

MICROSCIENCE MANUAL

Integrated Science Students' Manual (Draft)

First Guyana Version Adaptation of Teaching and Learning Materials on Microscience Experiments

United Nations Educational, Scientific and Cultural Organization

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The Ministry of Education wishes to acknowledge the team of participants in the consultations for the selection of the Microscience Experiments relevant to the national curriculum for Biology, Chemistry and Physics.

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Introduction

Introduction to the first Guyana version adaptation of UNESCO teaching and learning materials on micro science experiments.

The contents of this document are recommended by the participants of UNESCO/Kingston/Ministry of Education, NCERD consultations on Micro-Science Experiments held in Georgetown (Guyana) on 27-30 June, 2011. The present materials correspond fully to the existing National Curriculum for teaching basic sciences at the different levels. The materials were selected by the participants of the working consultations. The participants worked with teaching and learning packages on microscience experiments which are available on UNESCO's website and are free for all types of adaptations and modifications. The different types of microscience kits donated by UNESCO/Kingston Office to Guyana can be used in practical classes. The experiments are classified according to grades and some were given first priority (refer to appendix 1). The 'priority one' experiments are recommended for the pilot of the microscience experiments. It is very clear that, new experiments can be developed and tested using the same kit, as proposed by the participants of the working consultations which included curriculum development specialists. Developing new materials can be recommended, as a second stage of the project development. It is noted that the microscience experiments, as a new methodology for hands on laboratory work by students, can work in conjunction with macroscience experiments. Furthermore the microscience kits can be used by teachers for demonstration purposes. We hope, that the Science Teachers in Guyana will find the microscience experiments methodology and teaching and learning materials, interesting and of great value for the enhancement of science education.

Participants of the working consultations

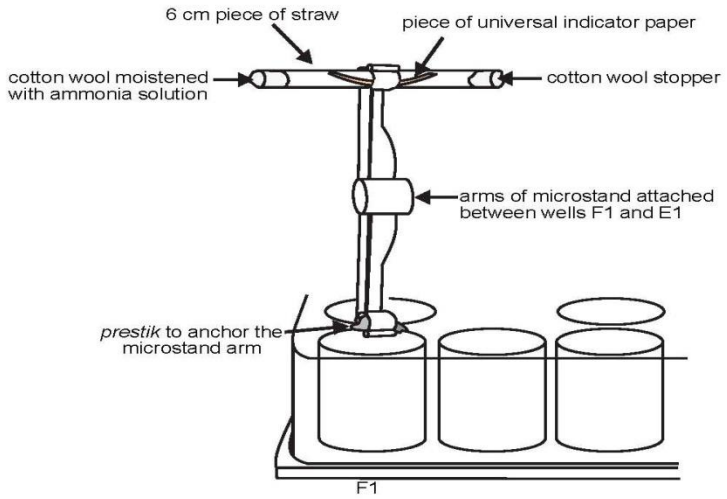
May 2012

CSEC Objective (s) - Section A Unit 1 Objective 3

Explain the processes of diffusion and osmosis using an experimental approach

Experiment 1 DIFFUSION IN A GAS

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 2 MORE DIFFUSION IN A GAS

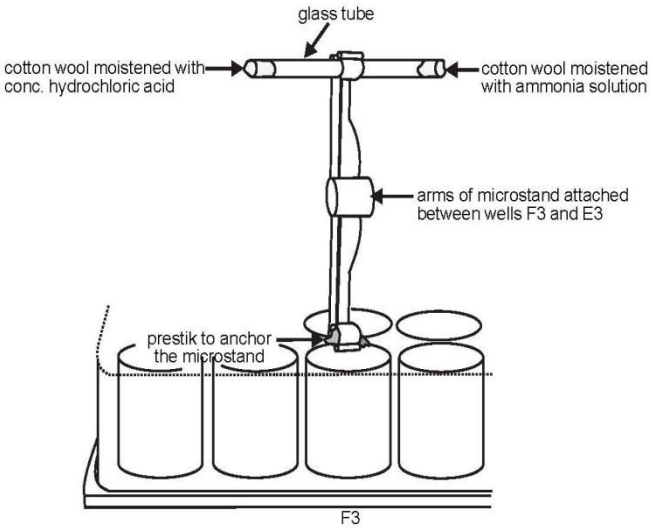
Grade Level – 10

You Need

Apparatus: 1 x comboplate®; 2 x propettes; 1 x microstand; 1 glass tube; Cotton wool; *Prestik*.
Chemicals: Ammonia solution ($NH_3(aq)$); Concentrated hydrochloric acid (HCl(aq))

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:



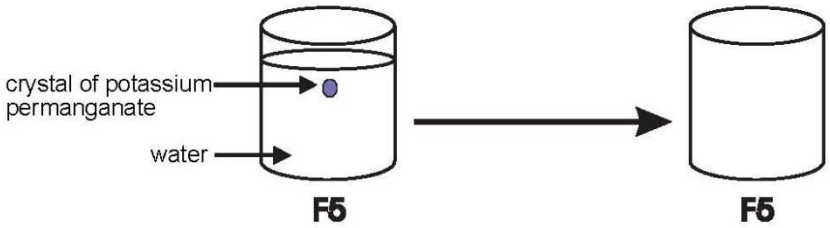
3. Shape a small tuft of cotton wool into a thin threadlike piece of about 1 cm long. Break it into two pieces and insert one piece into each end of the glass tube.
4. Use a clean propette to place a few drops of concentrated hydrochloric acid onto the cotton wool on the left hand side of the glass tube.
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?

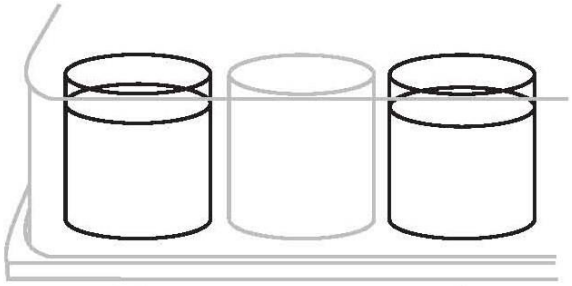
Experiment 3 DIFFUSION IN A LIQUID

Grade Level – 9&10

	You Need **Apparatus:** 1 x comboplate®. **Chemicals:** Potassium permanganate ($KMnO_4(s)$); 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 4 DIFFUSION IN A SOLID

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 5 HOW DOES OSMOSIS OCCUR IN LIVING TISSUE?

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.

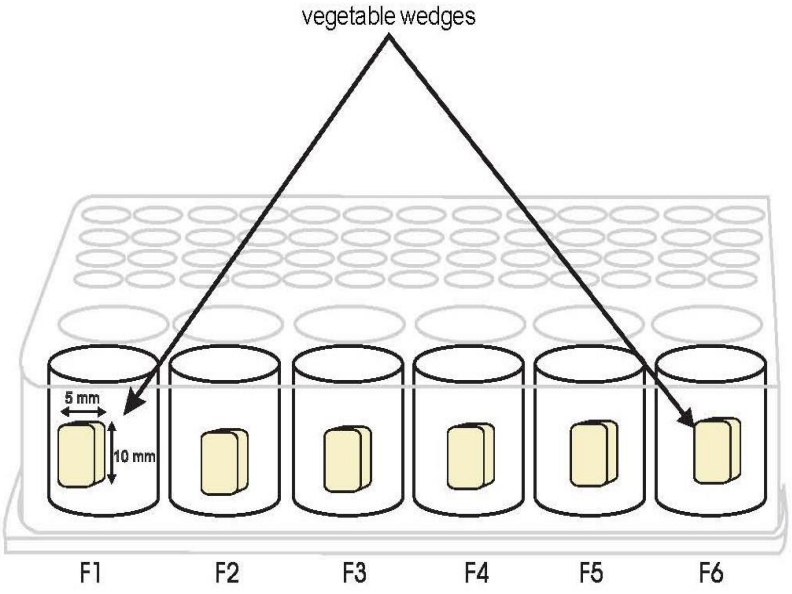
You Need

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

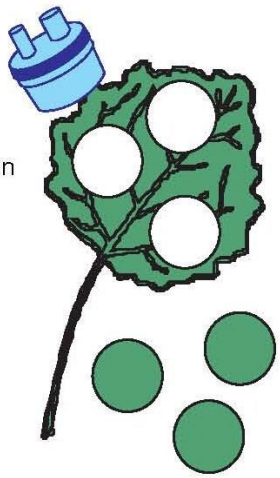
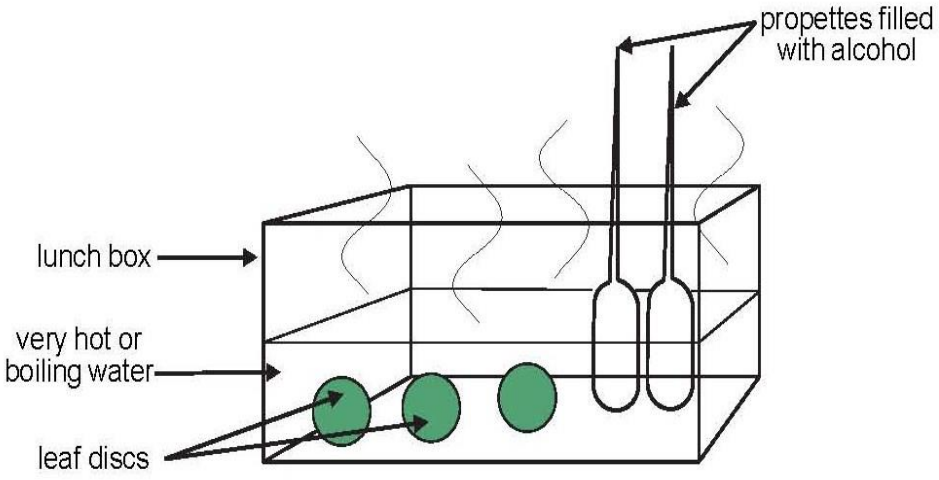
1. In general, what happened to the potato or other vegetable pieces in the tap water?
2. In general, what happened to the potato or other vegetable pieces in the 10 % sucrose solution?
3. In general what happened to the potato or other vegetable pieces in the 30 % sucrose solution?
4. Try to give reasons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

CSEC Objective (s) - Section A Unit 2 Objective 1

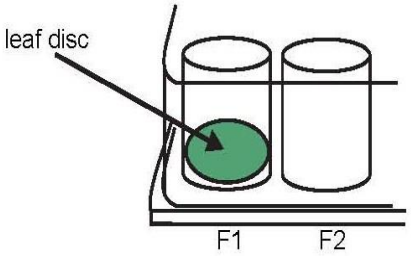
Describe the process of photosynthesis

Experiment 6 TESTING A LEAF FOR STARCH

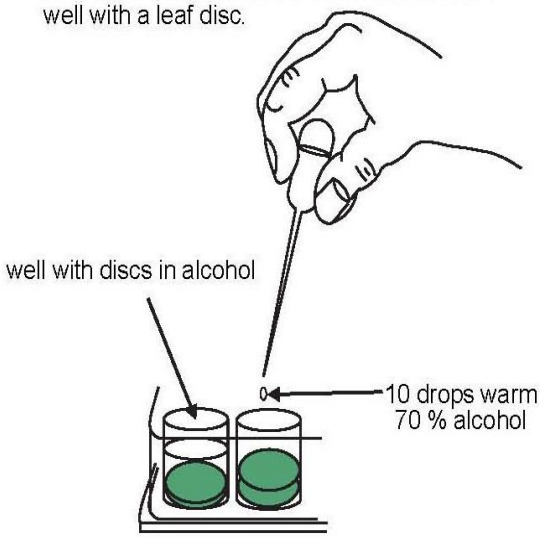
Grade Level – 9&10

	You Need **Apparatus:** Comboplate®; 2 x propettes; lid 1; 2 x plastic lunch boxes; Geranium leaf; Needle. **Chemicals:** I_2/KI solution (iodine solution); 70% alcohol.
	What to do Follow the instructions as set out. 1 Use the lid to cut discs from a green geranium leaf.  2 Place the discs in very hot water, (boiling if possible), in the lunch box for 5 minutes. In this way, the cell walls are broken down. At the same time, place the propettes, filled with alcohol, bulb down into the hot water. In this way, the alcohol is heated too. 

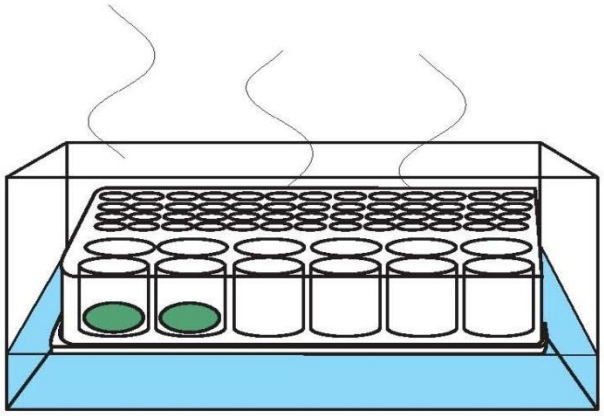
3 Use a needle to place 2 leaf discs in each of wells F1 and F2 of the comboplate®.



4 Add 10 drops of warm 70 % alcohol to each well with a leaf disc.



5 Fill the lunch box with hot water again and float the comboplate® on the water in the lunch box. (*See Questions 1, 2, 3*)



6 Use the needle to remove the leaf discs from the wells (CARE!) Place the discs in another lunch box of water at room temperature for a minute. In this way, the alcohol is rinsed from the discs.

7 Collect the chlorophyll extract from all the comboplate®s and place it in the empty lunch box in a cool place.

8 Rinse the comboplate®.

9 Use the forceps to place the leaf discs back in wells F1 and F2 of the comboplate®.

10 Use a propette to add 5 to 10 drops of I_2/KI solution (iodine solution) to each disc.

11 Observe any changes.

QUESTIONS

1. What is the colour of the alcohol after 10 minutes?
2. What is the colour of the leaf after 10 minutes?
3. What has the alcohol done to the leaf?
4. What colour did the leaf discs turn after the iodine was added?
5. What does this colour change tell you about the storage product in these leaves?

Experiment 7 IS CHLOROPHYLL NECESSARY FOR PHOTOSYNTHESIS?

Grade Level – 10

You Need

Apparatus: Comboplate®; 3 x propettes; lid 1 or lid 2; Plastic lunch box; Variegated leaf.

