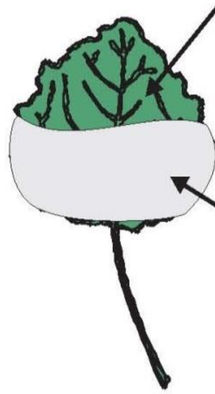
EXPERIMENT 22 – IS LIGHT NEEDED FOR PHOTOSYNTHESIS ?
CSEC OBJECTIVE: Section B 2.2

Grade Level – 10

	You Need **Apparatus:** Comboplate®; 2 x propettes; lid 1; Plastic lunch box; Paper clips; Forceps; Geranium leaf; Aluminium foil or black paper. **Chemicals:** I2/KI solution (iodine solution); 70 % alcohol.
	What to do Follow the instructions as set out underneath. For this investigation, you will use a leaf from a geranium plant which is growing in the garden or in a pot. The leaf remains on the plant until you are ready to do the starch test, then you remove the leaf.  1. As soon as possible after sunrise, cover part of the leaf TOP SIDE AND BOTTOM SIDE with aluminium foil or black paper. In this way, you are preventing light falling on the covered part of the leaf. 2. Wait for a day before doing anything else. 3. Draw the leaf accurately, marking exactly where the paper or foil covered the leaf. 4. Use lid 1 to cut discs from the leaf as in previous activities. 5. Keep discs from the covered part **separate** from discs from the uncovered parts of the leaf. 6. Test the discs for starch in the same way as you did in previous activities. 7. Tabulate your results.
	QUESTIONS 1. What did the foil or black paper do? 2. What do you suppose is the link between light and photosynthesis? 3. What does the word "*photosynthesis*" mean?

EXPERIMENT 23– IS CARBON DIOXIDE NEEDED FOR PHOTOSYNTHESIS ?
CSEC OBJECTIVE: Extension activity for Section B 2.4

Grade Level – 10

You Need

Apparatus: Comboplate®; Propettes; Large vial; Stopper to fit large vial;
Small pot plant with a few leaves*; Sharp knife.

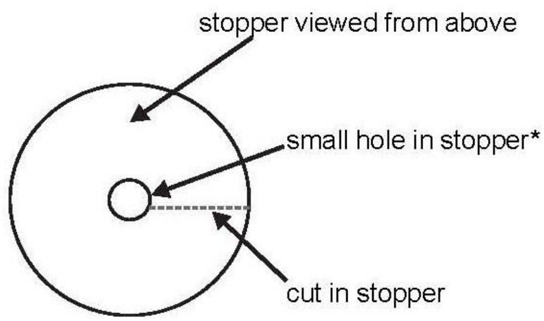
Chemicals: I2/KI solution (iodine solution); 70 % alcohol; Soda-lime; Petroleum jelly.

* A young seedling, recently germinated is very suitable provided the leaves ***are green*** i.e. have started photosynthesising.

What to do

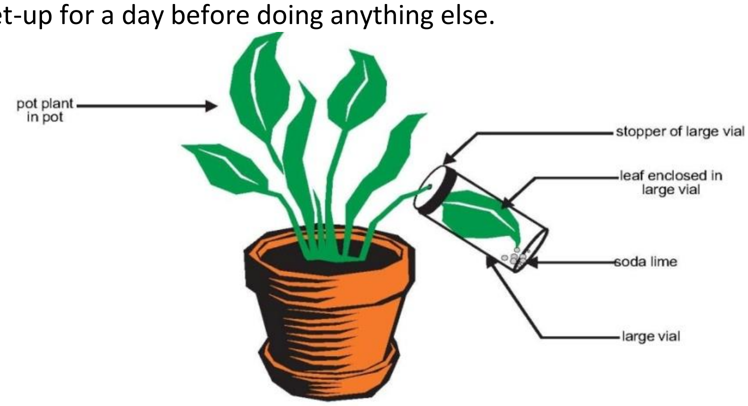
Follow the instructions as set out underneath.

1. Shake the soda lime into the large vial until the vial is one quarter full.
2. Use the knife to cut the stopper of the vial as shown below.



* the hole must be large enough for the petiole (stalk) of the leaf to fit

3. DO NOT PICK ANY LEAF OFF THE PLANT!!
4. Fit the stopper around a small leaf, sealing any gaps with petroleum jelly.
5. Place the vial with the soda lime onto the stopper as shown.
6. Seal all joints with petroleum jelly so that no air enters the jar.
7. Support the vial on any suitable and convenient item - the comboplate®, the pot, a pile of paper . . .
8. Leave the set-up for a day before doing anything else.



9. Pick the leaf which was enclosed and pick another leaf of similar size from the same

plant.

10. Test leaf discs for the presence of starch as you did in the previous investigations. Remember to keep the chlorophyll extracts in a cool place.

REMEMBER TO KEEP THE LEAF DISCS FROM THE LEAVES INSIDE THE BOTTLE AND OUTSIDE THE BOTTLE SEPARATE

11. Record your results in a table like the one below.

Leaf	Colour after Testing with Iodine Solution	Conclusion

QUESTIONS

1. Did the leaf discs which did not receive carbon dioxide have any stored starch?
2. Did the leaf discs which did receive carbon dioxide have any stored starch?
3. What do these results suggest to you?
4. What elements are present in carbon dioxide?
5. What elements are present in glucose and in starch?
6. Where does the additional element come from?

EXPERIMENT 24 – IS OXYGEN RELEASED DURING PHOTOSYNTHESIS?
CSEC OBJECTIVE: Section B 2.2

Grade Level – 10

You have already learned that light, chlorophyll and carbon dioxide are necessary for photosynthesis. In this activity, you are going to find out whether oxygen is released during photosynthesis.

You Need

Apparatus: Comboplate®; 2 x gas collecting tubes, A and B*; 2 x lids of gas collecting tubes*; 1 x microspatula; Water plant; Light source - such as a lamp**.

Chemicals: Methylene blue solution (0.1% aq); Tap water; Sodium hydrogencarbonate (NaHCO3(s)).

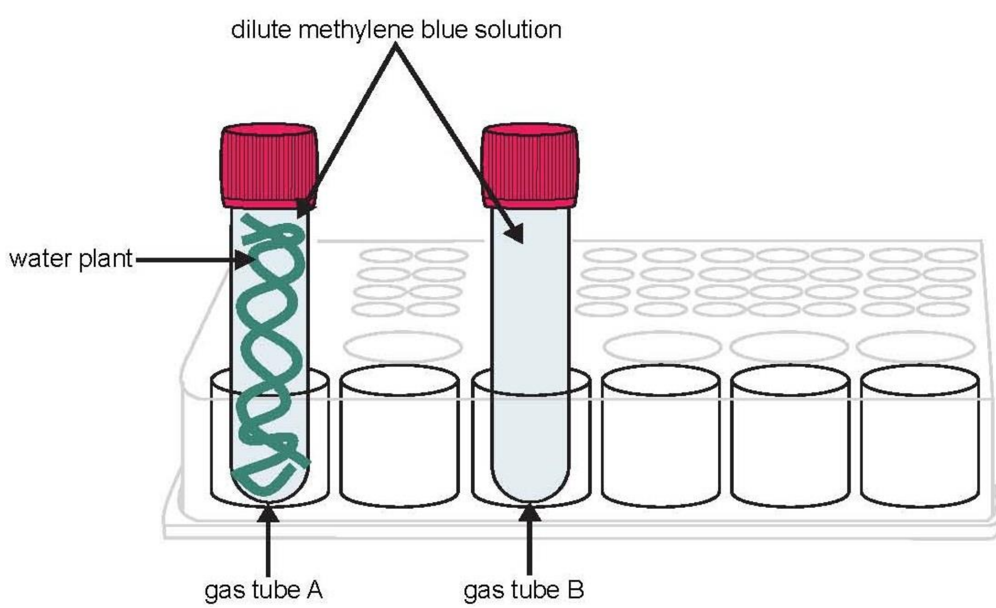
* *only one provided per kit.*

** *optional but recommended; not provided in kit.*

What to do

Work in groups, sharing equipment so that each group has access to all the equipment required.

