# Biology PAG 5: Photosynthesis

# Combined Science PAG B4: Photosynthesis

# Suggested Activity 2: Investigating factors that affect the rate of water uptake in plants

## Instructions and answers for teachers & technicians

This practical activity is composed of two parts; a teacher/technician section and the learner activity which can be found on [page 10](#_Suggested_Activity_1:). This Practical activity supports OCR GCSE Biology and Combined Science.

**When distributing the activity section to the learners either as a printed copy or as a Word file you will need to remove the teacher instructions section.**

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| --- |
| This is a **suggested** practical activity that can be used as part of teaching the GCSE (9-1) Gateway Science (A) and Twenty First Century Science (B) specifications.  These are **not controlled assessment tasks**, and there is **no requirement to use these particular activities**.  You may modify these activities to suit your learners and centre. Alternative activities are available from, for example, [Royal Society of Biology](https://www.rsb.org.uk/education/teaching-resources/secondary-schools), [Royal Society of Chemistry](http://www.rsc.org/learn-chemistry), [Institute of Physics](http://www.iop.org/education/teacher/resources/index.html), [CLEAPSS](http://science.cleapss.org.uk/) and [publishing companies](https://global.oup.com/education/content/secondary/key-issues/gcse_science_2016/?region=uk), or of your own devising.  Further details are available in the [specifications](http://www.ocr.org.uk/science) (Practical Skills Topics), and in these [videos](https://www.youtube.com/playlist?list=PLBD9B84FF4BD54AA4). |

**OCR recommendations:**

**Before carrying out any experiment or demonstration based on this guidance, it is the responsibility of teachers to ensure that they have undertaken a risk assessment in accordance with their employer’s requirements, making use of up-to-date information and taking account of their own particular circumstances. Any local rules or restrictions issued by the employer must always be followed.**

**CLEAPSS resources are useful for carrying out risk-assessments: (**<http://science.cleapss.org.uk>**).**

**Centres should trial experiments in advance of giving them to learners. Centres may choose to make adaptations to this practical activity, but should be aware that this may affect the Apparatus and Techniques covered by the learner.**

### Introduction

This investigation is included in the photosynthesis PAG, despite the fact that the uptake of water in plants is a very poor method to determine rate of photosynthesis (indeed SAPS do not even mention water uptake as a method <http://www.saps.org.uk/secondary/teaching-resources/157-measuring-the-rate-of-photosynthesis>). This is because the water that is taken up by a plant is not used exclusively for photosynthesis; it has a number of uses within the plant (e.g. structure, transport, transpiration, hydrolysis to name but a few). It is practically impossible in a school science laboratory to identify even the proportion of water that the plant uses solely for photosynthesis. Instead this practical can be used to teach synoptic links to other topics within the specification (e.g. plant transport – xylem and phloem, osmosis and other forms of transport, enzymatic action, water cycle, variation including plants that are more adapted to reduce water loss, environmental change and need to develop drought resistant crops by selective breeding/genetic engineering).

The practical can also be used by more able learners to evaluate the practical and suggest more suitable indicators of the rate of photosynthesis. In order to determine the rate of photosynthesis the equation needs to be understood:

6CO2 + 6H2O 🡒 C6H12O6 + 6O2

Using the above equation learners could suggest how the rate of photosynthesis could be measured e.g. by the uptake of carbon dioxide and/or water or the production of glucose and/or oxygen. (The measurement of oxygen is covered by PAG Activity – Biology – Photosynthesis – [Suggestion 1](http://www.ocr.org.uk/Images/340064-pag-activity-biology-photosynthesis-suggestion-1.docx).)

All these methods have their various drawbacks and these can all be discussed (e.g. oxygen and glucose may be a good markers, but they may provide an underestimate as they may be rapidly used by the plant in respiration; atmospheric carbon dioxide use may be measured – but the plant may use some carbon dioxide that was produced during respiration).