Chemicals: I_2/KI solution (iodine solution); Hot water; 70 % alcohol.

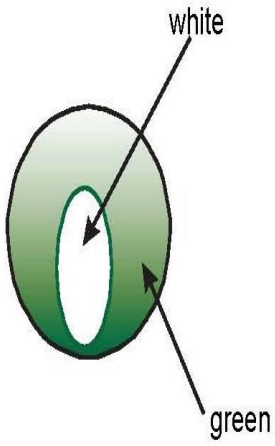
Notes

1. Use the plastic lunch box as a water bath.
2. This investigation uses a **variegated** leaf. Such a leaf has more than one colour. The type of variegated leaf you need is one which has both green and white parts in the same leaf.

What to do

Follow the instructions as set out underneath.

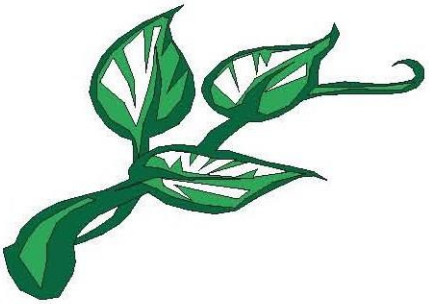
1. Pick a variegated geranium leaf around noon on a sunny day.
2. Cut discs from the leaf in the same way as you did for the first investigation.
   Ensure that you have discs which have BOTH green and white parts.
3. DRAW the discs showing the position of both the colours.
   A drawing could look something like the figure shown.
4. Soften the discs by placing them in hot water in the plastic lunch box.
5. At the same time, partly fill two propettes with alcohol and place these, bulb downwards into the hot water in the plastic lunch box.
   Doing this heats the alcohol and makes the chlorophyll extraction easier.



6. Place the discs in one or more of the F wells of the comboplate® as in previous activities.
7. Add 10 to 20 drops of warmed alcohol to each well which contains a disc. Extract the chlorophyll by allowing the discs to float in the warm alcohol. Ensure that the water in the plastic lunch box is as warm as possible.
8. When the discs have been decolorised, rinse them with water as in Photosynthesis Activity 1.
9. Rinse the comboplate® and then replace the leaf discs in the F wells of the comboplate®.
10. Use a clean propette to add a few drops of iodine solution to the leaf discs.
11. Observe any changes.

QUESTIONS

1. What was the final colour of the leaf discs which were originally green and white?
2. Make a drawing of a leaf disc which was originally both green and white.

	3. What do your results suggest about the role of chlorophyll in photosynthesis? 4. The white parts of the leaf discs had no starch. This means that there is no food for the plant in the white parts of the plant. The white parts of the leaf must get food, otherwise they would die. How do you suppose these parts get their food?
	SOMETHING TO THINK ABOUT Consider the leaves pictured alongside.  They are not variegated leaves. They are from a plant which is suffering from a deficiency of one or more essential nutrients. It may be possible to correct the problem by placing Epsom Salts on the soil around the plant and watering well. Find out why Epsom Salts could help to correct this problem.

Experiment 8 IS LIGHT NEEDED FOR PHOTOSYNTHESIS ?

Grade Level – 10

You Need

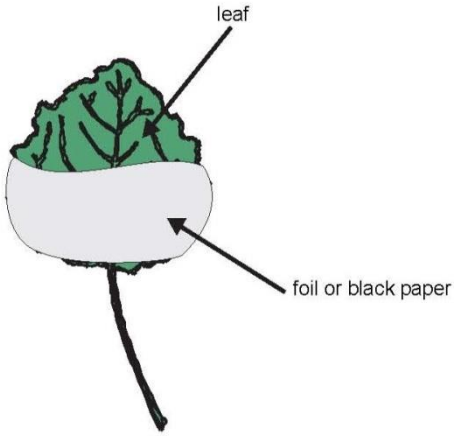
Apparatus: Comboplate®; 2 x propettes; lid 1; Plastic lunch box; Paper clips; Forceps; Geranium leaf; Aluminium foil or black paper.

Chemicals: I_2/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 9 IS CARBON DIOXIDE NEEDED FOR PHOTOSYNTHESIS?

Grade Level – 10

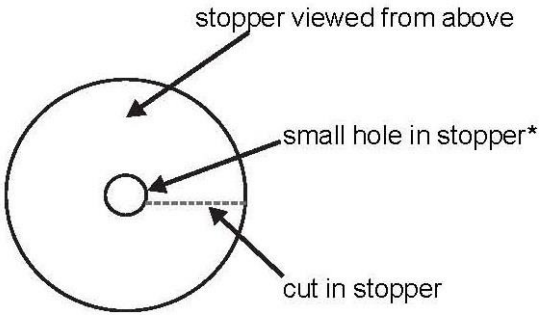
You Need

Apparatus: Comboplate®; Propettes; Large vial; Stopper to fit large vial;
Small pot plant with a few leaves*; Sharp knife.
Chemicals: I_2/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

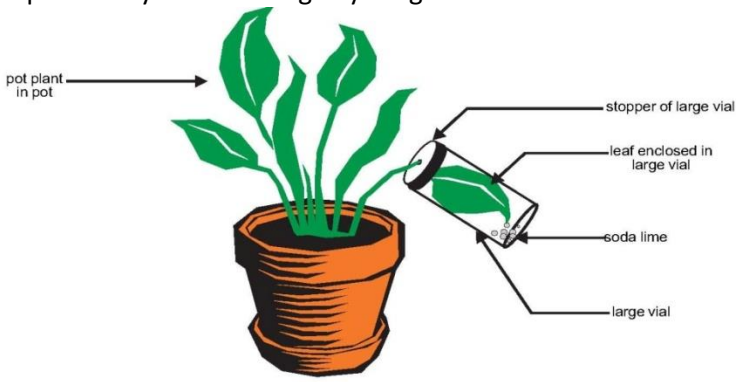
Follow the instructions as set out underneath.

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.

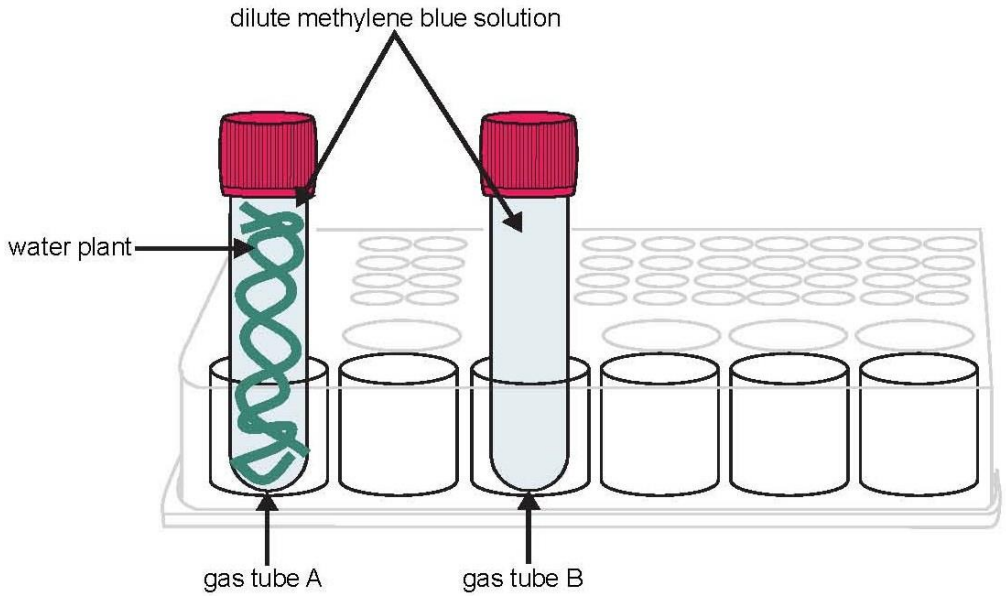
Leaf	Colour after Testing with Iodine Solution	Conclusion

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 10 IS OXYGEN RELEASED DURING PHOTOSYNTHESIS?

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 hydrogen carbonate ($NaHCO_3(s)$). * *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 hydrogen carbonate 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*) 

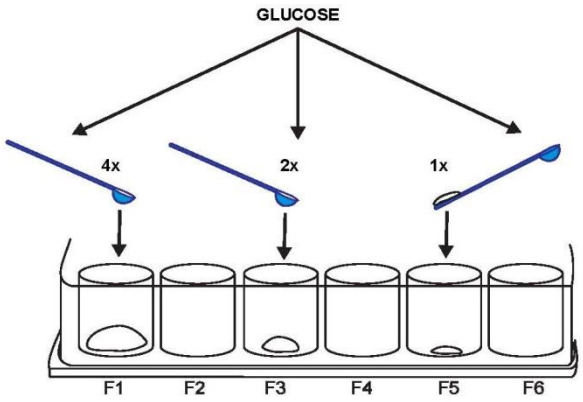
	QUESTIONS 1. Note what you observe in each of the tubes. 2. What can you deduce from your observations? 3. Why did we add sodium hydrogen carbonate ($NaHCO_3$) to the water? 4. What happened to the solution in tube B?

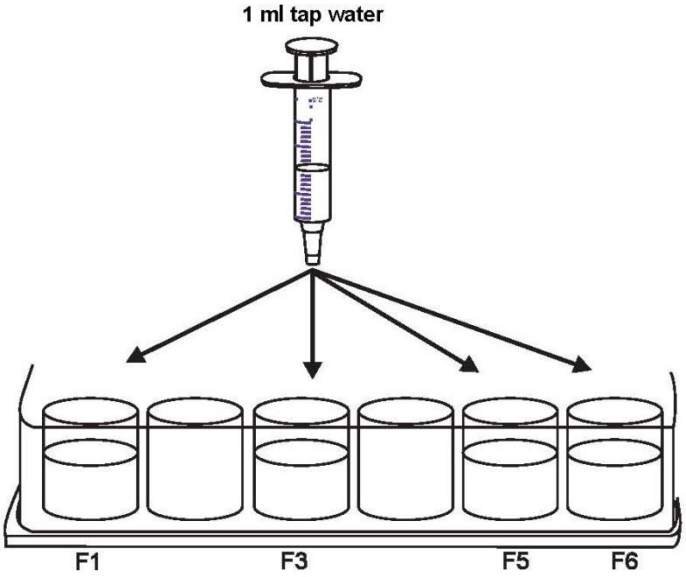
CSEC Objective (s) - Section A Unit 2 Objective 3

Explain the importance of food

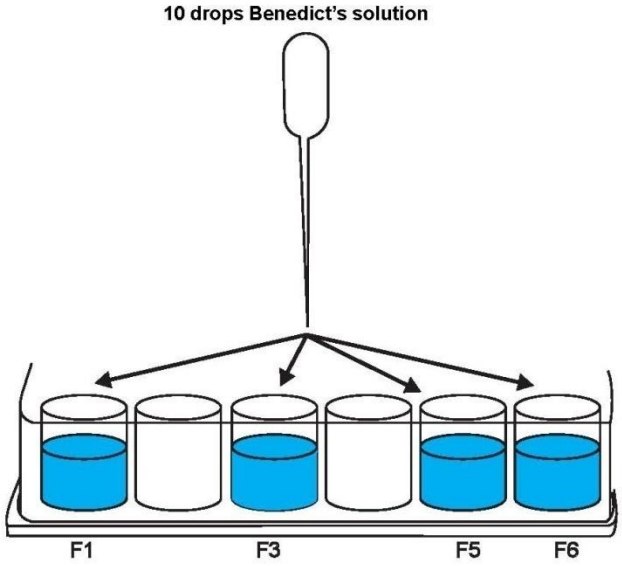
Experiment 11 BENEDICTS TEST FOR REDUCING SUGAR

Grade Level – 9&10

	Introduction: All monosaccharides, and some disaccharides, have the ability to reduce copper(II) to copper(I) in alkaline solution. These sugars are referred to as reducing sugars. During the reduction, the sugars are oxidised to their corresponding acids. Benedict's solution contains copper(II) sulphate in an alkaline medium. Positive tests for a reducing sugar with this solution are indicated by a series of colour changes as the copper(II) sulphate is reduced to copper(I) oxide. The purpose of this investigation is to establish what the colour changes are that indicate the presence of reducing sugars.
	You Need **Apparatus:** Comboplate®; 1 x plastic microspatula; 1 x thin stemmed propette; 1 x 2 ml syringe; *1 x water bath maintained at boiling temperature. **Chemicals:** Glucose/dextrose powder ($C_6H_{12}O_6$(s)); Benedict's solution; Tap water; Boiling water. *** Make a boiling water bath in the following way.** Fill a plastic container (such as a large bowl or your lunch box or an empty, 2 litre ice cream container) with boiling water from a kettle or cooking pot. It is best if each learner has their own water bath. If large containers are used, more than one learner can use them together, provided that the bath does not become too crowded with comboplates® so that they topple over when the container is replenished with boiling water.
	What to do 1. Using the spoon of the plastic microspatula, place four level spatulas of glucose/dextrose powder into well F1. 2. Similarly, place two level spatulas of the glucose/dextrose powder into well F3. 3. Turn the spatula around and using the narrow end, place one level spatula of the glucose/dextrose powder into well F5.  4. Use the 2 ml syringe to dispense 1.0 ml of tap water into each of wells F1, F3, F5 and F6.



5. Stir the contents of wells F1, F3 and F5 with the microspatula to dissolve the glucose.
6. Use a propette to add 10 drops of the Benedict's solution into each of wells F1, F3, F5 and F6. Stir the contents of the wells to thoroughly mix the solutions.



What is the colour of each solution in wells F1, F3, F5 and F6?

7. Pour freshly boiled water into the water bath. Carefully float the comboplate® in the water.
8. Leave the comboplate® in the hot water for about 5 minutes. Note what happens to the solutions in the wells while the comboplate® is being heated.
9. After 5 minutes, immediately remove the comboplate® from the water bath and enter your results in Table 1 below.

WELL	COLOUR CHANGE OBSERVED DURING HEATING	FINAL COLOUR OF SOLUTION AFTER 5 MINUTES

Rinse the comboplate®, syringe and propettes with water.

QUESTIONS

Q1. Why did the colour of the Benedict's solution change when it was heated with each of the glucose solutions?

Q2. Which well contained the highest concentration of glucose? Explain.

