}O_6 \text{ (glucose)} + 6O_2 \text{ (oxygen)}$$

Reactants: carbon dioxide / water (either order is fine)
Products: glucose / oxygen (either order is fine)

4. Limiting factors (2 marks) (1 mark each for naming, 2 marks for explaining)

Any 3 correct limiting factors:

- Light intensity
- Carbon dioxide concentration
- Temperature

Acceptable explanations (any one):

- "If light intensity is low, there is less energy for the reaction, so the rate of photosynthesis is slower."
- "If carbon dioxide levels are low, the plant has less raw material to make glucose."
- "If the temperature is too low or too high, enzyme activity decreases and photosynthesis slows down or stops."

5. Apply your knowledge

a) (1 mark) Oxygen
b) (1 mark) Any sensible method such as:

- "Measure the volume of oxygen using a gas syringe."
- "Repeat the experiment and take an average."
- "Use a ruler to measure distance from the light source precisely."

c) Simple sketch graph with:

X-axis: Light intensity (1 mark)
Y-axis: Rate of photosynthesis (1 mark)
Correct shape: increasing curve that plateaus (1 mark)

Exam Question Mark Scheme

(c) any **one** from:

- use (different) coloured bulb(s) / LED(s)
- use (different) coloured filter(s) in front of lamp
- put (different) coloured transparent material(s) over lamp / beaker

allow named transparent material(s)

1

(d) *independent*

colour of light

allow wavelength of light
ignore colour of filter / bulb / lamp

1

dependent

time (taken for 10 leaf discs to reach the surface of the solution)

1

(e) any **one** from:

- so that discs would sink (to the bottom of the beaker)

allow leaf for disc throughout
allow so the discs do not float

- so any gas (that makes the discs rise) is from photosynthesis
- air is a gas so any left in discs would add to the oxygen produced by photosynthesis

ignore reference to carbon dioxide
allow as a control variable

1

(f) (sodium hydrogencarbonate) provides / releases carbon dioxide

ignore (sodium hydrogencarbonate) contains carbon dioxide
ignore provides water

1

(carbon dioxide is used) for photosynthesis

1

(g) oxygen was produced in photosynthesis

1

oxygen / gas is trapped in / around disc / leaf

allow bubbles are trapped in / around the disc / leaf
allow oxygen / gas (makes leaf discs) less dense than solution / water
allow the oxygen / gas under the disc / leaf pushes the disc / leaf up

1