### DfE Apparatus and Techniques covered

The codes used below match the OCR Practical Activity Learner Record Sheet ([**Biology**](http://www.ocr.org.uk/Images/-295601-gcse-biology-learner-record-sheet.doc) / [*Combined Science*](http://www.ocr.org.uk/Images/304431-gcse-combined-science-learner-record-sheet.doc)) and Trackers ([**Biology**](http://www.ocr.org.uk/Images/323480-gcse-biology-practical-tracker.zip) / [*Combined Science*](http://www.ocr.org.uk/Images/323483-gcse-combined-science-practical-tracker.zip)) available online. **There is no requirement to use these resources.**

**1** *[1]***:** Use of appropriate apparatus to make and record a range of measurements accurately, including: **ii**[*ii*]) area**; iv**[*iv*]) time**; v**[*v*]) temperature**; vi**[*vi*]) volume of liquids

**3** *[3]*: Use of appropriate apparatus and techniques for the: i) observation of biological changes and/or processes; ii) measurement of biological changes and/or processes

**4** *[4]*: Safe and ethical use of living organisms (plants or animals) to measure: i) physiological functions; ii) responses to the environment

**5** *[5]*: Measurement of rates of reaction by a variety of methods including: ii) uptake of water

### Aims

To measure the rate of water uptake by plants and to evaluate this as a method of determining the rate of photosynthesis.

### Intended class time

This activity will take 60 minutes.

### Links to Specifications:

### Gateway

B2.4c describe photosynthesis as an endothermic reaction

B1.4d describe experiments to investigate photosynthesis

B1.4e explain the effect of temperature, light intensity and carbon dioxide concentration on the rate of photosynthesis

B1.4f explain the interaction of these factors in limiting the rate of photosynthesis

B2.2i explain the effect of a variety of environmental factors on the rate of water uptake by a plant

light intensity, air movement, and temperature

B2.2j describe how a simple potometer can be used to investigate factors that affect the rate of water uptake

### Twenty First Century

B3.1.1 describe the process of photosynthesis, including the inputs and outputs of the two mains stages and the requirement of light in the first stage, and describe photosynthesis as an endothermic process

B3.1.1b describe practical investigations into the requirements and products of photosynthesis

B3.2.6c describe how to use a simple potometer

### Mathematical Skills covered

Understand and use simple compound measures such as the rate of a reaction

Translate information between graphical and numerical form

Plot and draw appropriate graphs, selecting appropriate scales and axes

Extract and interpret information from graphs, charts and tables

Use simple compound measures such as rate

Carry out rate calculations

Plot, draw and interpret appropriate graphs

### Gateway Working scientifically references covered

WS1.2a use scientific theories and explanations to develop hypotheses

WS1.2b plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena

WS1.2c apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment

WS1.2d recognise when to apply a knowledge of sampling techniques to ensure any samples collected are representative

WS1.2e evaluate methods and suggest possible improvements and further investigations

WS1.3 a presenting observations and other data using appropriate methods to include: methods to include descriptive, tabular diagrammatic and graphically

WS1.3b translating data from one form to another

WS1.3c carrying out and representing mathematical and statistical analysis to include: statistical analysis to include arithmetic means, mode, median

WS1.3d representing distributions of results and make estimations of uncertainty

WS1.3e interpreting observations and other data; data to include: presentations to include verbal, diagrammatic, graphical, symbolic or numerical form interpretations to include identifying patterns and trends, making inferences and drawing conclusions

WS1.3f presenting reasoned explanations relating data to hypotheses

WS1.3g being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility

WS1.3h identifying potential sources of random and systematic error

WS1.3i communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions presentations through paper-based presentations using diagrammatic, graphical, numerical and symbolic forms

WS1.4a use scientific vocabulary, terminology and definitions

WS1.4b recognise the importance of scientific quantities and understand how they are determined

WS1.4c use SI units and IUPAC chemical nomenclature unless inappropriate base units & derived units

WS1.4e interconvert units

WS1.4f use an appropriate number of significant figures in calculation

WS2a carry out experiments to include: due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations, and following written instructions

WS2b make and record observations and measurements using a range of apparatus and methods keeping appropriate records

