

Practical 10 - The effect of wind speed on the rate of transpiration in a leafy shoot

This practical focuses on making measurements and observations, recording and presenting data, analysis, drawing conclusions and evaluating methods. You will also develop other assessed skills throughout the practical.

Intended learning outcomes

By the end of this practical you should be able to:

- Identify dependent and independent variables
- Make a hypothesis and express this in words and graphically
- Identify the variables that should be controlled
- Experience relevant methods, analysis and conclusion.
- Describe and explain the relationship between transpiration and wind speed
- Evaluate procedures

Safety Information



You should wear eye protection throughout this practical.

There are no particular hazards in this practical, however you must follow your laboratory rules.

Background information

- Transpiration is the movement of water through plants, from the roots where it is absorbed by osmosis, to the leaves where it is lost by evaporation.
- Water leaves a plant's leaves through stomata, the aperture of which is controlled by guard cells.
- Most plants open their stomata during the day and close them at night.
- Plants may close their stomata when stressed by losing too much water.
- The real purpose of stomata is to absorb carbon dioxide and release oxygen from photosynthesis without losing too much water.
- The evaporation of water is affected by wind speed, temperature, humidity and atmospheric pressure.

You will investigate how **wind speed** affects the rate of transpiration from a leafy shoot by using a **potometer**.

- Read the information above
- Identify and write down the dependent and independent variables
- Write down a hypothesis
- Draw a sketch graph to show what you think will happen

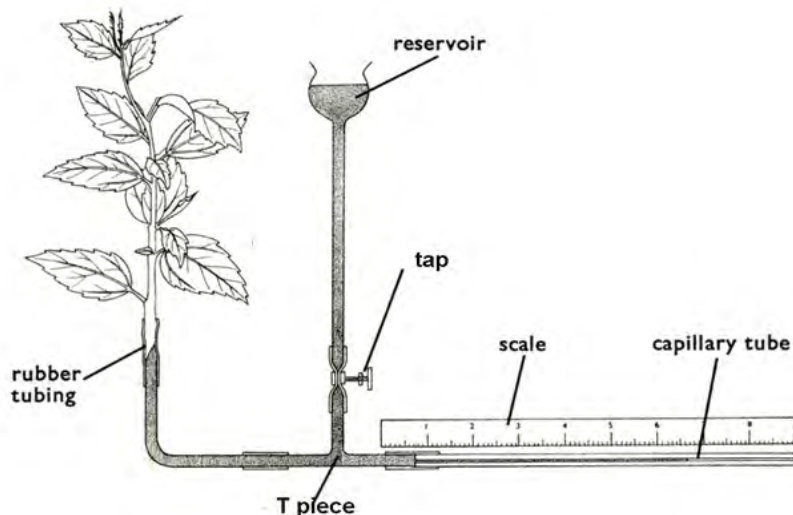
- Identify any variables that should be controlled and outline how this should be done
- What would be the best method for setting up the potometer?
- Plot a graph of the distance of the fan from the shoot, against the rate of water movement in the potometer, after the practical. Make sure you know how to calculate rate.

Wind speed in this case is varied by moving the fan to fixed distances from the leafy shoot. Although the wind speed from the fan will not accurately follow the inverse - square law, you would be well advised to understand how increasing the distance of the fan from the shoot, may affect the wind speed.

Method

Preparations

The apparatus should be assembled as shown in the following diagram.



1. Attach the rubber tubing, the capillary tube and the water reservoir to the T piece.
2. Fill the reservoir, capillary tube and rubber tubing with water. This can be done by placing them under water and gently squeezing the rubber tubing until all the air has been removed.
3. Leave the apparatus under water.
4. Cut a fresh leafy shoot with a sharp knife and immediately place the cut end under water.
5. Carefully attach the cut end of the shoot to the rubber tubing. This should be done with the cut end only under water.
6. Close the tap on the water reservoir.
7. Remove the apparatus from the water and attached to a clamp stand or support.
8. Place a mm scale behind the capillary tube.
9. Place a fan at a set distance from the leafy shoot. Do NOT switch on.

Making observations

1. Note the position of the air bubble in the capillary tube. It may be very close to then end of the tube.
2. Record the time taken for the air bubble to move a set distance along the tube. You will have to determine this distance base on the speed of the bubble. If the bubble is moving quickly the distance will need to be larger than if it is moving slowly.
3. Reset the air bubble to then end of the capillary tube by carefully opening

the tap on the water reservoir.

4. Turn on the fan and repeat the procedure.
5. Reset the apparatus and move the fan to another distance.
6. Repeat the procedure with the fan at at least five different distances.

You are advised to start with the fan at the furthest distance and gradually move it towards the leafy shoot.

Calculations

1. Calculate the rate of movement using $1/\text{time}$ taken for the air bubble to travel a set distance.
2. Record the rate of travel for each distance in the class result table on the board or flip chart.
3. When all of the results have been recorded in the class results table, calculate the mean rate of movement for each distance.
4. (Optional) – calculate the standard error for each distance.

Write up

- Record your results in a clear table ensuring units are put in headers.
- Plot a graph to show the mean rate of movement for each distance.
- (Optional – add error bars to your graph)
- Make an evaluation considering:
 - the limitations of the method used,
 - anomalous values if any,
 - replication and range of values of independent variable,
 - the confidence with which the conclusions should be drawn.
- Draw conclusions considering:
 - detailed description of the features of the results,
 - whether your results agree or contradict your hypothesis,
 - a scientific explanation of your results and conclusions,
 - any modifications you could make to improve the experiment.