1. Fill the gas collecting tubes with water and place 3 microspatulas full of sodium hydrogencarbonate in each tube.
2. Add a few drops of methylene blue solution to each tube. Take care not to add too much methylene blue. The water should not change colour to a marked extent.
3. Place a suitable length of water plant inside tube A. Do not place any water plant in tube B.
4. Place the tubes in two of the large wells of the comboplate® and leave the apparatus in the sunlight or near a light source for several hours.
5. Observe the set up closely. (*See Question 1*)



	QUESTIONS 1. Note what you observe in each of the tubes. 2. What can you deduce from your observations? 3. Why did we add sodium hydrogencarbonate (NaHCO3) to the water? 4. What happened to the solution in tube B?

EXPERIMENT 25 – THE PRODUCTS OF COMBUSTION
CSEC OBJECTIVE: Extension of Section B 3.2

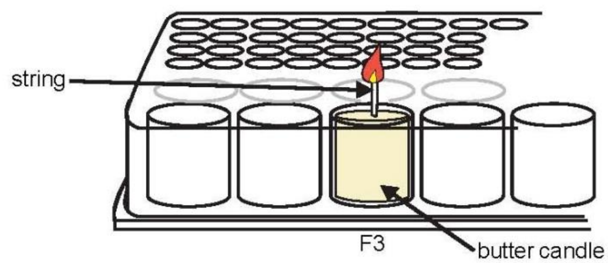
Grade Level – 10

INTRODUCTION
There are similarities and differences between respiration and combustion. In this investigation we demonstrate the products of combustion (by a burning candle).

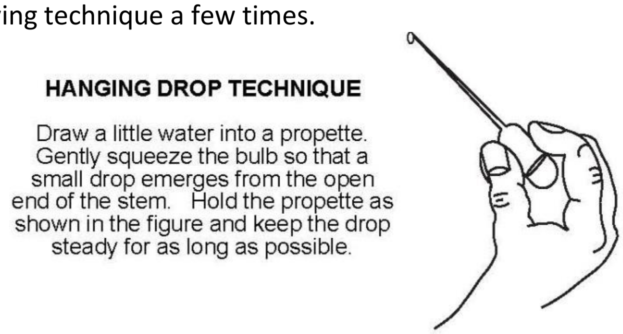
You Need
Apparatus: Comboplate®; 1 x 3 cm piece of string; 1 x propette; Matches; Vial.
Chemicals: Solid fat like butter or margarine; Lime water; 1 strip of anhydrous (blue) cobalt chloride paper.

What to do
Follow the instructions as set out underneath, using the diagrams to help you.

1. Shape the butter into a candle in well F3 of the comboplate®.
2. Insert the string - which acts as a wick - into the butter candle.
3. Light the wick and wait for about half a minute.



4. 4 Hold your hand over the flame.
   What do you notice?
5. 5 Hold a glass vial over the flame for a few seconds. Remove the vial and examine the surface.
   What do you notice?
6. 6 Dip a strip of cobalt chloride paper into a droplet on the vial. **What do you notice? What does this observation suggest to you?**
7. 7 Practise the following technique a few times.



8. Use the hanging drop technique with clear lime water and hold the drop near the flame of the butter candle for a few moments. **What changes occur in the lime water?**

	What does your observation suggest to you?
	QUESTIONS 1. What substances were produced during the combustion of the butter candle? 2. What else happened? 3. What happened to the butter candle?

EXPERIMENT 26 – IS CARBON DIOXIDE RELEASED DURING RESPIRATION IN GERMINATING SEEDS?

CSEC OBJECTIVE: Section B3.2

Grade Level – 10

As there is a lot of equipment required, work in groups; one group setting up the "experiment" and the other group setting up the "control". These must be set up at the same time.

You Need

Apparatus: 2 x comboplate®s; 2 x 2 ml syringes; 2 x lid 1; 2 x lid 2; *Prestik*;
2 x 50 mm lengths of silicone tubing; Germinating seeds; Dry, non-germinating seeds;
Paper towel or vermiculite.

Chemicals: Tap water; 2 ml clear lime water.

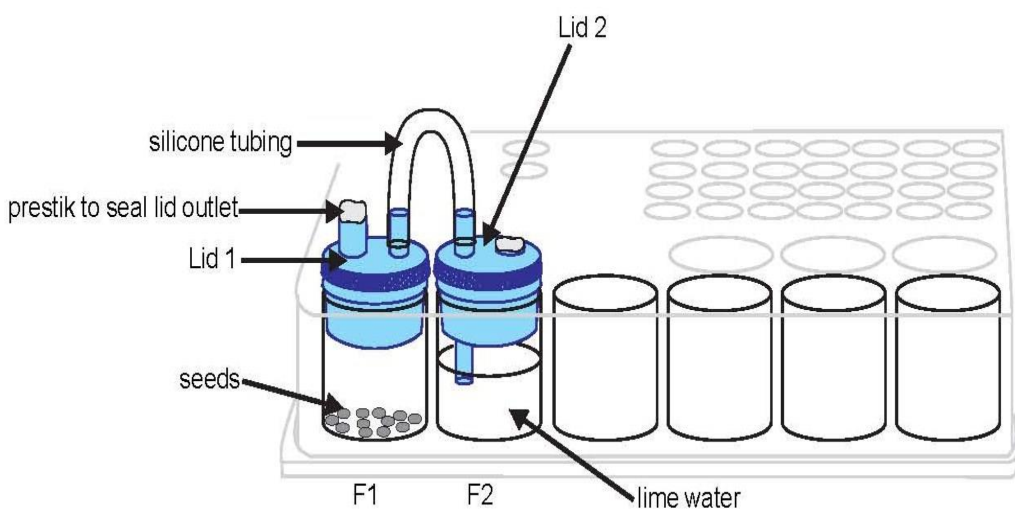
What to do

Follow the instructions as set out underneath, using the figure to help you.

1. **Experiment**
   Add the germinating seeds on moist paper towel or vermiculite to well F1 of one comboplate®.
   Control
   Add the non-germinating seeds on moist paper towel or vermiculite to well F1 of the other comboplate®.

Follow steps 2 to 7 for both comboplate®s.

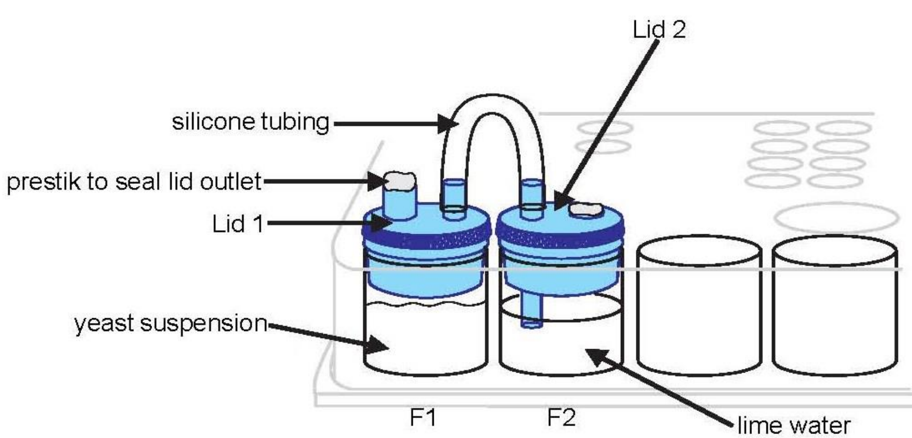
2. Add 2 ml clear lime water to well F2.
3. Cover well F1 with lid 1 and well F2 with lid 2.
4. Connect the outlet tubes of the lids with the silicone tubing.
5. Seal the remaining lid outlets with *prestik*.
6. Adjust the position of the lids so that there are no sharp bends or kinks in the silicone tubing.