WS2c presenting observations using appropriate methods to include: methods to include descriptive, tabular diagrammatic and graphically

WS2d communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions presentations through paper-based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms

### Twenty First Century IaS references covered

IaS1.1 in given contexts use scientific theories and tentative explanations to develop and justify hypotheses and predictions

IaS1.2 suggest appropriate apparatus, materials and techniques, justifying the choice with reference to the precision, accuracy and validity of the data that will be collected

IaS1.3 recognise the importance of scientific quantities and understand how they are determined

IaS1.4 identify factors that need to be controlled, and the ways in which they could be controlled

IaS1. 5 suggest an appropriate sample size and/or range of values to be measured and justify the suggestion

IaS1. 6 plan experiments or devise procedures by constructing clear and logically sequenced strategies to:

* make observations
* produce or characterise a substance
* test hypotheses
* collect and check data
* explore phenomena

IaS1.7 identify hazards associated with the data collection and suggest ways of minimising the risk

IaS1. 8 use appropriate scientific vocabulary, terminology and definitions to communicate the rationale for an investigation and the methods used using diagrammatic, graphical, numerical and symbolic forms

IaS2.1 present observations and other data using appropriate formats

IaS2.2 when processing data use SI units where appropriate (e.g. kg, g, mg; km, m, mm; kJ, J) and IUPAC chemical nomenclature unless inappropriate

IaS2.4 be able to translate data from one form to another

IaS2.5 when processing data interconvert units

IaS2.6 when processing data use an appropriate number of significant figures

IaS2.7 when displaying data graphically select an appropriate graphical form, use appropriate axes and scales, plot data points correctly, draw an appropriate line of best fit, and indicate uncertainty (e.g. range bars)

IaS2.8 when analysing data identify patterns/trends, use statistics (range and mean) and obtain values from a line on a graph (including gradient, interpolation and extrapolation)

IaS2.9 in a given context evaluate data in terms of accuracy, precision, repeatability and reproducibility, identify potential sources of random and systematic error, and discuss the decision to discard or retain an outlier

IaS2.10 evaluate an experimental strategy, suggest improvements and explain why they would increase the quality (accuracy, precision, repeatability and reproducibility) of the data collected, and suggest further investigations

IaS2.12 explain the extent to which data increase or decrease confidence in a prediction or hypothesis

IaS3.1 use ideas about correlation and cause to:

1. identify a correlation in data presented as text, in a table, or as a graph
2. distinguish between a correlation and a cause-effect link
3. suggest factors that might increase the chance of a particular outcome in a given situation, but do not invariably lead to it
4. explain why individual cases do not provide convincing evidence for or against a correlation
5. identify the presence (or absence) of a plausible mechanism as reasonable grounds for accepting (or rejecting) a claim that a factor is a cause of an outcome

### Equipment (all equipment in this section is per group)

This practical is available from the following web site:

<http://www.saps.org.uk/secondary/teaching-resources/1263-investigating-transpiration-with-a-potometer>

Here there are links to:

* [Learner sheet](http://www.saps.org.uk/attachments/article/1263/SAPS%20-%20Using%20a%20potometer%20to%20measure%20transpiration%20-%20student%20notes.doc)
* [Teaching/technical notes](http://www.saps.org.uk/attachments/article/1263/SAPS%20-%20Using%20a%20potometer%20to%20measure%20transpiration%20-%20teacher%20notes.doc)

### Health and Safety

**Cut hazard** teachers/technicians and students may cut themselves on the fragile glass capillary tubes, when assembling/producing the potometer.