Q3. What do you notice about the colour changes observed in well F1?

Q4. Which well contained the lowest concentration of glucose? Explain.

Q5. What do you notice about the colour changes observed in well F5?

Q6. From your answers to questions 3 and 5, deduce the relationship between the concentration of reducing sugar present in a sample, and the colour change/s observed in the Benedict's test within a specified time period.

Q7. Why did the colour of the solution in well F6 show no change?

Q8. How can one test for the presence of reducing sugars in food?

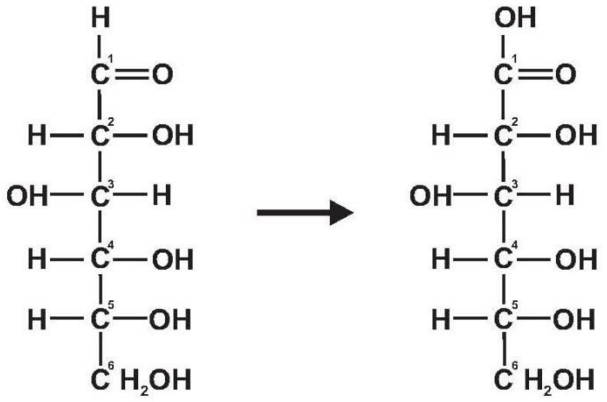
EXTENSION QUESTIONS

(These questions are aimed at students who also have a chemistry background.)

Q9. What was the purpose of testing water with the Benedict's solution?

Q10. Write down the ionic equation for the reduction of copper sulphate to copper oxide.

Q11. When glucose is oxidised, gluconic acid is formed. (See below.) Which functional group in glucose do you think is responsible for the reduction of copper(II) to copper(I)?



glucose gluconic acid

Q12. Give a reason for your answer to question 5.

Experiment 12 DOES THE FOOD WE EAT CONTAIN REDUCING SUGARS?

Grade Level - 9&10

Introduction:

The greater the concentration of reducing sugar present in a particular food, the greater the amount of copper(II) ions that are reduced to copper(I) ions. However, in the Benedict's test, the blue colour of the Benedict's solution does not change to red all at once, even if a food sample contains a high concentration of reducing sugar. A series of colour changes occurs as the reduction proceeds. These are always in the same order, making it possible to compare, approximately, the concentration of reducing sugar present in different samples.

You Need

Apparatus: Comboplate®; 1 x glass rod; 6 x thin stemmed propettes; 1 x kitchen grater or sharp knife;
1 x water bath maintained at boiling temperature; 1 x 2 ml syringe.

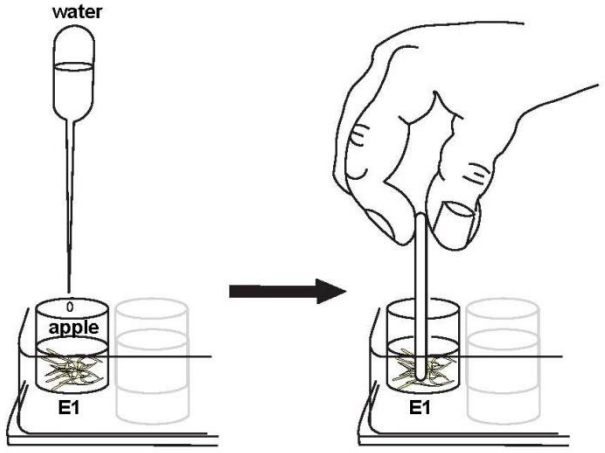
Chemicals: Tap water; 1 x fresh apple; 1 x fresh carrot; 1 x fresh potato; Cooked white rice; Cooked white mealie meal; Fresh milk; Benedict's solution.

NOTES

- The water bath can be constructed as described in Activity 1.
- Any food items available may be tested, not necessarily those listed above.

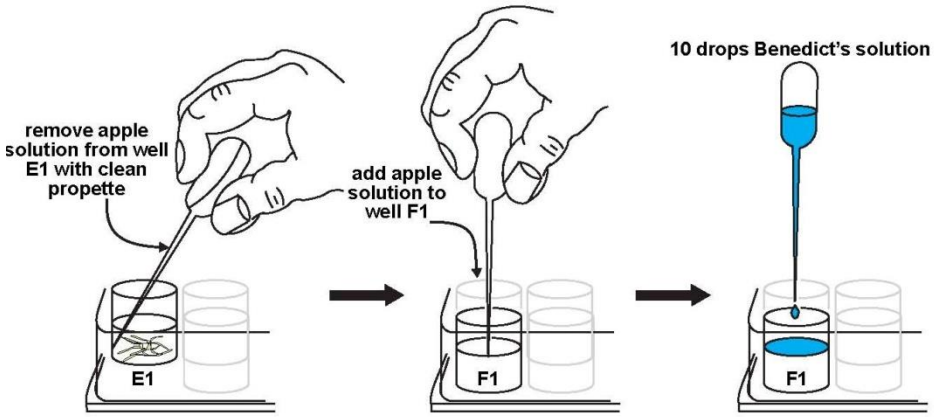
What to do

1. Finely grate a portion of each of the apple, carrot and potato. Clean the grater before grating each new food. (If a grater is not available, scrape across the flesh of each item with a sharp knife.)
2. Fill 1/3 of well E1 with the grated apple.
3. Add water from a propette to the apple, until well E1 is half full. Using the glass rod, grind the apple in the water.



4. Fill 1/3 of well E2 with grated carrot. Add water until the well is half full. Wipe the glass rod clean and use it to grind the carrot in the water.
5. Fill 1/3 of well E3 with grated potato. Treat the potato as you have the apple and carrot.
6. Fill 1/3 of well E4 with cooked white rice. Wipe the glass rod clean and use it to break the rice into smaller pieces before adding any water to the well.

7. Add water to well E4 until the well is half full. Stir the rice in the water with the glass rod.
8. Fill 1/3 of well E5 with the cooked mealie meal. Add water to the well until it is half full. Rinse the glass rod and use it to stir the mealie meal in the water.
9. Using a clean propette, suck up the solution from well E1. The pieces of apple will be too large to enter the stem of the propette.
10. Add all of the solution from the propette into well F1.
11. Add 10 drops of Benedict's solution with a propette to the solution in well F1. Stir the solution thoroughly with a microspatula.



12. Using another propette, suck up the carrot solution from well E2 and transfer all of the solution to well F2. Add 10 drops of Benedict's solution and stir to mix.
13. Repeat step 12 with the potato solution from well E3, dispensing the solution into well F3.
14. Repeat step 12, this time transferring the rice solution from well E4 into well F4.
15. Using a clean propette, insert the tip just under the surface of the mealie meal solution in well E5. The larger particles of meal should have settled and you can remove all of the solution above the solid material without blocking the propette stem.
16. Transfer this solution to well F5 and add the 10 drops of Benedict's solution. Stir to mix.
17. Rinse a propette with water and use it to add 10 drops of fresh milk into well F6. Add 10 drops of Benedict's solution and stir to mix.
18. Pour freshly boiled water into the water bath. Carefully float the comboplate® in the water bath.
19. Leave the comboplate® in the hot water for approximately 3 minutes. After 3 minutes, add about 1 cup more of freshly boiled water to the water bath.
20. Leave the comboplate® for a further 3 - 4 minutes. Note what happens to the solutions in the wells while the comboplate® is being heated. Remove the comboplate® from the water bath and enter your results in Table 1.

Table 1

WELL	FOOD SOLUTION	COLOUR OF SOLUTION AFTER HEATING

Rinse the comboplate®, syringe and propettes with water.

QUESTIONS

Q1. How is the colour of the solution related to the concentration of reducing sugar detected in the food during the time specified? (Hint: look at the results for Activity 1.)

Q2. Which food contains the highest concentration of reducing sugar/s? Explain.

Q3. Which food contains the lowest concentration of reducing sugar/s? Give a reason for your answer.

Q4. What is the answer to the focus question?

EXTENSION QUESTIONS

Q5. Besides the colour change that occurred, what other change did you notice in the appearance of the milk when it was heated with Benedict's solution?

Q6. Why did the appearance of the milk change?

Experiment 13 HOW CAN ONE TEST FOR THE PRESENCE OF A NON-REDUCING SUGAR IN FOOD?

Grade Level – 9&10

Introduction:

Some disaccharides, such as sucrose, are unable to reduce the copper(II) sulphate in Benedict's solution to copper(I) oxide. In these disaccharide molecules, the functional groups that could be involved in the redox reaction, are linked together in a glycosidic bond. Such disaccharides are called non-reducing sugars. The purpose of this investigation is to discover how the reducing sugars test can be modified to detect the presence of a non-reducing sugar in a food substance.

You Need

Apparatus: 1 x comboplate®; 2 x plastic microspatulas; 1 x 2 ml syringe; 2 x thin-stemmed propettes; 1 x water bath maintained at boiling temperature; 1 x cold water bath.

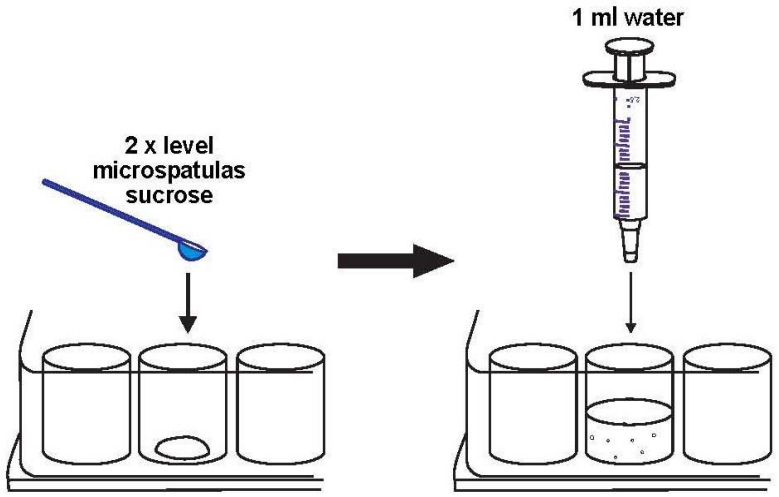
Chemicals: Sucrose/table sugar ($C_{12}H_{22}O_{11}(s)$); Benedict's solution;
Hydrochloric acid (HCl(aq)) [5.5 M]; Sodium bicarbonate/baking soda ($NaHCO_3(s)$);
Tap water.

*** Make a boiling water bath in the following way:**

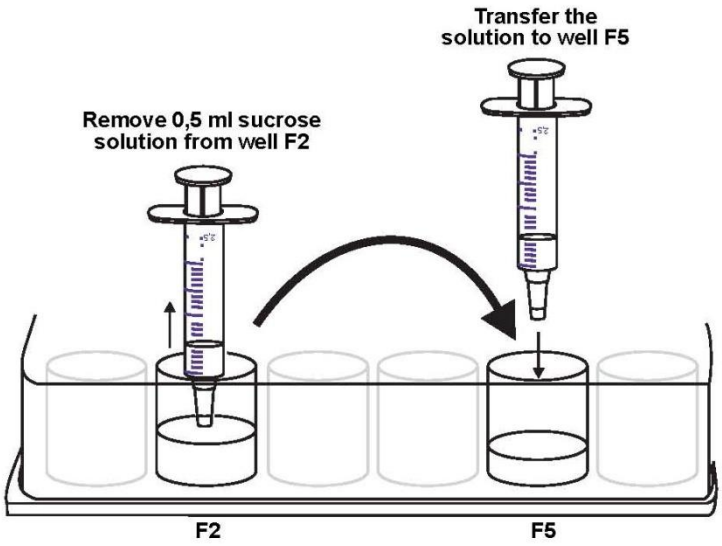
Fill a plastic container (such as a large bowl or your lunch box or an empty, 2 litre ice cream container) with boiling water from a kettle or cooking pot. It is best if each learner has their own water bath. If large containers are used, more than one learner can use them together, provided that the bath does not become too crowded with comboplates® so that they topple over when the container is replenished with boiling water.

What to do

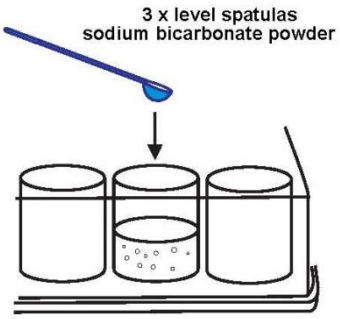
1. Using the spoon of a plastic microspatula, place 2 level spatulas of the sucrose into well F2.
2. Add 1,0 ml of tap water to the sucrose with the syringe. Stir to dissolve the sucrose.



3. Remove 0,5 ml of the sucrose solution with the syringe and transfer this to well F5.



4. Add 10 drops of Benedict's solution into the sucrose solution in well F2 only.
5. Fill the water bath with freshly boiled water. Float the comboplate® carefully in the water bath for a few minutes. *(See Question 1)*
6. Remove the comboplate® from the water bath.
7. Use a clean propette to add 3 drops of 5.5 M hydrochloric acid to the sucrose solution in well F5. Stir the contents with a microspatula.
8. Place the comboplate® in the boiling water bath for 1½ minutes. Remove the comboplate® from the hot water and place it in cold water for about 1 minute.
9. Remove the comboplate® from the cold water. Place 3 level spatulas of sodium bicarbonate with the spoon of a clean microspatula into well F5 to neutralise the solution. *(See Question 2)*
10. Add 10 drops of Benedict's solution to well F5. Stir the solution to mix.
12 Pour out the cooled water from the boiling water bath and add more freshly boiled water.
13 Return the comboplate® to the boiling water bath and leave for 5 - 7 minutes. *(See Question 3)*



Rinse the comboplate® and remaining equipment with water.

QUESTIONS

Q1. Does the colour of the solution in well F2 change after floating the comboplate in the water bath for a few minutes? What does this observation imply?

Q2. What happens when the sodium bicarbonate is added to the acidified sucrose solution?

Q3. What happens to the colour of the solution in well F5 during heating? What does this observation imply?

Q4. From your observations, what do you think is the function of the hydrochloric acid in this experiment?

Explain your answer.