7. Leave the set-up in a warm place for several days, observing the set up at least once

	every 24 hours. 8. Observe any changes which occur in the wells.
	QUESTIONS 1. What do you observe? a. Experiment: b. Control: 2. Why do you suppose the lime water turned milky? 3. Living organisms require fuel as a respiratory substrate. What did the seeds use as a substrate? 4. What will the seeds use as a substrate after the stored food is used up? 5. Design, without carrying out, an investigation to determine whether or not animals release carbon dioxide during respiration.

EXPERIMENT 27 – WHAT SUBSTANCES ARE FORMED DURING FERMENTATION? CSEC OBJECTIVE: Section B 3.2 Grade Level – 10

	INTRODUCTION Living organisms produce carbon dioxide during respiration. Most living organisms undergo aerobic respiration, which means that they use oxygen during the process. During aerobic respiration the substrate, glucose, forms carbon dioxide and water. Some organisms, however, do not undergo aerobic respiration; they do not use oxygen and glucose is converted to other organic compounds. In certain cases, carbon dioxide is also produced. In other words, some organisms undergo anaerobic "respiration". We call anaerobic "respiration" in certain organisms **fermentation**. During this investigation, you will examine **fermentation** by yeast.
	You Need **Apparatus:** 2 x comboplate®s; 2 x 2 ml syringes; 2 x lid 1; 2 x lid 2; *Prestik*; 2 x 50 mm lengths of silicone tubing. **Chemicals:** 1,5 ml yeast suspension in sucrose solution; 2 ml clear lime water.
	What to do Work in groups; one group being responsible for the "experiment" and the other group being responsible for the "control". Follow the instructions as set out underneath, using the diagram to help you. 1. Add 1,5 ml yeast suspension (experiment) or tap water (control) to well F1. 2. Add 2 ml clear lime water to well F2. 3. Cover well F1 with lid 1 and well F2 with lid 2. 4. Connect the outlet tubes of the lids with the silicone tubing 5. Seal the remaining lid outlets with prestik. 6. Adjust the position of the lids so that there are no sharp bends or kinks in the silicone tubing.  7. Leave the set-up in a warm place for 5 to 10 minutes.

	8. Observe any changes which occur in the wells.
	QUESTIONS 1. What do you observe? Experiment: Control: 2. Why do you suppose the yeast suspension became frothy? 3. How can you identify the gas? 4. What do you suppose would happen if there were no sugar in the yeast mixture? 5. Lift the lid of well F1 and smell the contents. What substance can you smell? 6. What is the formula of this substance? This compound is produced when glucose is acted on by the enzymes in yeast and in certain other organisms. We say that yeast is a ***facultative anaerobe***. This means that when oxygen is present it respires using oxygen, but is able to perform fermentation when necessary, i.e. when there is insufficient oxygen present.

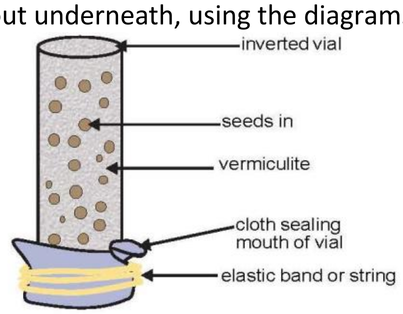
EXPERIMENT 28 – IS OXYGEN USED DURING RESPIRATION?
CSEC OBJECTIVE: Section B 3.1, B 8.3

Grade Level – 10

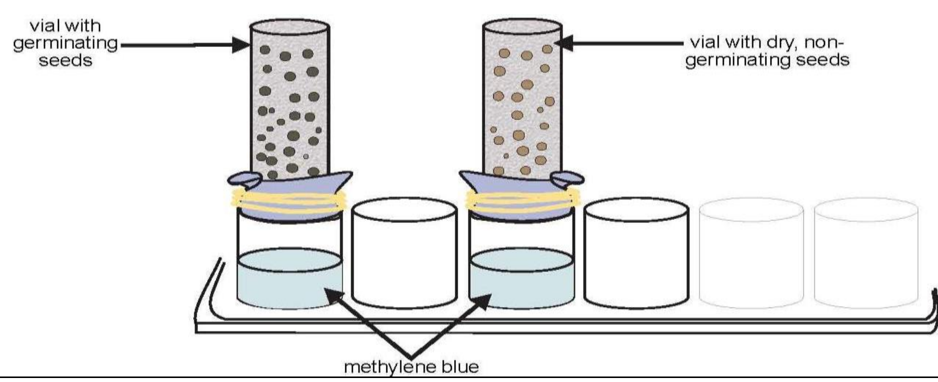
INTRODUCTION
Most living organisms undergo aerobic respiration, which means that they use oxygen during the process.
This investigation demonstrates the use of oxygen by germinating seeds.

You Need
Apparatus: 1 x comboplate®; 2 x small vials; 2 pieces of fine fabric - old stockings are ideal; elastic bands or string; *Prestik*; Dry, non-germinating seeds; Germinating seeds; Vermiculite or absorbent paper.
Chemicals: Methylene blue solution.

What to do
Follow the instructions as set out underneath, using the diagrams to help you.



1. Three-quarters fill one vial with germinating seeds in vermiculite and the other vial with dry, non-germinating seeds in vermiculite.
2. Tightly cover the mouth of each vial with a small piece of cloth. Secure the cloth with string or elastic band.
3. Invert the vials so that the seeds and vermiculite rest on the cloths.
4. Use a propette to half-fill wells F1 and F3 with methylene blue.
5. Place the inverted vials over the wells holding them steady with *prestik* if necessary.
6. Leave the set-up in a warm place for several days.
7. Observe and compare the growth of the seeds in the two vials.



	QUESTIONS 1. What do you observe? 2. What do your results suggest to you? 3. In this investigation, which set-up was the control?

EXPERIMENT 29 – IS ENERGY RELEASED DURING RESPIRATION ?
CSEC OBJECTIVE: Section B 3.2

Grade Level – 10

INTRODUCTION

The energy released in aerobic respiration is used by cells for many purposes. Some of these are: chemical reactions which require energy as well as growth, movement, reproduction and others.

This activity demonstrates the release of energy in the form of "heat" by living organisms.

You Need

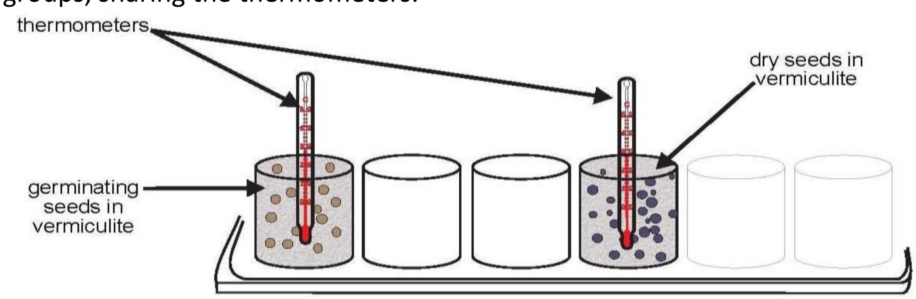
Apparatus: 1 x comboplate®; 2 x thermometers; *Prestik*; Dry, non-germinating seeds; Germinating seeds; Vermiculite or absorbent paper; Cotton wool.

Chemicals: Tap water.

What to do

Follow the instructions as set out underneath, using the diagrams to help you.

Work in groups, sharing the thermometers.



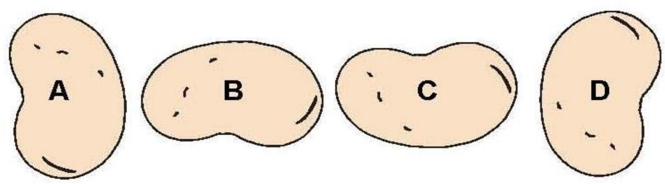
1. Fill well F1 with germinating seeds in vermiculite.
2. Fill well F4 with dry, non-germinating seeds in vermiculite.
3. Place a thermometer in each of wells F1 and F4, making sure that the bulbs are completely covered.
4. Leave the setups in a warm place, out of the sun and away from artificial heaters for a week.
5. Read the temperatures every day, at the same time of day if possible
6. Copy and complete the table on the next page into your notebook. Fill in your results. What do your findings suggest to you?