### Method

See <http://www.saps.org.uk/secondary/teaching-resources/1263-investigating-transpiration-with-a-potometer>

### Technician Notes

These can be found on <http://www.saps.org.uk/secondary/teaching-resources/1263-investigating-transpiration-with-a-potometer>

### Quiz answers

1. Name three processes that plants use water for.

|  |
| --- |
| Any **three** from:  Transport  Transpiration  Photosynthesis  Structure/support  Hydrolysis |

1. In order to maximise the yield of tomatoes a farmer decides to keep the greenhouse lights on overnight. He notices that the plants require more watering. Suggest why this is?

|  |
| --- |
| Longer time spent photosynthesising  Lights may also increase overnight temperature in the greenhouse |

1. In an experiment to test a number of carrots that are resistant to dry conditions a scientist produces the following data.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Uptake of water (litres per day) | | | | | | | |
|  | Humidity | | Wind speed | | Temperature | | Sunlight | |
|  | Low | High | Low | High | Low | High | Low | High |
| Plant A | 10 | 9 | 1 | 2 | 1 | 12 | 5 | 7 |
| Plant B | 4 | 3 | 2 | 12 | 3 | 5 | 2 | 4 |
| Plant C | 11 | 8 | 2 | 8 | 4 | 9 | 1 | 9 |

1. Assuming that the size of the carrots is the same for each plant, which plant would the scientist suggest as the most appropriate for a sheltered site in a desert.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Plant A |  | Plant B | 🗸 | Plant C |  |

1. Explain why you chose this plant. Ensure you refer to the data.

|  |
| --- |
| Best plant in high humidity and high temperature and high sunlight  Not best plant in high wind speed but the sheltered site should make this less important |

### Document updates

v1 February Published on the qualification pages

v1.2 June 2021 Update to meet digital accessibility standards



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# Biology PAG 5: Photosynthesis

# Combined Science PAG B4: Photosynthesis

# Suggested Activity 2: Investigating the factors that can affect the rate of photosynthesis

## Learner Activity

The importance of plants and photosynthesis in biology cannot be underestimated.

Plants are the producers for numerous food chains. They can remove carbon dioxide from the atmosphere. They produce oxygen which is essential for respiration in other organisms. They can be used for the bioremediation of waste. They are the source for many essential drugs. They provide raw materials for numerous processes and products.

### Aims

To measure the rate of water uptake by plants and to evaluate this as a method of determining the rate of photosynthesis.

### Method

Your teacher will give you a hand-out for this experiment from the SAPS website

<http://www.saps.org.uk/secondary/teaching-resources/1263-investigating-transpiration-with-a-potometer>

### Quiz questions

1. Name three processes that plants use water for.

|  |
| --- |
|  |

1. In order to maximise the yield of tomatoes a farmer decides to keep the greenhouse lights on overnight. He notices that the plants require more watering. Suggest why this is?

|  |
| --- |
|  |

1. In an experiment to test a number of carrots that are resistant to dry conditions a scientist has the following data.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Uptake of water (liters per day) | | | | | | | |
|  | Humidy | | Wind speed | | Temperature | | Sunlight | |
|  | Low | High | Low | High | Low | High | Low | High |
| Plant A | 10 | 9 | 1 | 2 | 1 | 12 | 5 | 7 |
| Plant B | 4 | 3 | 2 | 12 | 3 | 5 | 2 | 4 |
| Plant C | 11 | 8 | 2 | 8 | 4 | 9 | 1 | 9 |

1. Assuming that the size of the carrots is the same for each plant, which plant would the scientist suggest as the most appropriate for a sheltered site in a desert.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Plant A |  | Plant B |  | Plant C |  |

1. Why have you made this choice?

|  |
| --- |
|  |

### DfE Apparatus and Techniques covered

If you are using the OCR Practical Activity Learner Record Sheet ([**Biology**](http://www.ocr.org.uk/Images/-295601-gcse-biology-learner-record-sheet.doc) / [*Combined Science*](http://www.ocr.org.uk/Images/304431-gcse-combined-science-learner-record-sheet.doc)) you may be able to tick off the following skills:

| **Biology** | | | |  | ***Combined Science*** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1-ii | 1-iv | 1-v | 1-vi |  | *1-ii* | *1-iv* | *1-v* | *1-vi* |
| 3-i | 3-ii | 4-i | 4-ii |  | *3-i* | *3-ii* | *4-i* | *4-ii* |
| 5-ii |  |  |  |  | *5-ii* |  |  |  |