	Q5. Which reducing sugar/s caused the Benedict's solution to change colour? Give a reason for your answer. Q6. What is the name given to the reaction in this experiment where hydrochloric acid breaks up the disaccharide to form its constituent monosaccharides? Q7. What is the answer to the focus question?
	EXTENSION QUESTIONS Q8. What other biological compound will perform the same function as the hydrochloric acid in hydrolyzing sucrose? The following questions are aimed at students with a chemistry background. Q9. Write down the chemical equation for the reaction of the sodium bicarbonate with the acidified (HCl (aq)) sucrose solution. Q10. Use your answer to question 9 to explain why "fizzing" was heard when the sodium bicarbonate was added.

Experiment 14 IODINE TEST FOR STARCH

Grade Level – 9&10

You Need

Apparatus: 1 x comboplate®; 1 x plastic microspatula; 3 x thin stemmed propettes.

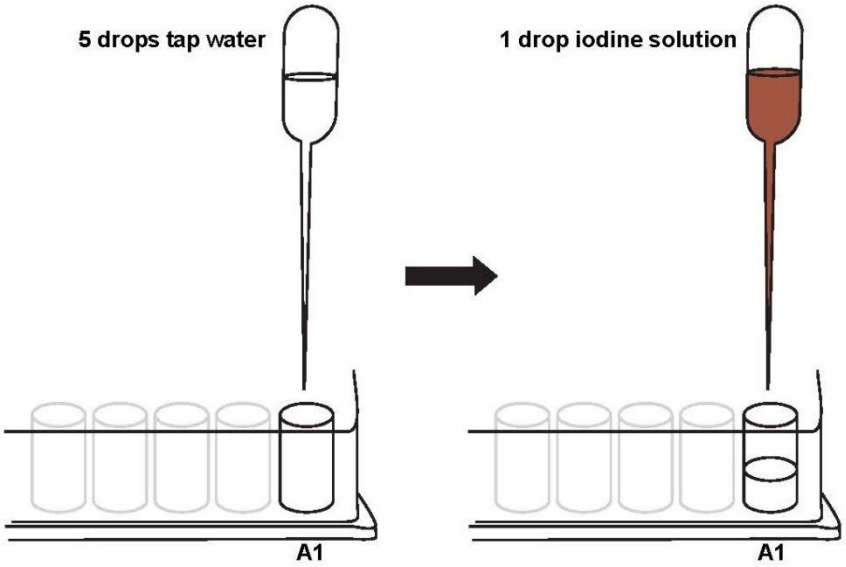
Chemicals: Starch solution [$(C_6H_{10}O_5)n(aq)$] [1%]; Iodine solution [I_2/KI(aq)] [1%]; Tap water.

NOTES

- If iodine and/or potassium iodide are not available, use the tincture of iodine obtainable from a chemist at low cost.

What to do

1. Use a propette to place 5 drops of tap water into well A1.
2. Place one drop of iodine solution from a propette into the water in well A1. (*See Question 1*)



3. With a clean propette, place 5 drops of the 1% starch solution into well A2.
4. Place one drop of iodine solution into the starch solution in well A2. (*See Question 2*)

Rinse the comboplate® and propettes with water.

QUESTIONS

Q1 What is the colour of the solution in well A1 after adding a drop of iodine solution?

Q2 What is the colour of the solution in well A2 after adding a drop of iodine solution?

Q3 How can one test for the presence of starch in food?

Experiment 15 DOES THE FOOD WE EAT CONTAIN STARCH?

Grade Level – 9&10

You Need

Apparatus: 1 x comboplate®; 1 x 2 ml syringe; 1 x glass rod; 6 x thin stemmed propettes; *1 x kitchen grater or sharp knife (not in the kit).

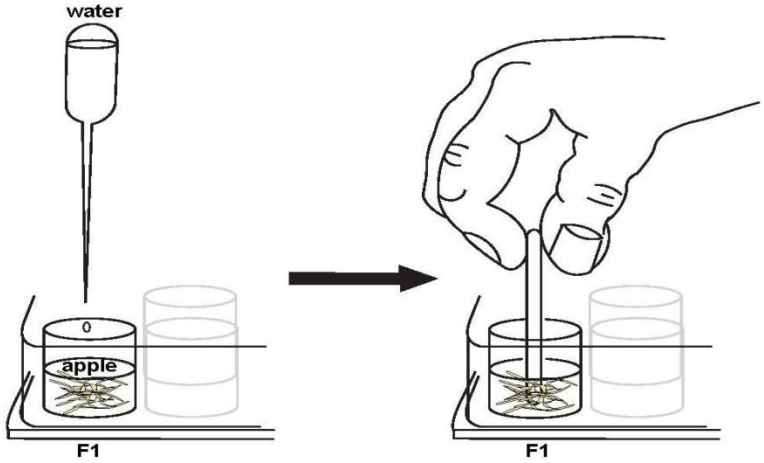
Chemicals: Iodine solution (I2/KI(aq)) [1%]; Tap water; 1 x fresh apple; 1 x fresh carrot; 1 x fresh potato; Fresh milk; Cooked white rice; Cooked white mealie meal.

NOTES

- The food items are not included in the kit.
- Any food items may be used; not necessarily those listed above.

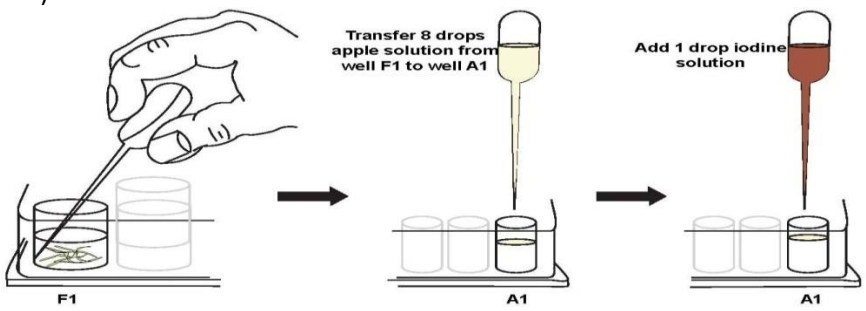
What to do

1. Finely grate a portion of each of the apple, carrot and potato. Clean the grater before grating each new food. (If a grater is not available, scrape across the flesh of each item with a sharp knife.)
2. Fill 1/3 of well F1 with the grated apple. Add water from a propette to the apple until well F1 is half full.
   Using the glass rod, grind the apple in the water.



3. Fill 1/3 of well F2 with grated carrot. Add water until the well is half full. Wipe the glass rod clean and use it to grind the carrot in the water.
4. Fill 1/3 of well F3 with grated potato. Treat the potato as you have the apple and carrot.
5. Fill 1/3 of well F4 with cooked, white rice. Rinse the glass rod and use it to break the rice into smaller pieces before adding any water.
6. Add water from a propette to the rice, until well F4 is half full. Stir the mixture with the glass rod.
7. Fill 1/3 of well F5 with cooked, white mealie meal. Add water to well F5 until it is half full.
8. Rinse the glass rod and use it to stir the mixture in well F5.
9. Using a clean propette, suck up the solution from well F1. The pieces of apple will be too large to enter the stem of the propette. Add 8 drops of the apple solution into well A1.

10. Add one drop of the iodine solution to well A1 and stir the contents of the well. (*See Question 1*)



11. With another propette, suck up all of the carrot solution from well F2. Add 8 drops of the solution into well A3. Add one drop of iodine solution and stir the contents of the well. (*See Question 1*)
12. Repeat step 11 with the potato solution from well F3, transferring this solution into well A5. (*See Question 1*)
13. Place 8 drops of fresh milk into well A7 with a clean propette. Add one drop of iodine solution. (*See Question 1*)
14. Repeat step 11 with the rice solution from well F4, adding the solution to well A9. Add 1 drop of the iodine solution to well A9. (*See Question 1*)
15. Allow the solid material in well F5 to settle. Insert the tip of a clean propette just under the surface of the solution in well F5 and suck up all of this solution.
16. Add 8 drops of the mealie meal solution into well A11. Add 1 drop of the iodine solution to well A11 and record your result in Table 1. (*See Question 1*)

Rinse the comboplate®, syringe and propettes with water.

QUESTIONS

Q1. Prepare a table like Table 1 below in your books. Record your results in Table 1.

Table

WELL	FOOD SOLUTION	COLOUR OF SOLUTION AFTER IODINE ADDED
A1		
A3		
A5		
A7		
A9		
A11		

Q2. What is the answer to the focus question?

	EXTENSION QUESTIONS Q3. Starch is a polymer of glucose. What does this statement mean? Q4. Starch molecules (polymers) can be broken down into glucose molecules (monomers) by hydrolysis, in the same way that sucrose is broken down into fructose and glucose. Using this information, choose the food/s from Table 1 above which you would eat the most of if you were going to run a long race the next day. Explain your choice. Q5. Consider the statement made above in question 4. What result would you expect in the Benedict's test if the potato, rice or maize solutions were heated with 5.5 M HCl (aq), neutralised with sodium bicarbonate, treated with Benedict's solution and then placed in a boiling water bath? Explain your answer.

Experiment 16 EMULSION TEST FOR LIPIDS

Grade Level – 9&10

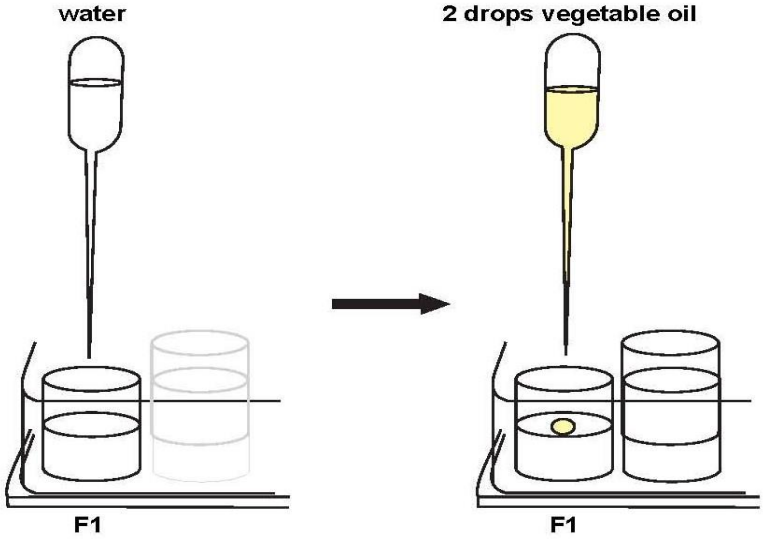
You Need

Apparatus: 1 x comboplate®; 5 x thin stemmed propettes.

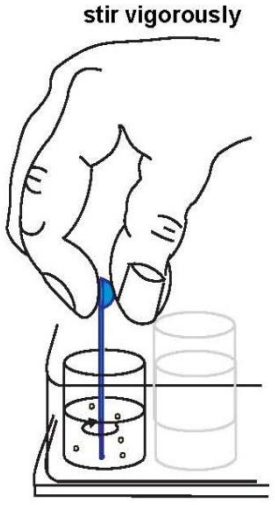
Chemicals: Ethanol ($C_2H_5OH(l)$); Vegetable oil (eg. corn oil, olive oil etc.); Tap water.

What to do

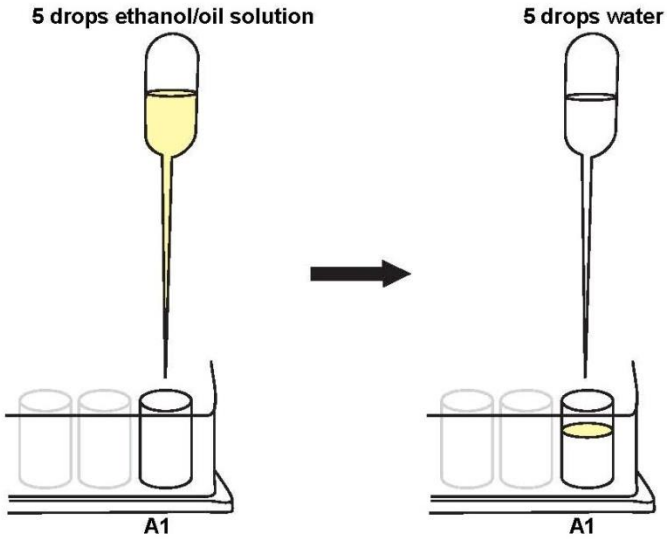
1. Fill ½ of well F1 with water from a propette.
2. Add 2 drops of vegetable oil using a clean propette. (*See Question 1*)



3. Stir the contents of well F1 vigorously with a plastic microspatula.
   (*See Question 2*)
4. Place 2 drops of oil into well F3. Add ethanol to well F3 from a clean propette until the well is half full.
   (*See Question 3*)



6. Suck up the ethanol/oil solution in well F3 with a clean propette and place 5 drops of this solution into well A1.
1. Add 5 drops of water to the solution in well A1. (*See Question 4*)



Keep both the oil/water and oil/ethanol mixtures for the next experiment.

QUESTIONS

Q1. What do you observe in well F1 after adding the vegetable oil?

Q2. What do you see in well F1 after stirring?

Q3. What happens to the oil in well F3 when the ethanol is added?

Q4. What happens in well A1 after adding the water to the ethanol/oil mixture?

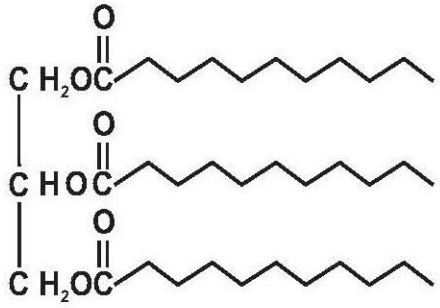
Q5. What is the general name given to the kind of cloudy liquid observed in well A1?

Q6. How can one identify lipids in food using the emulsion test?

EXTENSION QUESTION

(The following question is aimed at students with a chemistry background.)

Q7. The structure of a a complete lipid molecule is given below. Use this structure to explain your observation when oil was added to water.



a lipid molecule

Experiment 17 GREASE SPOT TEST FOR LIPIDS

Grade Level – 9&10

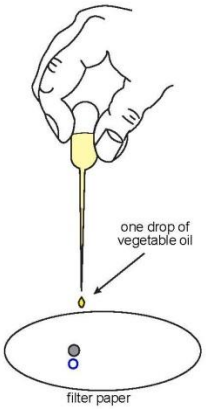
You Need

Apparatus: 1 x comboplate®; 5 x thin stemmed propettes; Filter paper or brown paper (not in the kit).