	Temperature in well F1 (0C)	**Temperature in well F4 (0C)**
Day 1		
Day 2		
Day 3		
etc. for a week		

	QUESTIONS 1. Which setup was the control in this investigation? 2. What else could be used as a control? 3. Why do you suppose that it is necessary to keep the setups away from the sun and artificial heaters? 4. Give another example of a temperature rise due to respiration.

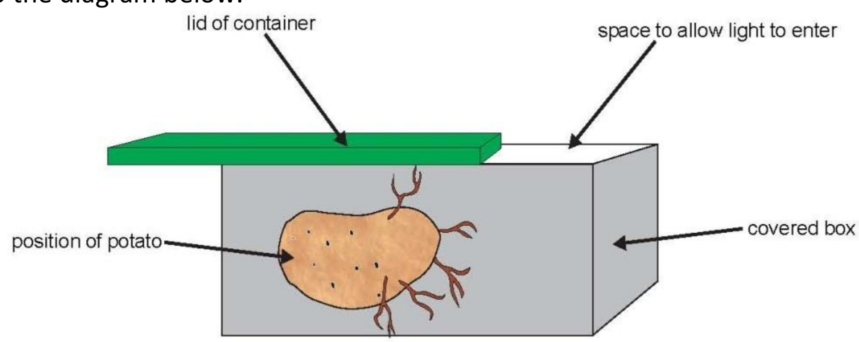
EXPERIMENT 30 – DO THE RADICLES OF SEEDS ALWAYS GROW DOWNWARDS?
CSEC OBJECTIVE: Section B 7.2 (a)

Grade Level – 11

	You Need **Apparatus:** Comboplate®; Suitable seeds; Small plant pots; Vermiculite. **Chemicals:** Tap water.
	What to do Follow the instructions as set out underneath. 1. Soak a number of seeds of the same type overnight. 2. Moisten enough vermiculite to fill 4 small plant pots. 3. Place the seeds *in different positions* in the moist vermiculite of each of the pots.  4. Leave the seeds in a warm, sheltered place for several days. Do not leave in direct sunlight and do not allow the seeds to dry out. 5. **IT IS VERY IMPORTANT TO KEEP THE VERMICULITE MOIST OR ELSE THE SEEDS WILL NOT GERMINATE** 6. Allow the seeds to germinate. Watch the behaviour of the radicles (young roots).
	QUESTIONS 1. Write down what you observe when the seeds germinate. 2. What happened to the plumules (young shoots) of the seedlings? 3. Use what you have learned about tropisms to complete the following sentence about the behaviour of roots and shoots. Roots are ____________ geotropic and negatively ______________; shoots are ____________ phototropic and ___________ geotropic. 4. What is the advantage of tropism ***to the species***? [HINT]: Think of the ways in which seeds fall to the ground when they are scattered.

EXPERIMENT 31 – IN WHICH DIRECTION DO YOUNG SHOOTS GROW ?
CSEC OBJECTIVE: Section B 7.2 (a)

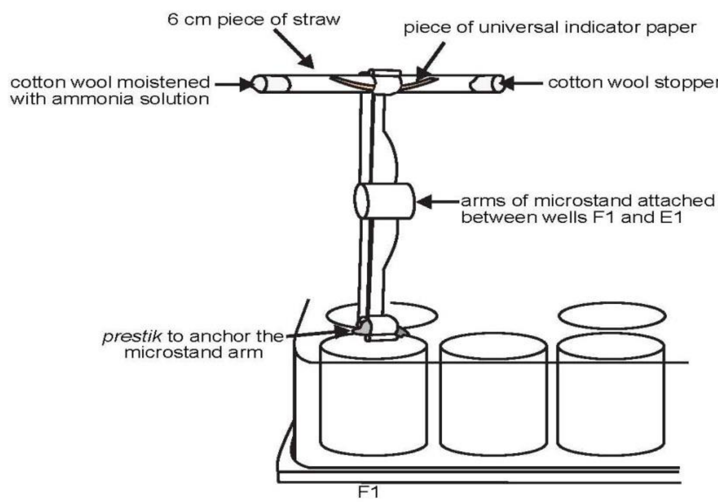
Grade Level – 11

	You Need **Apparatus:** Plastic lunch box with lid; A sprouting potato*; Dark paper or aluminium foil; Scissors and tape. **Chemicals:** No special chemicals required. * Your teacher will tell you what to do.
	What to do Follow the instructions as set out underneath. 1. Allow the potato to sprout until the shoots are about 1,5 cm to 2 cm long. 2. Place the potato at one end of the plastic container. 3. Place the lid on the container so that 6 cm is left uncovered at the end opposite the potato. 4. Cover the container with paper or foil in such a way so that light can enter the box only at the end opposite the potato. Refer to the diagram below.  5. Leave the setup for a few days, looking into the box once a day to observe any changes.
	QUESTION 1. Note your observations. 2. What does your observation tell you about the behaviour of the shoots? 3. What other evidence of this phenomenon do we see in our everyday lives?

EXPERIMENT 32 – DIFFUSION IN A GAS

CSEC OBJECTIVE: Section B 1.6

Grade Level – 10

	In this activity, two microstand arms are needed. Therefore it is suggested that students work in groups to ensure that there is sufficient apparatus. Please read and follow the instructions which follow. Use the figure to help you.
	You Need **Apparatus:** Comboplate®; 1 x propette; 1 x microstand; 1 glass tube; 1 clear plastic straw (6 cm piece); Cotton wool; *Prestik*. **Chemicals:** Ammonia solution; Universal indicator paper; Tap water.
	What to Do 1. Firmly attach one microstand arm with prestik between wells F1 and E1. See diagram below.  2. Cut a strip of universal indicator paper 4 cm long and 2 - 3 mm wide and place it in the middle of the straw. 3. Use cotton wool to make a "stopper" of about 1 cm at each end of the straw. 4. Use a propette to transfer a few drops of ammonia solution to the cotton wool at each end of the straw. The cotton wool should be damp, not soaking wet. Do not let the wet cotton wool touch the universal indicator paper. 5. Carefully observe what happens to the universal indicator paper.
	QUESTIONS 1. What colour was the universal indicator paper when it was placed in the straw? 2. What happens to the indicator paper when ammonia solution is dropped onto the cotton wool? 3. What caused the colour of the universal indicator paper to change? 4. Do you think that an air current through the tube could be responsible for the change which occurred to the universal indicator paper?

EXPERIMENT 33 – MORE DIFFUSION IN A GAS

CSEC OBJECTIVE: Section B 1.6

Grade Level – 10

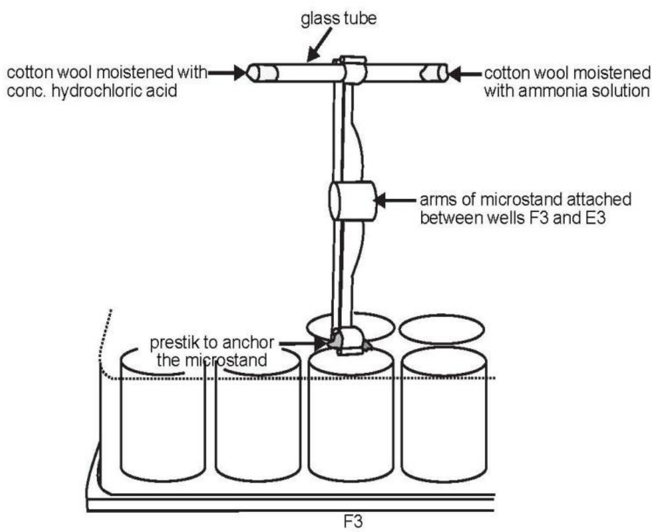
You Need

Apparatus: 1 x comboplate®; 2 x propettes; 1 x microstand; 1 glass tube; Cotton wool; *Prestik*.