Practical 10 - Lesson Plan

The effect of wind speed on the rate of transpiration in a leafy shoot.

Context

A practical investigation set in the context of 9700 syllabus – Investigate experimentally the factors that affect transpiration rate.

Key aims of the lesson

This practical is designed to develop the skills of planning, observation, analysis and evaluation.

Intended learning outcomes

By the end of the practical and the write-up the student should be able to:

- make a hypothesis and express this in words and graphically
- identify the dependant and independent variables
- identify the variables that should be controlled
- experience relevant methods, analysis, conclusions and evaluation
- describe and explain the relationship between wind speed and the rate of transpiration in a leafy shoot.

Resources required

White board or flipchart and suitable pens or blackboard and chalk

Practical materials specified on the Technical Information Sheet.

Copies of the student worksheets.

Planned activities (timings can be altered to suit shorter or longer lessons)

Timings/ minutes	Teacher/ Student Activities
End of previous lesson	Preparation – 2 page student worksheet given out for students to read in preparation for the practical lesson. To consider identification of the variables, formulate a hypothesis and review previous learning on water movement through plants.
0 - 3	Introduction to the aims, intended outcomes and shape of the lesson – teacher led oral presentation
3 - 5	Context – review transpiration in plants. Teacher led questioning, student responses / discussion regarding the factors that can affect the rate of transpiration and how they might be measured.
5 - 10	Introduction to method – Teacher briefly demonstrates the procedure for setting up the potometer and explains the importance of not having any air in the apparatus until the introduction of the air bubble. Teacher emphasises safety concerns with the sharp knife.
10 - 40	Carrying out the practical – students carry out the practical work..
40 - 50	Obtain results – Students enter results into table and clear away apparatus as soon as they have finished
50 - 60	Drawing together the threads – Teacher led discussion on the skills that have been developed as well as discussion on results obtained. Practical write up to be completed in following lesson or as homework activity to include identification of variables, the hypothesis, results and graphs along with a full detailed write of the experiment and an explanation of how the experiment could be extended.

Useful information

- The evaporation of water from a leaf is affected by wind speed, temperature, humidity and air pressure, the first three having the most significant affect.
- Increased temperature increases the kinetic energy of the water molecules thus increasing the rate of evaporation.
- Increased wind speed blows away evaporated molecules form around the opening of the stomata thus maintaining a greater diffusion gradient for the water molecules.

- Increased humidity lowers the concentration gradient and thus slows down the rate of evaporation.
- Reduced air pressure increases the rate of evaporation.
- Factors such as light are affected by the inverse square law where doubling the distance reduces the light intensity by a factor of four. Although this does not hold true for wind speed, you should be aware that doubling the distance of the fan from the leafy shoot, will not necessarily mean that the wind speed is reduced by half.
- Possible variables to control include temperature and humidity.

For students unable to obtain accurate data, the following table of results may be used.

rate of movement / 1/time in seconds	distance of fan from shoot / cm
0.016	200
0.018	175
0.023	150
0.034	125
0.055	100
0.071	75
0.092	50
0.11	25

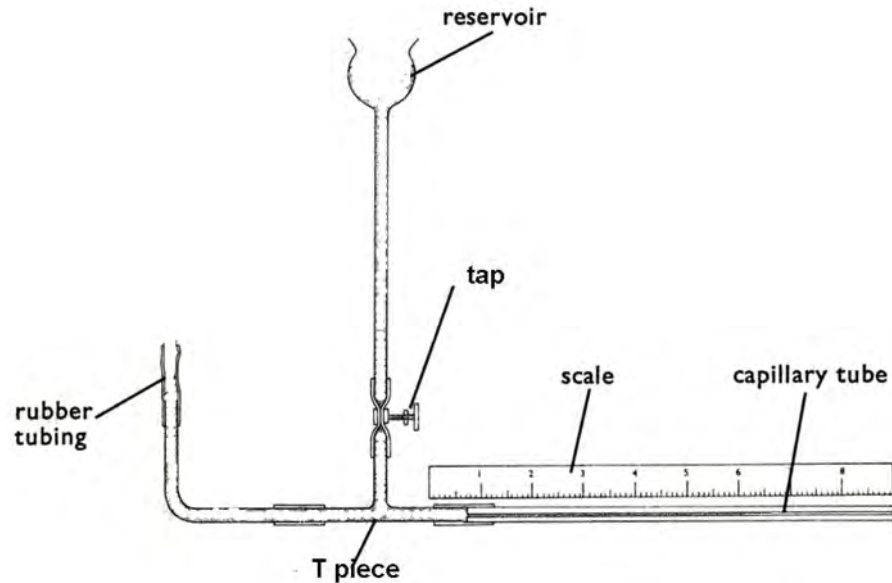
Practical 10 - Technical information

The effect of wind speed on transpiration in a leafy shoot

The apparatus and materials required for this practical are listed below.

The amount of apparatus listed is for **one student or one group of students** if they are to work in groups.

1. 1 freshly cut leafy shoot that has been put immediately into fresh water
2. 1 potometer set up as shown in the diagram below.



3. electric fan
4. meter rule
5. sight of a stop watch or clock

Additionally each student will require access to a sink and running water.

Safety Precautions/Risks.

No specific hazards identified.

A risk assessment should be carried out as a matter of course.