Chemicals: Ethanol/oil solution from Lipid Activity 1; Water/oil mixture from Lipid Activity 1; Ethanol (C_2H_5OH (l)); Vegetable oil (eg. corn oil, olive oil etc.); Tap water.

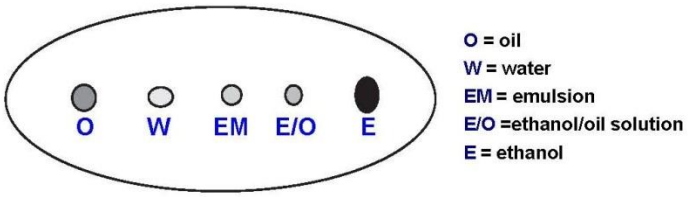
What to do

1. Place 1 drop of vegetable oil onto a piece of filter paper. Write the letter **O** on the filter paper beneath the spot with a pencil.



2. Place 1 drop of water next to the oil spot on the filter paper. Write the letter **W** on the filter paper beneath the water spot.
3. Shake the oil/water mixture in the propette so that a temporary emulsion forms inside the bulb of the propette.
4. Immediately place a drop of the emulsion on the filter paper next to the water spot. Write the letters **EM** beneath the emulsion spot.
5. Place 1 drop of the ethanol/oil solution next to the spot of the emulsion on the filter paper. Write **E/O** beneath the spot with a pencil.
6. Finally, place 1 drop of ethanol next to the ethanol/oil spot on the paper. Write the letter **E** beneath the spot with a pencil.
7. Leave the filter paper to dry. Observe the dry paper. *(See Question 1)*
8. Hold the paper up to the light. *(See Question 2)*

Rinse the comboplate® with a soap solution.



	QUESTIONS Q1. What do you see on the surface of the filter paper once it has dried? Q2. What do you notice about the oil stains on the paper when the paper is held up to the light? Q3. It was found in the emulsion test that oil dissolves in ethanol. Why, then, was an oil stain left where the ethanol/oil spot was placed on the filter paper? Q4. Explain your observations concerning the spot of the oil/water mixture. Q5. What would you have seen on the dried filter paper if the oil and water were not shaken together in the propette before placing a spot on the paper? Explain. Q6. How can the grease spot test distinguish between lipids and non-lipids in food?

Experiment 18 DOES THE FOOD WE EAT CONTAIN LIPIDS?

Grade Level – 9&10

You Need

Apparatus: 1 x comboplate®; 6 x thin stemmed propettes; 1 x kitchen grater or sharp knife; Filter paper or brown paper.

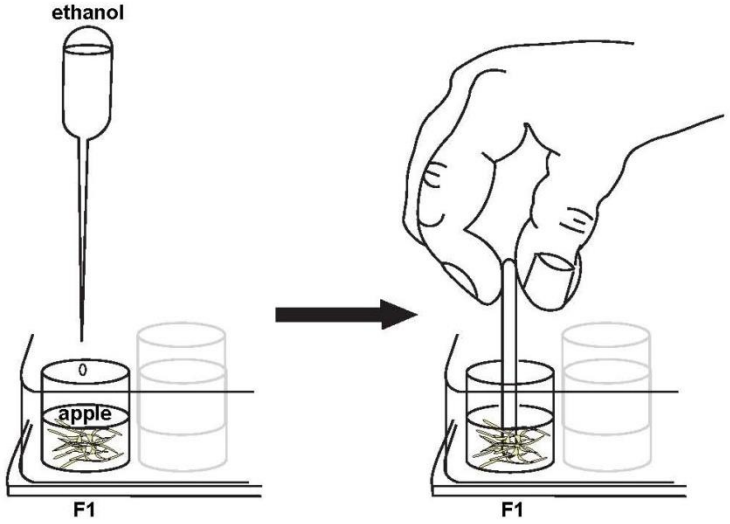
Chemicals: Ethanol (C_2H_5OH (l)); 1 x fresh apple; 1 x fresh carrot; Cooked white mealie meal; Cooked white rice; Fresh full cream milk; Tap water.

NOTE

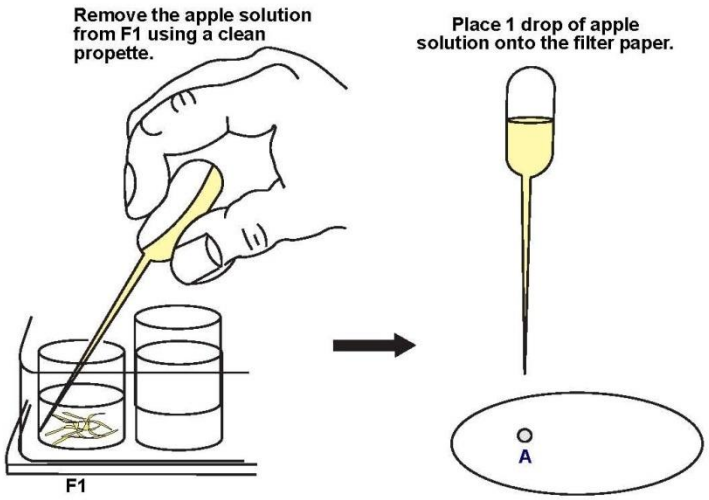
- The food items are not included in the kit.
- The meal and rice must be cooked in plain water. No milk, sugar, salt, butter, etc. may be added.

What to do

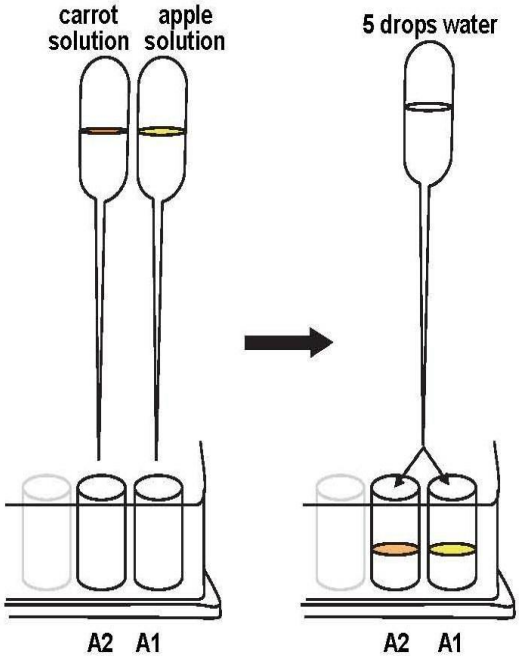
1. Use the kitchen grater to grate a portion of each of the apple and carrot. Clean the grater between each food item. (If a grater is not available, use a sharp knife to scrape across the flesh of each item.)
2. Fill 1/3 of well F1 with grated apple. Add ethanol from a clean propette to the apple in well F1 until the well is half full.
3. Grind the apple in the ethanol with a glass rod. Any food items may be used; not necessarily those listed above.



4. Fill 1/3 of well F2 with grated carrot. Add ethanol to the carrot until the well is half full. Wipe the glass rod clean and use it to grind the carrot in the ethanol.
5. Fill 1/3 of well F3 with cooked, white rice. Wipe clean the glass rod and use it to break the rice into smaller pieces before adding any ethanol.
6. Add ethanol to the rice until well F3 is half full. Stir the solution with the glass rod.
7. Fill 1/3 of well F4 with cooked, white mealie meal. Add ethanol to the meal until the well is half full.
8. Rinse the glass rod and use it to stir the mixture in well F4. (After stirring the meal should settle at the bottom of the well.)
9. Remove all of the solution from well F1 with a clean propette and place 1 drop of this solution onto a piece of filter or brown paper. Write the letter **A** under the spot.



10. Remove all of the carrot solution from well F2 with a clean propette and place 1 drop of this solution onto the filter paper next to the apple spot. Write the letter **C** under the carrot spot.
11. Repeat the above step with the rice solution in well F3 . Write the letter **R** under the rice spot.
12. Repeat the above step with the maize solution in well F4. Write the letters **MM** under the spot.
13. Using a propette, place one drop of full cream milk next to the meal on the filter/brown paper. Write the letter **M** under the milk spot.
14. Place the paper on one side and allow it to dry. While you are waiting, place 5 drops of the apple solution into well A1. Add 5 drops of water to well A1. (*See Question 1*)
15. Place 5 drops of the carrot solution into well A3. Add 5 drops of water to well A3. (*See Question 2*)
16. Repeat the emulsion test with both the rice and mealie meal solutions. (*See Question 3*)
17. Examine the dry piece of filter paper and record your results in Table 1. (*See Question 4*)



Rinse the comboplate® with a soap solution.

QUESTIONS

Q1. Does an emulsion form in well A1 when the water is added to the apple solution?

Q2. Does an emulsion form in well A3 when the water is added to the carrot solution?

Q3. Do emulsions form with rice and mealie meal?

Q4. Prepare a table like table 1 below in your books. Complete the table.

Table 1

FOOD TESTED	APPEARANCE OF PAPER AFTER DRYING

Q5. What is the answer to the focus question?

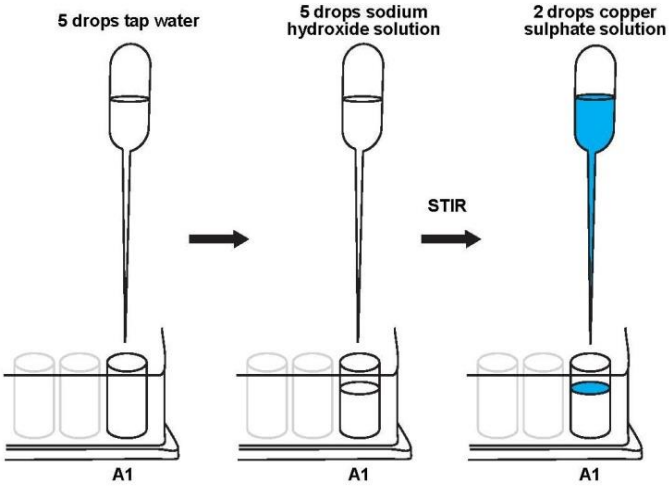
Q6. Give reasons for your answer to question 5.

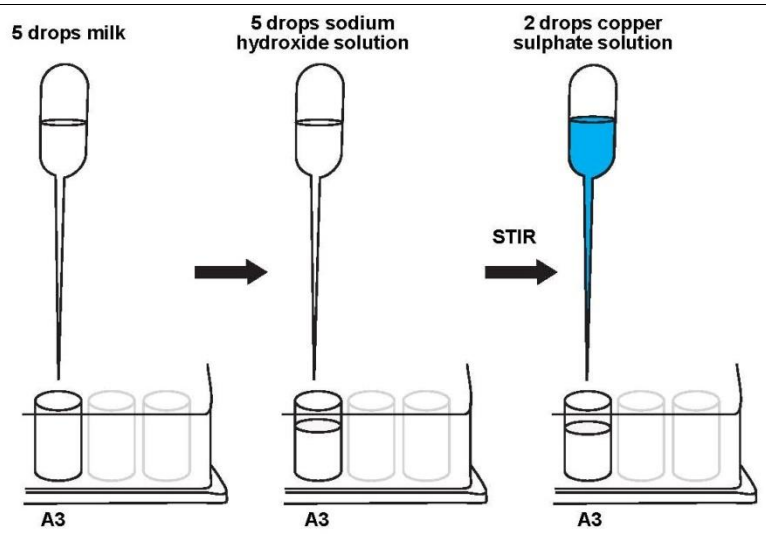
EXTENSION QUESTION

Q7. Why was the emulsion test not carried out on the milk? (Hint: what does milk look like?)

Experiment 19 BIURET TEST FOR PROTEINS

Grade Level – 9&10

	Introduction The Biuret test uses a dilute solution of copper(II) sulphate, which is made alkaline by the addition of sodium hydroxide. When the copper(II) ions come into contact with peptides or complete proteins, they form a complex with the nitrogen atoms in the peptide chain. The purpose of this experiment is to establish the colour of this complex as an indication of the presence of proteins in food.
	You Need **Apparatus:** 1 x comboplate®; 5 x thin stemmed propettes; 2 x plastic microspatulas. **Chemicals:** Sodium hydroxide solution (NaOH(aq)) [10%]; Copper sulphate solution ($CuSO_4$ (aq)) [1%]; Fresh milk; Tap water. **NOTE** • The food item (milk) is not included in the kit. • A dilute suspension of egg white (albumin) can be used in place of the milk as a source of protein.
	What to do 1. Using a propette, place 5 drops of water into well A1. 2. Add 5 drops of 10% sodium hydroxide solution to the water in well A1. Stir the solution with a plastic microspatula. 3. Add 2 drops of 1% copper sulphate solution with a clean propette. (*See Question 1*)  4. Place 5 drops of fresh milk into well A3. 5. Add 5 drops of 10% sodium hydroxide solution to the milk in well A3. Stir the solution with the microspatula. 6. Add 2 drops of 1% copper sulphate solution. (*See Question 2*)



7. Stir the solution in well A3 with a microspatula. (*See Question 3*)

Rinse the comboplate® and remaining equipment with water .

QUESTIONS

Q1. What do you observe in well A1 after adding the copper sulphate solution?

Q2. What do you observe in well A3 after adding the copper sulphate solution?

Q3. What happens to the solution in well A3 when it is mixed with the copper sulphate?

Q4. How can one test for the presence of proteins in food?

Experiment 20 DOES THE FOOD WE EAT CONTAIN PROTEIN?

Grade Level – 9&10

INTRODUCTION

The longer the peptide chain, the greater the number of peptide bonds in the chain and therefore the greater the number of complexes that will form between the copper(II) and the -NH- bonds present in the peptide chain, during the Biuret test. As a result, the complexity of the protein in a sample can be determined by the difference in the colours of the solutions. Proteins with only a few amino acids and hence few peptide bonds, are termed simple or lower proteins. Proteins with large numbers of peptide bonds are the complex or higher proteins, especially since they may also show secondary and/or tertiary structure. In the Biuret test, violet-purple indicates the higher proteins, pink indicates the lower proteins and a pale blue colour indicates that no proteins are present.

You Need

Apparatus: 1 x comboplate®; 6 x thin stemmed propettes; 2 x plastic microspatulas; 1 x glass rod; 1 x food grater or sharp knife.