Chemicals: Ammonia solution ($NH3(aq)$); Concentrated hydrochloric acid ($HCl(aq)$); Universal indicator paper; Tap water.

What to Do

1. Firmly attach a microstand arm with prestik between wells F3 and E3.
2. Secure a glass tube into the microstand as shown in the diagram:



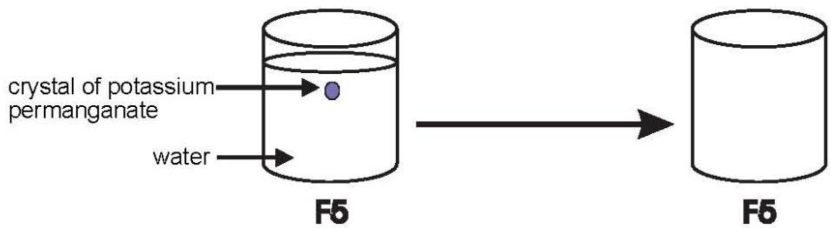
3. Shape a small tuft of cotton wool into a thin threadlike piece of about 1 cm long. Break it into two pieces and insert one piece into each end of the glass tube.
4. Use a clean propette to place a few drops of concentrated hydrochloric acid onto the cotton wool on the left hand side of the glass tube.
5. Use another, different, clean propette to place a few drops of ammonia solution onto the cotton wool on the right hand side in the glass tube.
6. Leave the set-up to stand for several minutes.
7. Record your observations in a table like the one below:

Time in Minutes	Observation
5	
10	
15	

	QUESTIONS 1. What happened in the glass tube? 2. What are the tiny white spots which have formed on the glass tube? 3. How did these white spots appear?

EXPERIMENT 34 – DIFFUSION IN A LIQUID
CSEC OBJECTIVE: Section B 1.6

Grade Level – 9&10

	You Need **Apparatus:** 1 x comboplate®. **Chemicals:** Potassium permanganate ($KMnO4(s)$); Tap water.
	What to Do 1. Fill well F5 with water. 2. Drop a crystal of potassium permanganate into the water. 3. Draw your observation in a diagram like the one below: 
	QUESTIONS 1. What happened when the crystal of potassium permanganate was dropped into the water? 2. Explain your observation:

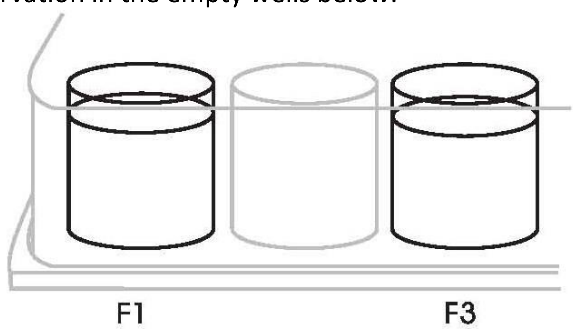
EXPERIMENT 35 – DIFFUSION IN A SOLID
CSEC OBJECTIVE: Section B 1.6

Grade Level – 9&10

You Need
Apparatus: 1 x comboplate®; Teaspoon*; Suitable container like a cup*; 1 x 2 ml syringe.
Chemicals: Potassium permanganate ($KMnO_4(s)$); Copper sulphate ($CuSO_4.5H_2O(s)$); Gelatine; Tap water.
* not provided in the kit.

What to Do

1. Add 2 teaspoons of gelatine to 50 ml of warm water in the cup and stir.
2. Use the syringe to draw up some of the gelatine mixture and fill both wells F1 and F3 to the top with the mixture.
3. Wait until the gelatine has set.
4. When the gelatine has set, add a few crystals of potassium permanganate to well F1.
5. Similarly, add a few crystals of copper sulphate to well F3.
6. Observe the setup every two minutes for 10 minutes.
7. Draw your observation in the empty wells below:



QUESTIONS

1. What did you observe in F1?
2. What did you observe in F3?
3. Why did the colours move downwards in well F1 and F3?
4. If you leave these wells to stand for another day what would happen?

EXTENSION QUESTION
Repeat the entire procedure. This time, wait for half an hour then invert (turn upside down) the comboplate® after step 5. Discuss your findings with other members of the class.

EXPERIMENT 36 – OBSERVING OSMOSIS USING DIALYSIS TUBING

CSEC OBJECTIVE: Section B 1.6

Grade Level – 10

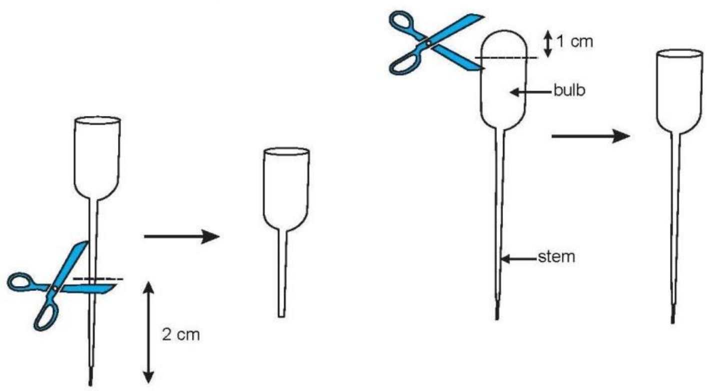
You Need

Apparatus: Comboplate®; 2 x propettes; 1 x microstand; 2 x glass vials; Scissors; 2 pieces of 8 cm square dialysis tubing; Cotton, thin string or elastic band; *Prestik* .

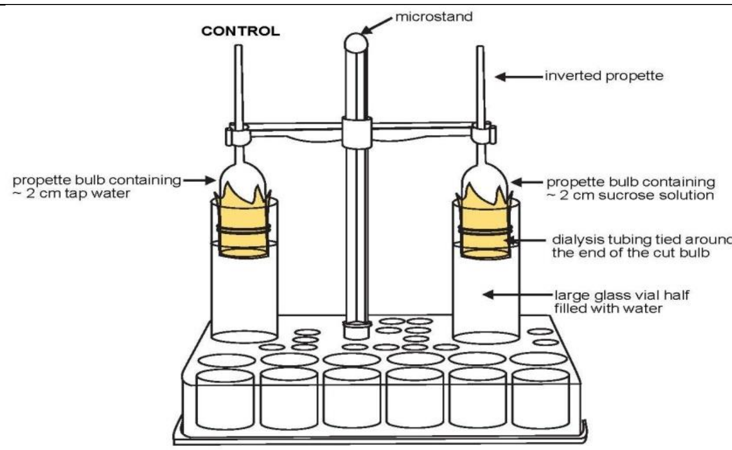
Chemicals: Sucrose solution, or orange juice, or syrup with water; Tap water.

What to Do

1. Place the microstand in well C5.
2. Half fill two large glass vials with water.
3. Secure one vial onto the comboplate® with prestik underneath the left hand arm of the microstand and another one underneath the right hand side of the microstand.
4. Cut about 1 cm off the bulbous ends of the two propettes.
5. Then cut about 2 cm off the thin end of the propettes.



6. Cut two 8cm square pieces of dialysis tubing (which has been soaked in water for (1 - 2 hours) and tie them **firmly** around the open cut ends of the propettes with a piece of string or elastic (whichever is easier).
7. Insert the thin cut end of one propette into the sucrose solution and draw up about 2 cm of sucrose solution.
8. Invert the propette containing the sucrose solution into the vial with water as shown in the diagram:



9. Secure the thin stem of the propette with prestik onto the microstand.
10. Mark the level of the sucrose solution with a marking pen and leave to stand for about an hour.
11. Do the same with the second propette but this time use tap water. This is the CONTROL.
12. Observe and note whether any change has taken place.
13. Mark any changes with the marking pen every 15 minutes and record these changes in a table like the one below.

Time (Minutes)	**Height of Solution (mm)**
15	
30	
45	
60	

QUESTIONS

1. What did you observe about the level of the water in the propette?
2. Why did the level in the stem rise?
3. Is the dialysis tubing totally permeable, selectively permeable or impermeable?
4. Do you think that the sugar molecules are able to move through the dialysis tubing? Give a reason for your answer by referring to the structure of the membrane.
5. The water molecules can / cannot move through the dialysis tubing. Which is correct?
6. Draw a graph to show how the level of the solution in the stem of the propette changes with time.