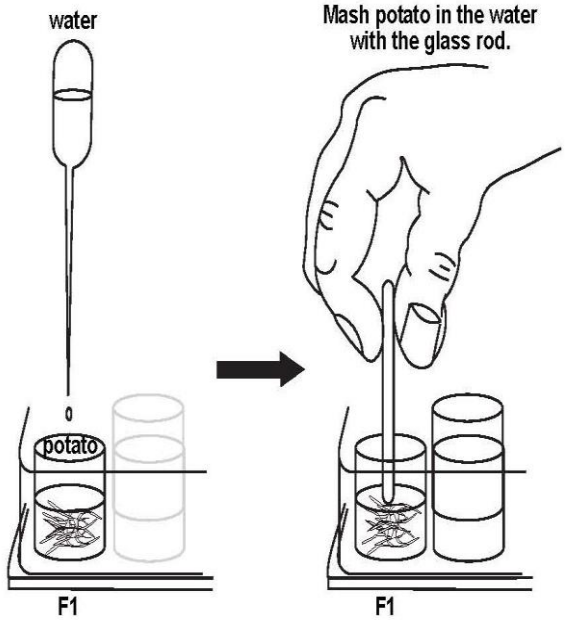
Chemicals: Sodium hydroxide solution (NaOH(aq)) [10%];
Copper sulphate solution (CuSO4(aq)) [1%]; 1 x fresh potato; 1 x fresh apple;
1 x fresh carrot; Cooked white rice; Cooked white mealie meal; Tap water.

NOTE

- The food items are not included in the kit.
- The meal and rice must be cooked in plain water. No milk, sugar, salt, butter, etc. may be added.
- Any food items may be used; not necessarily those listed above.

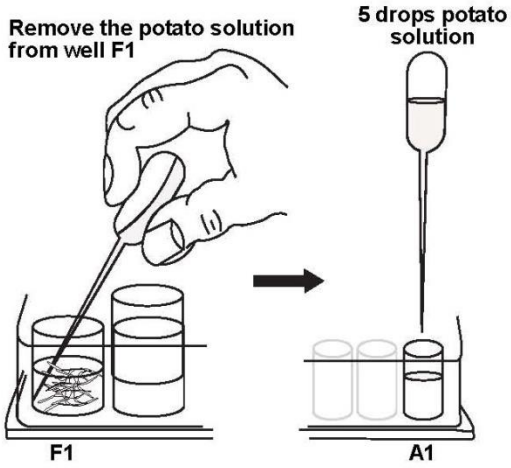
What to do

1. Use the food grater to grate a portion of each of the potato, apple and carrot. Wipe the grater clean before each new food is grated. (If a grater is not available, then scrape across the flesh of each item with a sharp knife.)
2. Fill 1/3 of well F1 with grated potato. Add water to the potato from a propette until well F1 is half full. Mash the potato in the water with the glass rod.

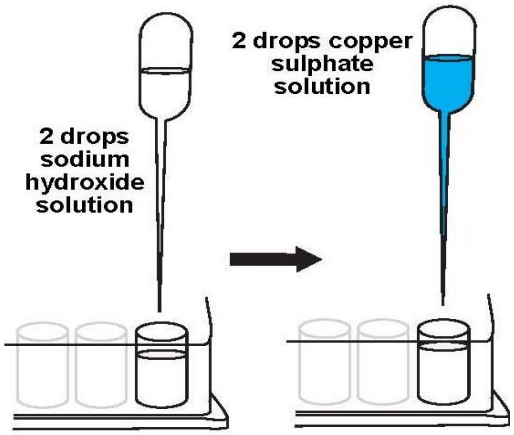


3. Fill 1/3 of well F2 with grated apple. Add water to the apple until well F2 is half full.
4. Wipe the glass rod and mash the apple in the water with the rod.

5. Fill 1/3 of well F3 with grated carrot. Treat the carrot in the same manner as you have the potato and apple.
6. Fill 1/3 of well F4 with cooked white rice. Rinse the glass rod and use it to break the rice into smaller pieces before adding any water.
7. Add water to the rice until well F4 is half full. Stir the mixture with the glass rod.
8. Fill 1/3 of well F5 with cooked, white mealie meal. Add water to the meal until the well is half full. Rinse the glass rod and use it to stir the meal in the water.



9. Use a clean propette to remove the Potato solution from well F1. Place 5 drops of this solution into well A1.
10. Add 2 drops of 10% sodium hydroxide solution and stir with a microspatula.
11. Add 2 drops of the 1% copper sulphate solution and stir. Record your results in Table 1 (*See Question 1*).



12. Remove the apple solution from well F2 with another propette. Place 5 drops of this solution into well A3.
13. Add 2 drops of 10% sodium hydroxide solution and stir with a microspatula.
14. Add 4 or 5 drops of 1% copper sulphate solution. Stir and record your results. (*See Question 1*)
15. Remove all of the carrot solution from well F3 and place 5 drops into well A5. Add 2 drops of 10% sodium hydroxide solution and stir with a microspatula.
16. Add 5 drops of copper sulphate solution. Stir and record your results. (*See Question 1*)
17. Repeat steps 15 - 16 with the rice solution from well F4. Place the solutions into well A7. Record your results in Table 1. (*See Question 1*)
18. The particles of mealie meal in well F5 will block the stem of a propette. Therefore, make sure that all solid material has settled in the well before attempting to remove the mealie meal solution with a propette.
19. Place 5 drops of this solution into well A9 and add 10 drops of 10% sodium hydroxide solution. Stir with a clean microspatula.
20. Add about 5 drops of the copper sulphate solution to well A9 and stir. Record your results in Table 1. (*See Question 1*)

Rinse the comboplate® and remaining equipment with water.

QUESTIONS

Q1. Prepare a table like Table 1 below in your workbooks. Record your results with the different foods tested.

Table 1

WELL	FOOD SOLUTION	COLOUR WITH COPPER SULPHATE

Q2. What is the answer to the focus question?

Q3. What does the colour of the potato solution tell you about the type of proteins present in potato?

EXTENSION QUESTION

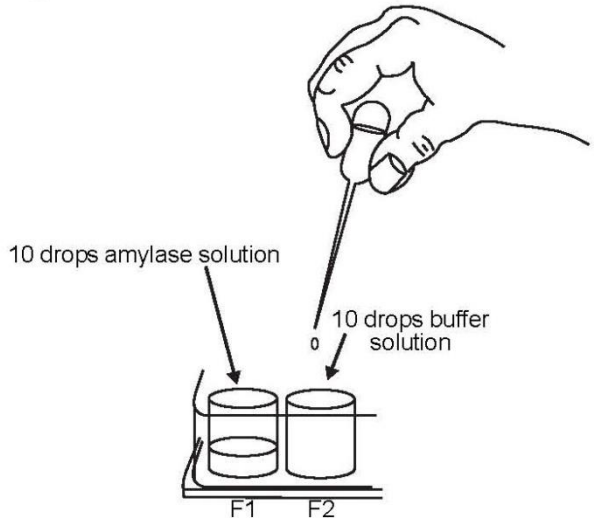
Q4. It is often stated that rice and mealie meal contain protein. Mealie meal is a staple food in many African countries. How can the results obtained in this experiment help to explain the high incidence of Kwashiorkor (an illness related to a lack of protein in the diet) in Africa?

CSEC Objective (s) Section A Unit 2 Objective 5

Explain the process of digestion in human beings

Experiment 21 THE ACTION OF AMYLASE ON STARCH

Grade Level - 10

	You Need **Apparatus:** Comboplate®; 2 x propettes; Plastic lunch box; Thermometer. **Chemicals:** Starch suspension;Amylase solution; I_2 /KI solution (iodine solution); pH 6.5 buffer solution; Hot water; Tap water at room temperature. Use the plastic lunch box as a water bath in the following way: • Pour a little tap water at room temperature into the container. • Slowly add hot water, stirring occasionally until a temperature of between 30 ^oC and 40 ^oC is reached.
	What to do 1. Add 20 drops of starch suspension to each of wells F1 and F2 of the comboplate®. 2. Add 10 drops of amylase solution to well F1 and 10 drops of buffer solution to well F2 of the comboplate®. See the figure below.  3. Float the comboplate® on a water bath at between 30 ^oC and 40 ^oC for 10 minutes. **CARE** DO NOT LET WATER FROM THE WATER BATH ENTER ANY OF THE COMBOPLATE® WELLS. 4. After 10 minutes add 5 drops of I_2 /KI solution (iodine solution) to each of wells F1 and F2. 5. Observe any changes.
	QUESTIONS 1. What is the colour of the I_2 /KI solution (iodine solution)?

	2. What happens when we add iodine solution to starch suspension or to a food which contains starch? 3. What is the colour of the mixture in well F2 after iodine solution has been added? 4. What does this observation suggest? 5. What is the colour of the solution in well F1 after iodine solution has been added? 6. What does this observation suggest? 7. What substance did well F1 have which well F2 did not have? 8. What did the amylase do? 9. Where do we find amylase in ourselves? 10. Amylase is an enzyme. What sort of enzyme is it?

Experiment 22 THE ACTION OF AMYLASE ON STARCH OVER A PERIOD OF TIME

Grade Level - 10

You Need

Apparatus: Comboplate®; 2 x propettes; Stopwatch or clock.

Chemicals: Starch suspension;Amylase solution; pH 6.5 buffer solution; I_2/KI solution (iodine solution).

What to do

1. Add 20 drops of starch suspension to each of wells F1 to F6 of the comboplate®.
2. Add 10 drops of amylase solution and 10 drops of buffer to each of wells F1 to F6 of the comboplate®.
3. Add 5 drops of I_2/KI solution (iodine solution) to the contents of well F1 immediately. This well represents the situation before amylase has acted on the starch. In other words it shows the zero time situation.
4. Start measuring the time from zero time.
5. One minute from zero time, add 5 drops of I_2 /KI solution (iodine solution) to the contents of well F2.
6. Two minutes from zero time, add 5 drops of I_2 /KI solution (iodine solution) to the contents of well F3.
7. Four minutes from zero time, add 5 drops of I_2 /KI solution (iodine solution) to the contents of well F4.
8. Eight minutes from zero time, add 5 drops of I_2 /KI solution (iodine solution) to the contents of well F5.
9. Sixteen minutes from zero time, add 5 drops of I_2/KI solution (iodine solution) to the contents of well F6.
10. Wait for 5 minutes.
11. During this time, copy the table below. It represents the F wells of the comboplate®. You will use the table to record the final colours of the mixtures in the appropriate wells.

Table to Show the Effect of Amylase on Starch over a Period of Time

Well	F1	F2	F3	F4	F5	F6
Colour						

12. Place the comboplate® on a sheet of white paper so that you can see the colours clearly.
13. Use the table to record your observations.

QUESTIONS

1. What was the substrate in this investigation?
2. What was the enzyme in this investigation?
3. What do you think the end-products of the reaction are?
4. What do your observations suggest?
5. Amylase acts in the mouth which has a pH around 7. What do you suppose happens when the food with enzyme enters the stomach which has a pH around 2 to 3?

Experiment 23 THE EFFECT OF pH ON THE ACTION OF AMYLASE ON STARCH

Grade Level - 10

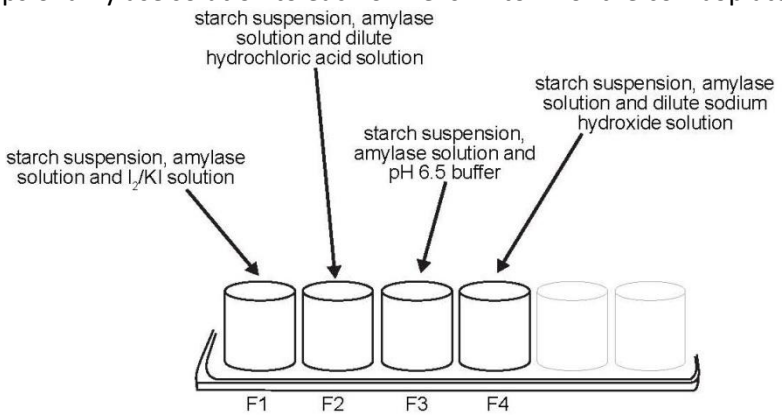
You Need

Apparatus: Comboplate®; 5 x propettes; Stopwatch or clock.

Chemicals: Starch suspension;Amylase solution; pH 6.5 buffer solution; I_2/KI solution (iodine solution);
Dilute hydrochloric acid (0.1 M); Dilute sodium hydroxide solution (0.1 M).

What to do

1. Add 20 drops of starch suspension to each of wells F1 to F4 of the comboplate®.
2. Add 10 drops of amylase solution to each of wells F1 to F4 of the comboplate®.



3. Add 5 drops of I_2/KI solution (iodine solution) to the contents of well F1 immediately. This represents the situation before amylase has acted on the starch. In other words it is the blank.
4. Add 10 drops of dilute hydrochloric acid solution to well F2 of the comboplate®.
5. Add 10 drops of pH 6.5 buffer solution to well F3 of the comboplate®.
6. Add 10 drops of dilute sodium hydroxide solution to well F4 of the comboplate®.
7. After 10 minutes, add 5 drops of I_2/KI solution (iodine solution) to each of wells F2 to F4.
8. During the 10 minute wait, copy the table below. It represents the F wells of the comboplate®. You will use the table to record the final colours of the mixtures in the appropriate wells.

Table to Show the Effect of Amylase on Starch in Solutions of Different pH

Well	F1	F2	F3	F4
Solution				
Colour				

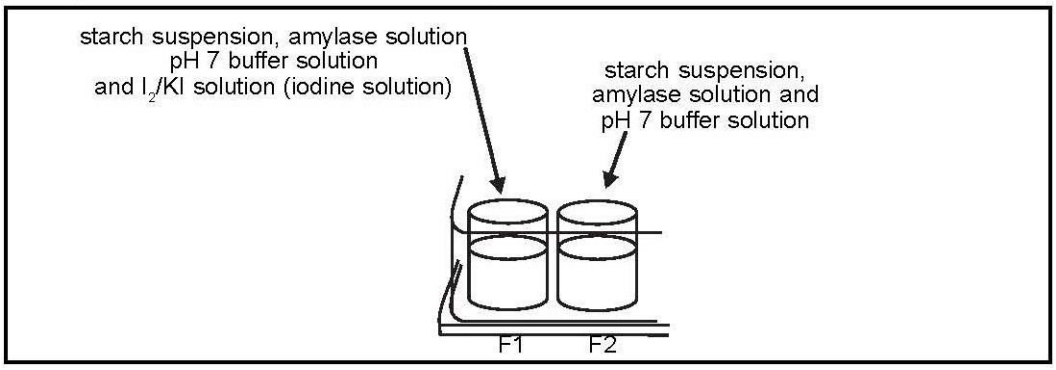
9. Place the comboplate® on a sheet of white paper so that you can see the colours clearly.
10. Use the table to record your observations.

	QUESTIONS 1. What was the substrate in this investigation? 2. What was the enzyme in this investigation? 3. What do you think the end-products of the reaction are? 4. What do your observations suggest? 5. Amylase acts in the mouth which has a pH around 7. What do you suppose happens when the food with enzyme enters the stomach which has a pH around 2 to 3? 6. Explain your answer in terms of the lock-and-key theory of enzyme activity.

Experiment 24 THE EFFECT OF TEMPERATURE ON THE ACTION OF AMYLASE ON STARCH

Grade Level - 10

	You Need **Apparatus:** 4 x comboplate®s; 5 x propettes; *4 x plastic lunch boxes; 4 thermometers; Stopwatch or clock. **Chemicals:** Starch suspension; Amylase solution; pH 6.5 buffer solution; I_2/KI solution (iodine solution); Ice; Hot water. ***Use the plastic lunch boxes as water baths in the following way:**
	Between 0 ^{0}C and 10 ^{0}C • Pour a little tap water at room temperature into one of the lunch boxes. • Slowly add ice, stirring occasionally until a temperature of between 0 ^{0}C and 10 ^{0}C is reached.
	Between 30 ^{0}C and 40 ^{0}C Similarly, using another plastic lunch box, • Pour a little tap water at room temperature into one of the lunch boxes. • Slowly add hot water, stirring occasionally until a temperature of between 30 ^{0}C and 40 ^{0}C is reached.
	Between 80 ^{0}C and 100 ^{0}C Repeat the procedure using another plastic lunch box and more hot water, in order to obtain a temperature between 80 ^{0}C and 100 ^{0}C.
	Room Temperature Use plain tap water for the water bath at room temperature. Keep checking the temperatures of the water in the water baths. Add either hot or cold water as necessary in order to maintain the correct temperature range.
	What to do Four comboplate®s as well as four water baths are needed. We suggest you work in four groups, each group taking responsibility for a different temperature set-up. 1. Place the first comboplate® in a 0 ^{0}C to10 ^{0}C water bath (i.e. in a water bath of icy or very cold water). 2. Place the second comboplate® in a water bath at room temperature. 3. Place the third comboplate® in a 30 ^{0}C to 40 ^{0}C water bath. 4. Place the fourth comboplate® in a 80 ^{0}C to 100 ^{0}C water bath (i.e. in a water bath with very hot water). **Follow steps 5 to 10 for each of the four comboplate®s** 5. Add 20 drops of starch suspension to each of wells F1 and F2. 6. Add 10 drops of pH 7 buffer solution to each of wells F1 and F2. 7. Add 10 drops amylase solution to each of wells F1 and F2. 8. Add 5 drops of I_2/KI solution (iodine solution) to the contents of well F1 immediately. This reaction represents the situation before amylase has reacted with the starch. Each comboplate® should look like the situation pictured below.

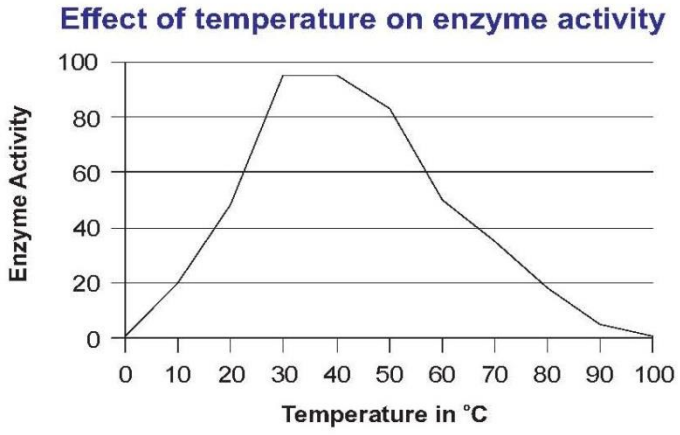


9. After 10 minutes, add 5 drops of I_2/KI solution (iodine solution) to the contents of well F2.
10. Place the comboplate® on a sheet of white paper so that you can see the colours clearly.
11. Record your observations of the colour in well F2 as shown below:

Comboplate® 1 (0 ^{0}C to 10 ^{0}C):
Comboplate® 2 (room temperature):
Comboplate® 3 (30 ^{0}C to 40 ^{0}C):
Comboplate® 4 (80 ^{0}C to 100 ^{0}C):

QUESTIONS

1. What are the possible variables in this investigation?
2. What was the altered variable in this investigation?
3. What do your observations suggest?
4. What is the significance of a temperature around 30 ^{0}C to 40 ^{0}C?
5. What do you suppose happens to the enzyme at low temperatures?
6. What do you suppose happens to the enzyme at high temperatures?
7. An experiment, similar to the one which you have just done, was conducted in order to determine the effect of temperature on an enzyme. The enzyme was allowed to react for half an hour. The results of the experiment are shown in the graph below.



7.1 What is the optimum temperature for this enzyme?
7.2 At which temperature(s) does the enzyme function at 20% activity?
7.3 How do you suppose enzyme activity is measured?
7.4 Why does the enzyme activity not reach 100%?

Experiment 25 THE ACTION OF THE ENZYME CATALASE ON HYDROGEN PEROXIDE

Grade Level - 10

INFORMATION

Nearly all living tissue contains an enzyme called ***catalase***. This enzyme speeds up the decomposition of hydrogen peroxide into water and oxygen. Oxygen is a gas which bubbles through the solution as it is being produced. The more catalase present, the more quickly the oxygen is produced and therefore the more bubbly or fizzy the solution appears.

You Need

Apparatus: 1 x comboplate®; 1 x 2 ml syringe; Small knife* (not in kit).

Chemicals: 12 ml hydrogen peroxide ** (provided by your teacher); Pieces of living tissue (carrot, onion, apple, liver, meat, potato etc).

What to do

1. Cut small pieces of the tissue, about the size of a pea, and place one piece of each type into wells F1 to F6.
2. In your book, write down the types of tissue in a table like the one below.
3. Use the syringe to add 2 ml of the hydrogen peroxide solution to each of the wells with the tissue.
4. Observe any changes.

Tissue	Effect

5. Decide which tissue has the greatest effect on the hydrogen peroxide and which tissue has the least effect.
6. In the table, write the word "greatest" next to the tissue which had the greatest effect and the word "least" next to the tissue which had the least effect.

Rinse the comboplate® (not down the drain - use a waste bucket) and shake it dry.

QUESTIONS

1. What is the effect of the enzyme catalase on hydrogen peroxide?
2. Suggest another name for the enzyme catalase.

HINT: *Enzymes are often named after the substrate on which they act.*

CSEC Objective (s) - Section A Unit 3 Objective 3

Discuss the importance of respiration to organisms

Experiment 26 IS ENERGY RELEASED DURING RESPIRATION?

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

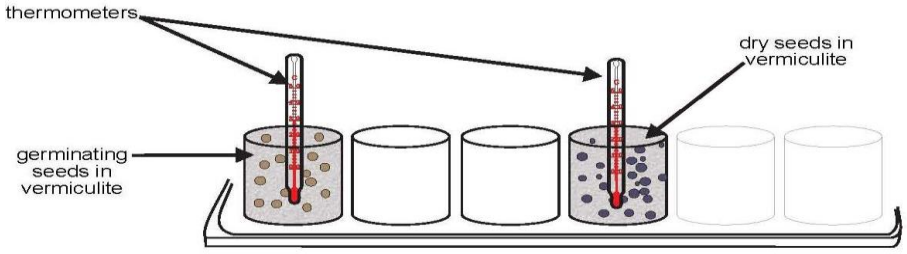
Apparatus: 1 x comboplate®; 2 x thermometers; *Prestik*; Dry, non-germinating seeds; Germinating seeds; Vermiculite or absorbent paper; Cotton wool.

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 (^{0}C)	**Temperature in well F4 (^{0}C)**
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 27 IS OXYGEN USED DURING RESPIRATION?

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.

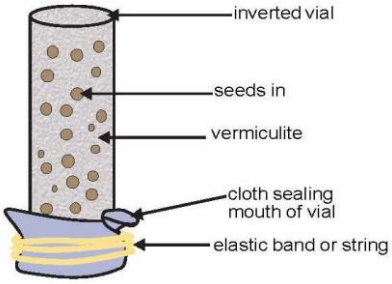
You Need

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.

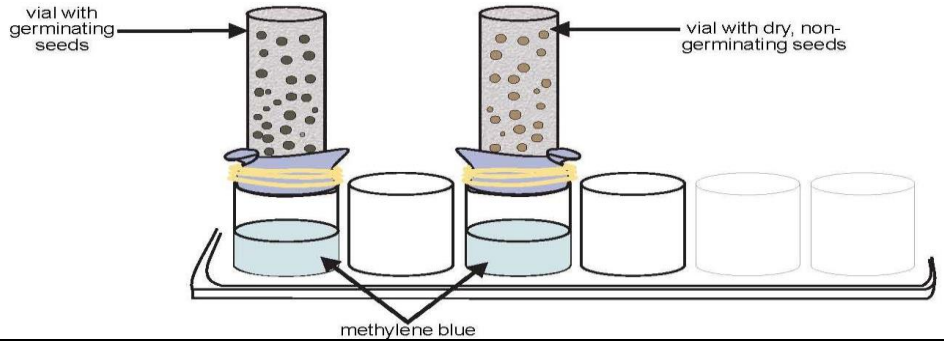
Chemicals: Methylene blue solution.

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?

CSEC Objective (s) - Section A Unit 3 Objective 6

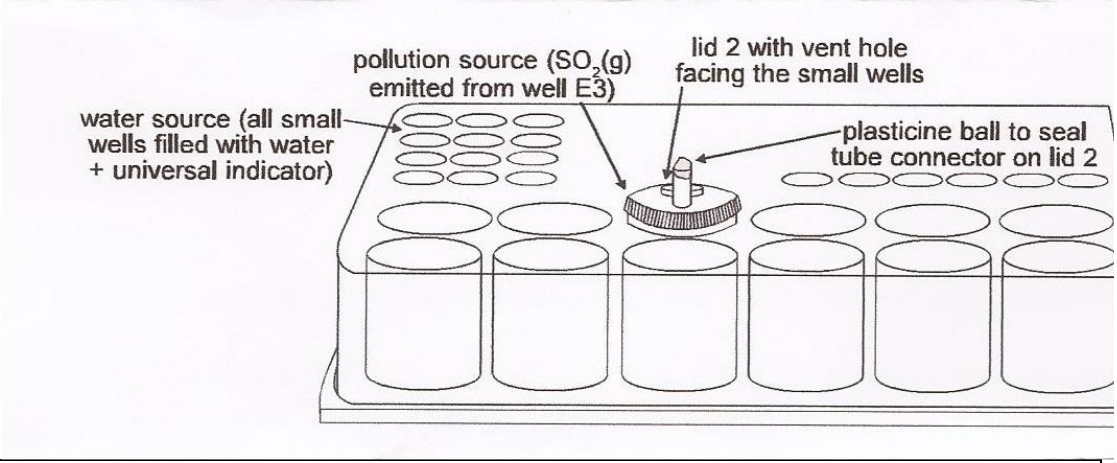
Identify the causes of air pollution

Experiment 28 AIR POLLUTION BY SULPHUR DIOXIDE

PART 1 - Uncontrolled Emission of Sulphur Dioxide

Grade Level – 10/11 and 12

	REQUIREMENTS **Apparatus:** 1 x 2 ml syringe; 2 x thin stemmed propettes; 1 x plastic microspatula; 1 x comboplate®;1 x lid 2; 1 x piece of plasticine (5 mm x 5 mm x 5 mm). **Chemicals:** Hydrochloric acid (HCl(aq)) [5.5 M]; Anhydrous sodium sulphite powder (Na_2SO_3(s)); Universal indicator solution; Tap water.
	INTRODUCTION This experiment aims to simulate an industrial plant, which produces gaseous sulphur dioxide, and determine what factors influence the effect of the air-pollution on the water in the vicinity. The small wells of the comboplate®, filled with water, will be used to represent the water supply.
Note	**PROCEDURE** 1. Place the comboplate® under a running water tap and fill all the small wells (wells A1 to D12) with water. 2. Use an empty propette to suck up, and then discard any water that may have got into the large wells. Use a paper towel to gently soak up any water between the small wells on the surface of the comboplate®. 3. Use a propette to add one drop of universal indicator solution into each of the small wells filled with water. (See Question 1) 4. Using the spooned end of a plastic microspatula, add three spatulas of anhydrous sodium sulphite powder into well E3. Insert lid 2 into well E3 in such a way that the vent is closest to the small wells and the tube connector is pointed away from the small wells (see the figure below). 5. Seal the tube connector on lid 2 with a piece of plasticine (see the figure below). **If there are any draughts in the room, the results of the experiment may be affected slightly. If you like, you can use a shallow container such as an empty cardboard box to prevent the effect of any draughts on the experiment. This is, however, not a necessity.** 6. Fill the syringe with 0,2 ml of 5.5 M hydrochloric acid. Hold the nozzle of the syringe just inside the vent in lid 2. Add all of the hydrochloric acid into well E3. Do not push the nozzle of t he syringe all the way into the vent of lid 2, because the syringe will become stuck in the lid. Be careful not to drop any of the hydrochloric acid into the water. 7. Wait about three to five minutes



8. After about 1½ minutes of waiting, briefly lift the comboplate® to the light and observe the colour of the aqueous solutions from underneath the comboplate®. (See Question 2)
9. After about 5 minutes count the number of acidified wells, and hold the comboplate® to the light once again. (See Questions 7, 9).

Clean the comboplate® thoroughly before proceeding with part 2.

QUESTIONS

Q 1. What is the colour and pH of the aqueous solution of universal indicator at the beginning of the experiment?

Q 2. What happens to the colour of the aqueous solution of universal indicator in the wells? What is happening to the pH of this solution?