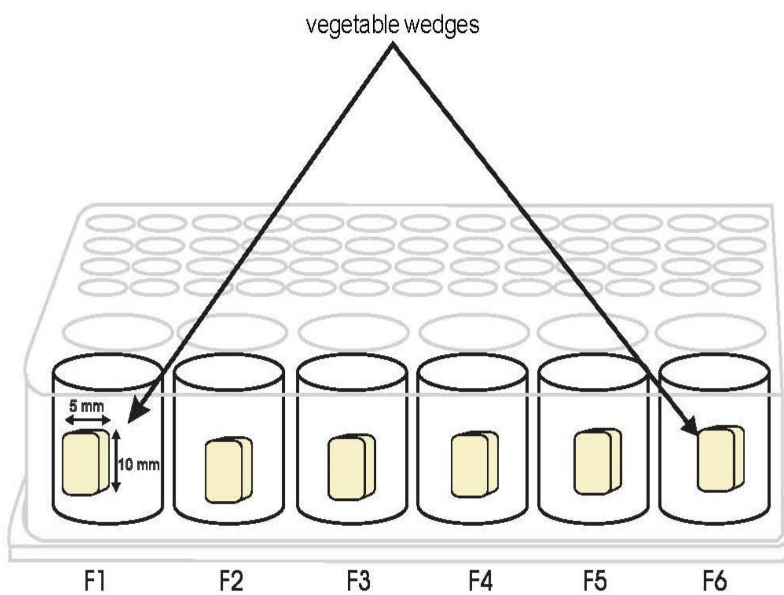
EXPERIMENT 37 – HOW DOES OSMOSIS OCCUR IN LIVING TISSUE?
CSEC OBJECTIVE: Section B 1.6

Grade Level – 10

INTRODUCTION
You have learnt that water moves by osmosis through selectively permeable membranes like dialysis tubing.
The following activity investigates osmosis in living tissue.

You Need
Apparatus: Comboplate®; 3 x propettes; Sharp knife; Ruler; Paper towel;
Fresh potato or other vegetable like carrot, sweet potato, turnip, parsnip;
Accurate mass meter (optional).
Chemicals: 30 % sucrose solution; 10 % sucrose solution; Tap water.

What to Do
1. Remove the skin from the potato or other vegetable and cut 6 equal-sized pieces of potato or other vegetable with the knife. The pieces should be approximately 10 mm x 5 mm x 5 mm.
2. Measure the pieces with the ruler and feel them between thumb and forefinger.
3. Place 1 potato or other vegetable piece in each of the F wells of the comboplate®.



4. Use a clean propette to fill wells F1 and F2 with tap water.
5. Use a clean propette to fill wells F3 and F4 with 10 % sucrose solution.
6. Use a clean propette to fill wells F5 and F6 with 30 % sucrose solution.
7. Leave the setup for several hours.
8. Remove the potato or other vegetable pieces and place them on the paper towel.
9. Feel the pieces again between thumb and forefinger. Note your findings.
10. Measure the pieces again with the ruler. Note your findings.

11. Record your results in a table like that below.

Potato or Other Vegetable Piece	What it Felt Like	Length in mm
F1 (tap water)	Before:	
	After:	
F2 (tap water)	Before:	
	After:	
F3 (10 % sucrose solution)	Before:	
	After:	
F4 (10 % sucrose solution)	Before:	
	After:	
F5 (30 % sucrose solution)	Before:	
	After:	
F6 (30 % sucrose solution)	Before:	
	After:	

Compare your findings with those of other groups.

QUESTIONS

1. In general, what happened to the potato or other vegetable pieces in the tap water?
2. In general, what happened to the potato or other vegetable pieces in the 10 % sucrose solution?
3. In general what happened to the potato or other vegetable pieces in the 30 % sucrose solution?
4. Try to give reasons for your findings in each case.

EXPERIMENT 38 – PATH OF WATER THROUGH THE PLANT
CSEC OBJECTIVE: Section B 4.8

Grade Level – 9&10

	INTRODUCTION You have seen that water passes into cells and tissues by osmosis. In this way, water passes into the roots of plants. The next question to ask is **"What happens to the water once it is in the root system of a plant?"** The following activity investigates the path of water through the plant.
	You Need **Apparatus:** Comboplate®; 1 x propette; Vial; Microstand; Hand lens; Young, healthy seedling between 6 cm and 10 cm tall; Blade. **Chemicals:** Tap water; Red food colouring.

What to Do

1 Remove the seedling from the soil immediately before you start the investigation.

2 Wash the soil from the roots.

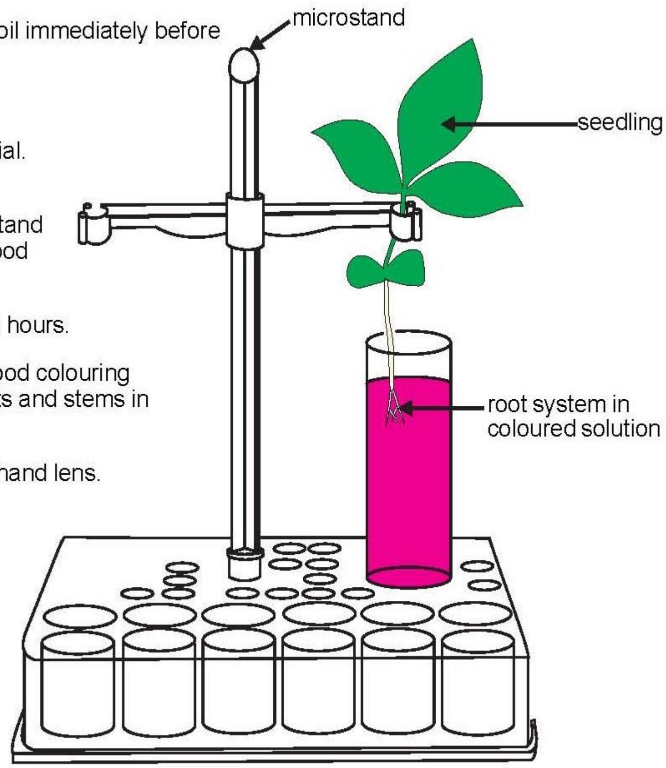
3 Place the food colouring in the vial.

4 Support the aerial parts of the seedling in an arm of the microstand and submerge the roots in the food colouring as shown alongside.

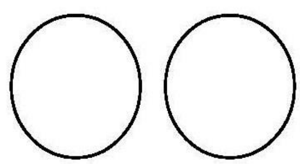
5 Allow the setup to stand for 1 - 3 hours.

6 Remove the seedling from the food colouring and use the blade to cut the roots and stems in transverse section.

7 Examine the sections using the hand lens.



8 Copy the circles below, draw what you see and mark with a coloured pen or pencil the areas where you can see the red food colouring.



Use a reference book to identify the tissues if you do not know their names.

QUESTIONS

1. In what tissue did you observe the red food colouring?
2. What can you conclude from this observation?

EXTENSION ACTIVITIES

1. Repeat the procedure with other plants which have variegated (for example, green and white) leaves and observe the leaf veins after a few hours.
2. Repeat the procedure with pale-coloured flowers and observe changes which occur in the petals.

EXPERIMENT 39 – DOES THE ROOT SYSTEM OF A PLANT PUSH WATER UP THE STEM?

CSEC OBJECTIVE: Section B 4.8

Grade Level – 9&10

INTRODUCTION

You have seen that water is carried in the xylem of plants from the roots to the stems and to other aerial parts.

This activity investigates how water passes upwards in plants.

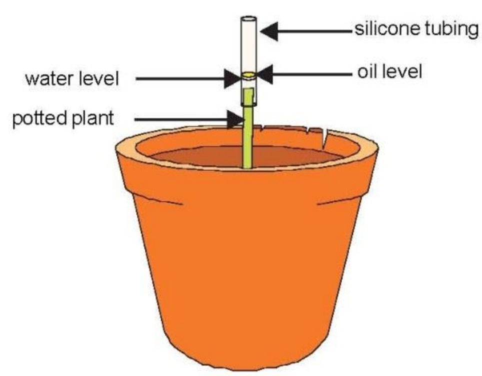
You Need

Apparatus: Small, young potted plant; Silicone tubing (2 cm length); 2 x propettes; Blade.

Chemicals: Tap water; Oil.

What to Do

1. Select a plant with a stem that will fit into the silicone tube.
2. Ensure that the plant has been well watered for a few days.
3. Use the blade to cut off the top of the plant about 2 cm above soil level. Discard the top of the plant.
4. Push one end of the silicone tube over the cut stem.
5. Use a propette to put water into the silicone tube until the water is just visible.
6. Use another propette to add a few drops of oil on the water in the tube.
7. Mark the level of the water in the tube.
8. Water the potted plant 2 or 3 times over the next 24 hours.
9. Observe any changes.



QUESTIONS

1. Why do you suppose we placed oil over the water in the tube?
2. What did you observe about the level of water in the tube above the stem?
3. Where did this water come from?
4. Do you think the water level rose because of transpiration?
5. What system of the plant caused the water level to rise?

EXPERIMENT 40 – IS WATER LOST THROUGH THE AERIAL PARTS OF A PLANT?

CSEC OBJECTIVE: Section B 4.8

Grade Level – 9&10

INTRODUCTION

You have already learned that water passes into plants via the root system and is transported in the xylem throughout the plant. This activity investigates which parts of plants release water.

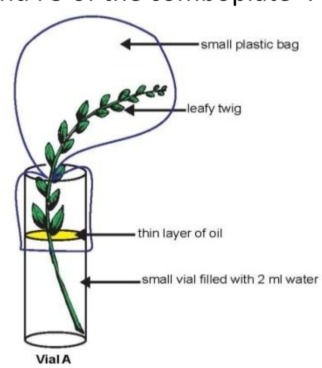
You Need

Apparatus: Comboplate®; 3 vials (A, B and C); A small leafy twig; A small leafless twig; A small flower on a stalk; propettes; 1 x 2 ml syringe; 3 small plastic bags; Elastic bands.

Chemicals: Tap water; Anhydrous (blue) cobalt chloride paper.

What to Do

1. Use the syringe to place 2 ml water in each of the vials.
2. Place the plant parts in the vials as follows:
    a. A leafy twig;
    b. B leafless twig;
    c. C flower on stalk
3. Use a clean propette to place a thin layer of oil on the water in each of the vials.
4. Cover vials A, B and C with the plastic bags and secure these with elastic as shown below.
5. Place the vials in wells F1, F3 and F5 of the comboplate®.



6. 6 Leave the setup for several hours, or overnight.
7. 7 Remove the plastic bags from the vials and estimate which bag contains the most, second most and least liquid. Record your estimations.
8. 8 Test the liquid in each one with cobalt chloride paper. Record your findings.

QUESTIONS

1. What was the purpose of the oil on the surface of the water?
2. Which plant part lost the most, second most and least liquid?
3. What happened to the blue cobalt chloride paper when you used it to test the liquids in each of the plastic bags?
4. What liquid did the plant parts lose?
5. Summarise all your findings in a single sentence.

EXPERIMENT 41 – INVESTIGATING HOW THE LEAVES OF PLANTS LOSE WATER

CSEC OBJECTIVE: Section B 4.8

Grade Level – 9&10

You Need

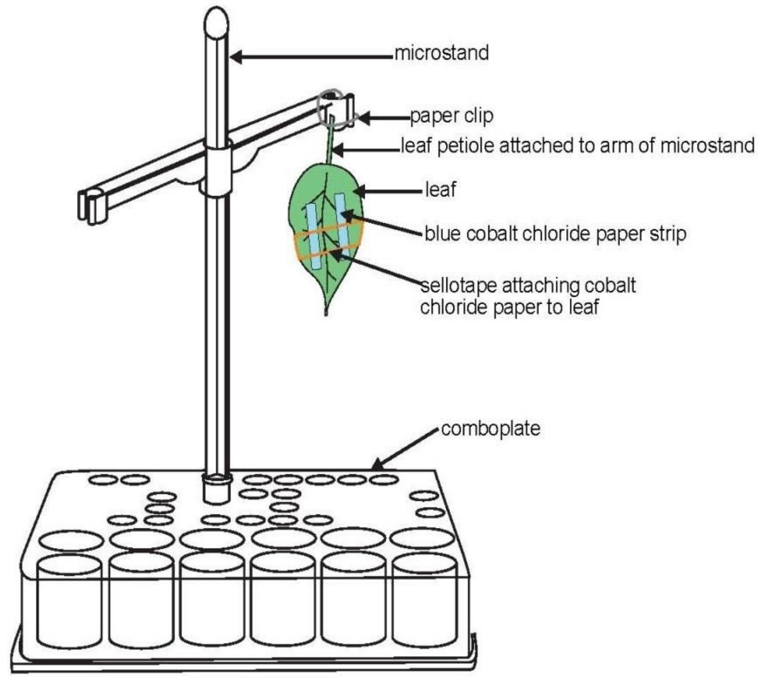
Apparatus: Comboplate®; Microstand; Leaf of plant (with petiole); Paper clip; Sellotape - width 10 mm; Hand lens.

Chemicals: Vaseline; Anhydrous (blue) cobalt chloride paper.

What to Do

Each student group should use a different leaf. In this way, comparisons can be made later.

1. Set up the comboplate® with a microstand in one of the small wells.
2. Select a suitable leaf.
3. Place small strips of cobalt chloride paper onto both dorsal (top) and ventral (bottom) sides of the leaf with the sellotape.
4. Attach the petiole of the leaf to an arm of the microstand as shown.



5. Leave to stand in a shady position. Examine the setup every five minutes and note any changes.
6. Examine one or two leaves with the hand lens. Draw what you see.

QUESTIONS

1. Was there any change in the colour of the cobalt chloride paper on any side of the leaves?
2. What does this observation suggest?

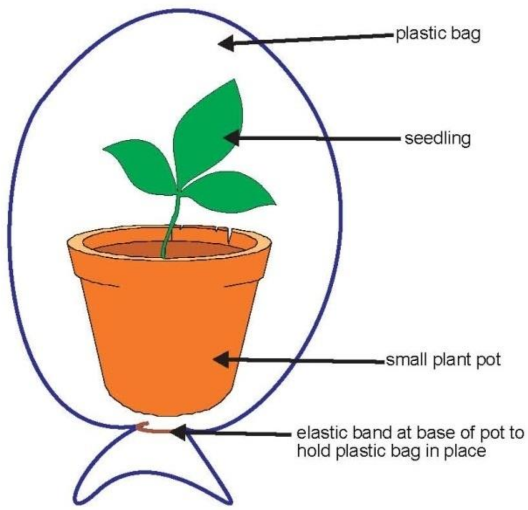
3. Do leaves lose water from both surfaces, from the upper surface, from the lower surface?
4. 4. Record your results in a table like that below.

LEAF	**SIDE**	**TIME**	**Colour of Cobalt Chloride Paper**
LEAF A	Dorsal		
	Ventral		
LEAF B	Dorsal		
	Ventral		
LEAF C	Dorsal		
	Ventral		

EXPERIMENT 42 – LOSS OF LIQUID WATER FROM PLANTS

CSEC OBJECTIVE: Extension of Section B 4.8

Grade Level – 9&10

	You Need **Apparatus:** Seedlings of three different plant species e.g. mealie, lentil, radish, already planted in pots; 3 small plant pots; Plastic bags large enough to cover the pots with the seedlings; Elastic bands. **Chemicals:** Tap water.
	What to Do 1. Ensure that the seedlings are well watered for a few days and that the soil or vermiculite is kept moist. 2. Cover the seedlings with the plastic bag held in place by an elastic band around the base of the pot.  **NOTE:** ***Steps 1 and 2 (above) create very humid conditions around the leaves.*** 3. Observe the seedlings over the next day or two.
	QUESTIONS 1. What can be seen along the margins of the leaves? 2. What process has taken place? 3. Under which environmental conditions would this process take place in plants? 4. Why would guttation occur under these conditions?

EXPERIMENT 43 – LOSS OF WATER FROM PLANTS UNDER VARIOUS ENVIRONMENTAL CONDITIONS

CSEC OBJECTIVE: Section B 4.9

Grade Level – 10&12

INTRODUCTION

You have already learned that transpiration is the evaporation of water from plant surfaces, particularly from the stomata on leaves. The quantity of water that plants lose in this way depends on both internal and external factors.

You Need

Apparatus: Comboplate®; *Prestik*; Gas collecting tube; Propette; 2 ml syringe;
China marker or felt-tipped pen; Plastic bag; String or elastic bands;
Small stalks of celery or other leafy twig.

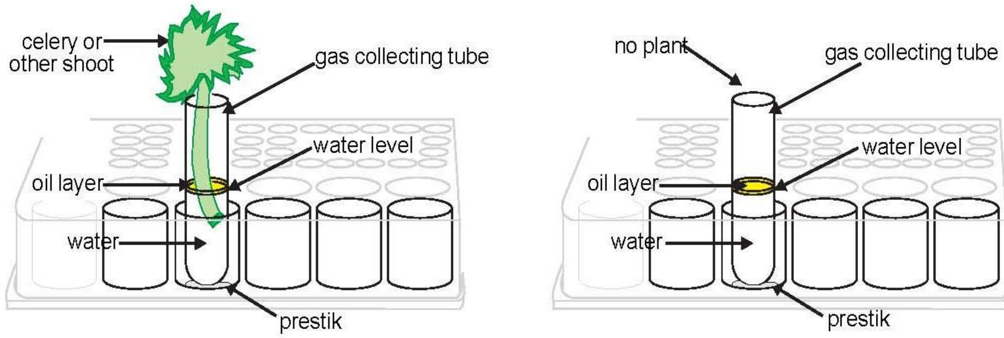
Chemicals: Tap water; Cooking oil.

NB The plants which you select must be of the same type (species) and must be as similar as possible. That is, they should have equal numbers of leaves, be of the same age and so on in order to make meaningful comparisons.

What to Do

A. As duplicate equipment is needed, work in groups so that each group has access to all the requirements. In this way, each group can take responsibility for a plant under different conditions.
   Half of the groups should have set-ups without plants. These setups serve as the controls.
B. It is advisable to prepare the setups as early as possible in the day, as nightfall alters the environmental conditions.
C. Follow the instructions underneath.

1. Use *prestik* to secure the gas collecting tube (open end up) in an F well of the comboplate®.
2. Use the syringe to add 3 ml tap water to the gas collecting tube.
3. Place the celery stalk in the water.
4. Use the propette to put a THIN layer of oil (about 6 drops) on the water.
5. Mark the level of the water in the tube.
6. Repeat the entire procedure without the plant.



EXPERIMENT **CONTROL**

7. Place the paired setups (one with plant; one without plant) under different environmental conditions; each **pair** to **one** set of conditions.

Examples include:

- a cool windy area,
- a cool still area,
- a hot windy area,
- a hot still area,
- a humid area,
- a sunny area,
- a shady area.

Plastic bags may also be placed over the gas collecting tubes to simulate humid conditions.

8. Leave the setups for several hours.
9. Examine the water levels of each setup and record your results in a table like that underneath.

Condition	**Final Water Level**	
Windy	No plant	- 1 mm
	Plant	
Sunny	No plant	
	Plant	
Dark	No plant	
	Plant	

QUESTIONS

1. Which plant or plants lost the most water?
2. Which plant or plants lost the least water?
3. Was any water lost from the control setups?

EXPERIMENT 44 – FLOWERING PLANTS - SEED STRUCTURE
CSEC OBJECTIVE: Section B 8.2 (Optional Activity Section B 2.6, 4.12)

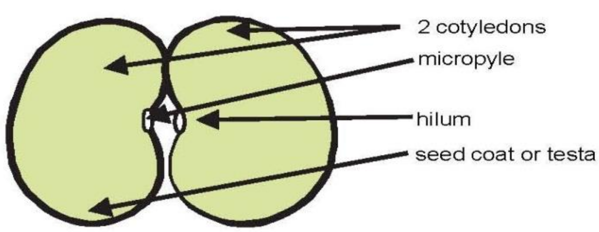
Grade Level –

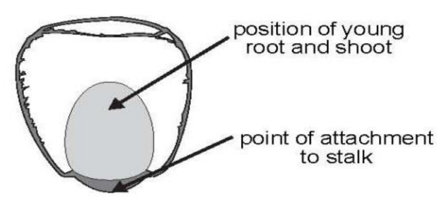
INFORMATION
Flowering plants, known as **angiosperms**, are very widely spread on Earth. Flowers carry the reproductive structures of these plants. Flowering plants are classified into two groups, monocotyledons and dicotyledons - depending on the structure of the seeds of these plants. There are also differences between various other parts of the plants in these groups. In this series of activities, you will examine the parts of flowering plants.
You will also learn to recognise whether the plant is a monocotyledon or a dicotyledon.

You Need
- Plastic lunch box with lid
- Forceps
- Hand lens
- Potting soil *
- Seeds of plants*
- Paper towel
- Petri dish

* To be obtained from your teacher

What to do
Stage 1 - The seed
1. Obtain a bean seed or a peanut and a maize or wheat seed.
2. Use the diagrams below to help you identify the external parts of the seeds.





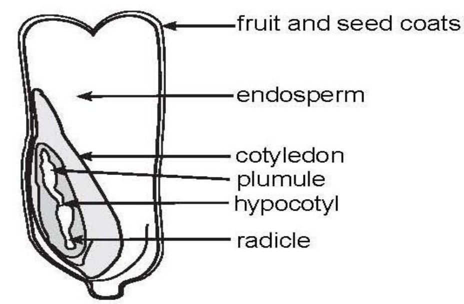
3. Gently break open the bean or peanut. You will see that it can be broken into two similar "halves".
   These two "halves" are the reason for the term **Di**cotyledon; **Di** means **two**.
4. Try to break the maize or wheat seed (grain) into two parts in the same way.
   Is it possible to break these seeds into two?
   For this reason, these types of plants are called **Mono**cotyledons; **Mono** means **one**.

Internal Structure of the Seed
Obtain seeds which have been soaked for 24 hours.
Complete the following exercise for each of the seeds which you examine.
1. In what ways is the soaked seed different from a dry seed?
   HINT: Compare size, shape, texture.

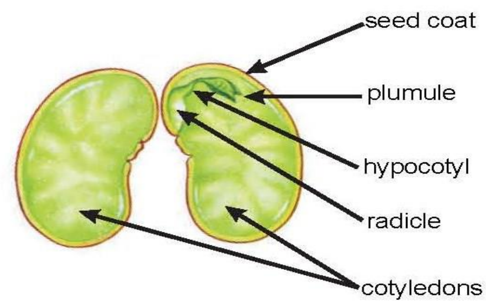
Remove the seed coat and examine the inside of the seed. You will observe a small embryo inside the seed.

Use the diagrams below to identify the following parts of the seeds which you will study.

Internal Structure of Maize Grain



Internal Structure of Bean Seed



Use a biology dictionary or other text as well as your own knowledge and insight to help you complete the following question.

2. Match the word in column A with the phrase in column B by writing out the word with the correct phrase next to it.

A WORD	B PHRASE
1 coleoptile	a the root of the embryo
2 radicle	b stored food for the developing embryo
3 endosperm	c the portion of the seedling stem below the cotyledon/s
4 hypocotyl	d the shoot of the embryo
5 plumule	e protective covering of plumule

QUESTIONS

1. How do the embryos obtain food?