Q 3. Explain your answer to question 2 using a chemical equation to represent the reaction that could be occurring.

Q 4. Does the colour of the aqueous solution change uniformly:
a) across the surface area of the solution in each well,
b) from top to bottom in each well ?

Q 5. Suggest a reason for your answer to question 4.

Q 6. Is the acidification of the solution the same throughout all the small wells of the comboplate® ? Explain your answer.

Q 7. In how many wells has the water been acidified? (Answer this no longer than 5 minutes from the time you began the experiment.)

Q 8. Would the number of wells showing water acidification be more or less if six microspatulas of sodium sulphite were added to well E3 instead of three, when the experiment began? Explain your answer.

Q 9. How has the distribution of the acidification changed from the first time you viewed the wells from beneath the comboplate® ? Explain your answer.

PART 2 – The Function of a Chimney in Dispersing Air Pollutants

Grade Level – 10/11 and 12

	REQUIREMENTS **Apparatus:** 1 x 2 ml syringe; 2 x thin stemmed propettes; 1 x plastic microspatula; 1 x comboplate®; 1 x lid 1; 1 x piece of plasticine (5 mm x 5 mm x 5 mm); 1 x silicone tube (1.5 cm x 4 mm). **Chemicals:** Hydrochloric acid (HCl(aq)) [5.5 M]; Anhydrous sodium sulphite powder (Na_2SO_3(s)); Universal indicator solution; Tap water.
Note	**PROCEDURE** 1. Repeat steps 1 to 3 in part 1. 2. Using the spooned end of a plastic microspatula, add three spatulas of anhydrous sodium sulphite powder into well E3. Insert lid 1 into well E3 in such a way that the tube connector is closest to the small wells and the syringe inlet is pointed away from the small wells. 3. Fit the silicone tube over the tube connector on lid 1. This will model the chimney. **As in part 1, the remainder of the steps may be performed in a draught-free area.** 4. Fill the syringe with 0,2 ml of 5.5 M hydrochloric acid. Fit the syringe into the syringe inlet in lid 1. Add all of the 5.5 M hydrochloric acid gently into well E3. Do not add the acid too quickly as the increase in pressure in the well may force acid out through the silicone tube. Be careful not to drop any of the hydrochloric acid into the water. 5. Immediately after completing step 4, remove the syringe from lid 1 and seal the syringe inlet with a piece of plasticine. Be careful not to drop any of the hydrochloric acid into the water. 6. Wait about 3 to 5 minutes and observe. (See Questions 1, 2) **Clean the comboplate® thoroughly before proceeding with part 3.**

PART 3 – The Elimination of Emission by an Absorbing Substance

Grade Level – 10/11 and 12

	REQUIREMENTS **Apparatus:** 1 x 2 ml syringe; 3 x thin stemmed propettes; 2 x plastic microspatulas; 1 x comboplate®; 1 x lid 1; 1 x piece of plasticine (5 mm x 5 mm x 5 mm); 1 x silicone tube (1.5 cm x 4 mm); 1 x piece of cotton wool (3 mm x 3 mm) **Chemicals:** Hydrochloric acid (HCl(aq)) [5.5 M]; Anhydrous sodium sulphite powder (Na_2SO_3(s)); Calcium oxide powder (CaO(s)); Universal indicator solution; Tap water.
Note	**PROCEDURE** 1. Repeat steps 1 to 3 in part 1. 2. Using the spooned end of a plastic microspatula, add three spatulas of anhydrous sodium sulphite powder into well E3. Insert lid 1 into well E3 in such a way that the tube connector is closest to the small wells and the syringe inlet is pointed away from the small wells. 3. Insert a small piece of cotton wool into the opening of one end of the silicone tube. Thereafter fit this end of the tube over the tube connector on lid 1. **4.** Use the narrow end of a clean, plastic microspatula to add calcium oxide powder into the other end of the silicone tube. Add sufficient calcium oxide powder to fill the silicone tube up. Try to pack the calcium oxide quite tightly into the tube so that it is not forced out of the tube when the hydrochloric acid is added into the well. This will be the emission absorber. **As in parts 1 and 2, the remaining steps may be performed in a draught-free area.** 5. Fill the syringe with 0,2 ml of hydrochloric acid. Fit the syringe into the syringe inlet in lid 1. Add all of the 5.5 M hydrochloric acid into well E3. Do not add the acid too quickly as the increase in pressure in the well may force all the calcium oxide out of the silicone tube. Be careful not to drop any of the hydrochloric acid into the water. 6. Immediately after completing step 5, remove the syringe from the inlet in lid 1 and seal the inlet with a piece of plasticine. 7. Wait about three to five minutes and observe. (See Question 1)
	QUESTIONS – PART 2 Q 1. Is the acidification of the solution the same throughout all the small wells of the comboplate®? Explain your answer. Q 2. In how many wells has the water been acidified? (Answer this no longer than 5 minutes from the time you began the experiment.) Q 3. Compare your answer to question 2 above with your answer to question 7 in part 1. Is the number of wells showing water acidification greater or smaller when a chimney is present?

	QUESTIONS – PART 3 Q 1. In how many wells has the water been acidified? (Answer this no longer than 5 minutes from the time you began the experiment.) Q 2. Write down a balanced chemical equation to show the reaction between the $SO_2(g)$ and the CaO(s) in the chimney. Q 3. Write a statement describing the effect of calcium oxide on SO_2 emission

CSEC Objective (s) - Section A Unit 4 Objective 1

Compare growth patterns in selective organisms

Experiment 29 PATH OF WATER THROUGH THE PLANT

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.

Experiment 30 DOES THE ROOT SYSTEM OF A PLANT PUSH WATER UP THE STEM?

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.

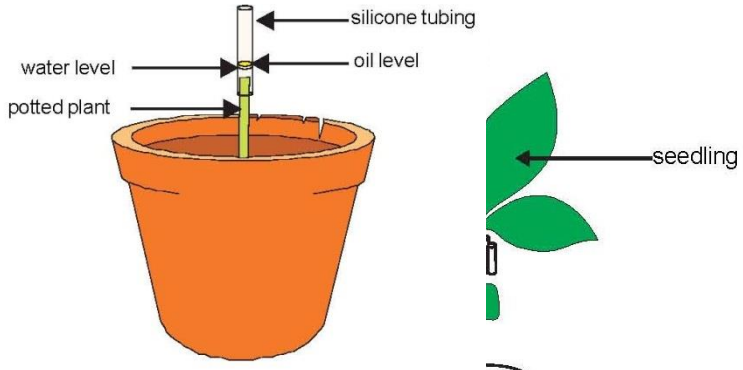
1 Remove the seedling fro
you start the investigatior

2 Wash the soil from the rc

3 Place the food colouring

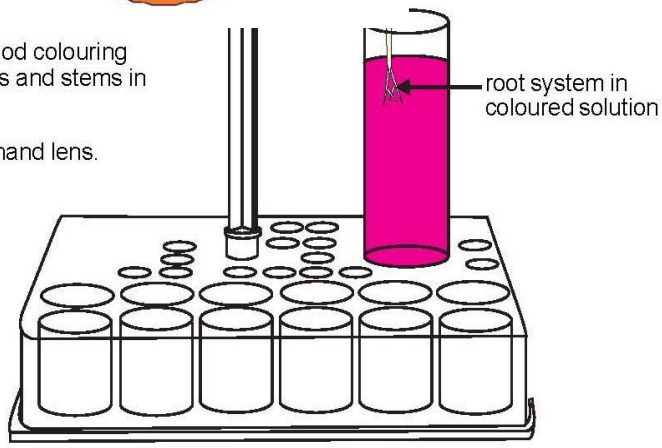
4 Support the aerial parts c
seedling in an arm of the
and submerge the roots
colouring as shown alonc

5 Allow the setup to stand

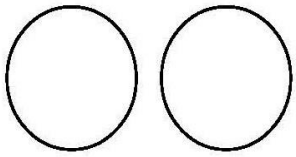


6 Remove the seedling from the food colouring and use the blade to cut the roots and stems in transverse section.

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

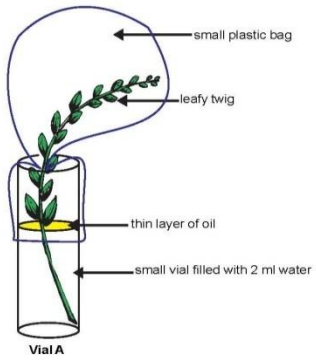
1. Repeat the procedure with other plants which have variegated (for example, green and white) leaves and observe the leaf veins after a few hours.
2. Repeat the procedure with pale-coloured flowers and observe changes which occur in the petals.

CSEC Objective (s) - Section A Unit 5 Objective 3

Identify the waste product of flowering plants and methods of excretion

Experiment 31 IS WATER LOST THROUGH THE AERIAL PARTS OF A PLANT?

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 leafy twig; a. B leafless twig; b. 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®.  Vial A 6. Leave the setup for several hours, or overnight. 7. Remove the plastic bags from the vials and estimate which bag contains the most, second most and least liquid. Record your estimations. 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 one or two sentences.

Experiment 32 INVESTIGATING HOW THE LEAVES OF PLANTS LOSE WATER

Grade Level – 9&10

You Need

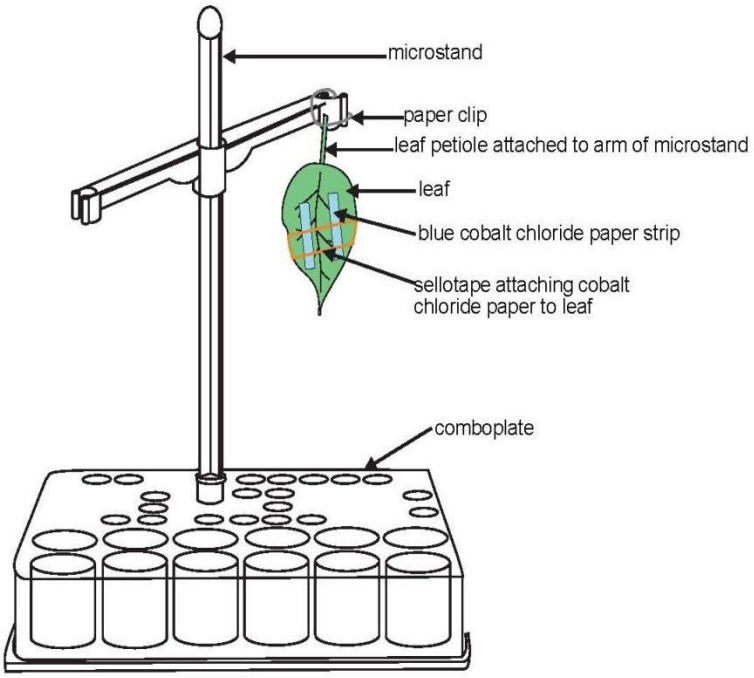
Apparatus: Comboplate®; Microstand; Leaf of plant (with petiole); Paper clip; Sellotape - width 10 mm; Hand lens.

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.

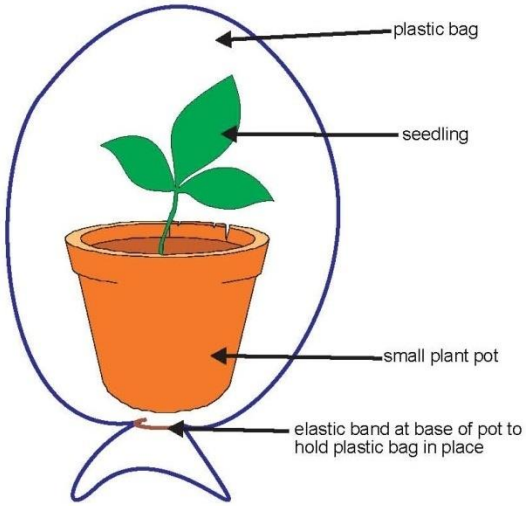
QUESTIONS

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 33 LOSS OF LIQUID WATER FROM PLANTS

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 34 LOSS OF WATER FROM PLANTS UNDER VARIOUS ENVIRONMENTAL CONDITIONS

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.

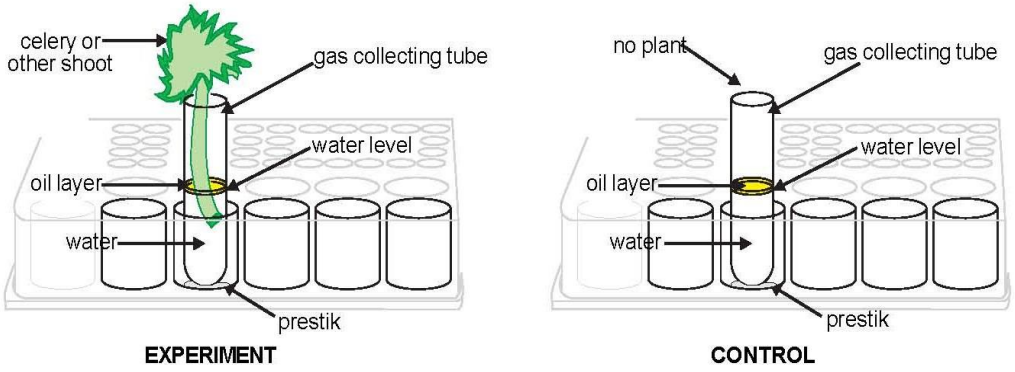
You Need

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.



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?

CSEC Objective (s) - Section A Unit 7 Objective 8

Compare growth patterns in selective organisms

Experiment 35 OBSERVING GERMINATION

Grade Level – 10

Stage 2 - Germination of the Seed

You Need

- Small planting pot*
- Potting soil*
- Seeds*
- Tap water

* Your teacher will provide these

What to do

A Preparation

The following preparation must be carried out at least two weeks before the observation stage of the investigation.

1. Place the potting soil in a small planting pot so that the pot is about half full.
2. Plant the seeds in the soil about 3 cm apart.
3. In your notebook, draw a table like the one below, leaving space for at least 14 days. Observe and record the germination and growth of the young plant.

DAY	OBSERVATION	
	RADICLE	PLUMULE
1	none visible	none visible
2		
3		
etc....		
10	**example:** 3 cm long	
etc....		

4. Sprinkle water on the seeds and the soil EVERY DAY for about 2 weeks. (Growth rate depends on temperature so the time is not exact.)
5. Leave the small planting pot in a sheltered area.

B Observation

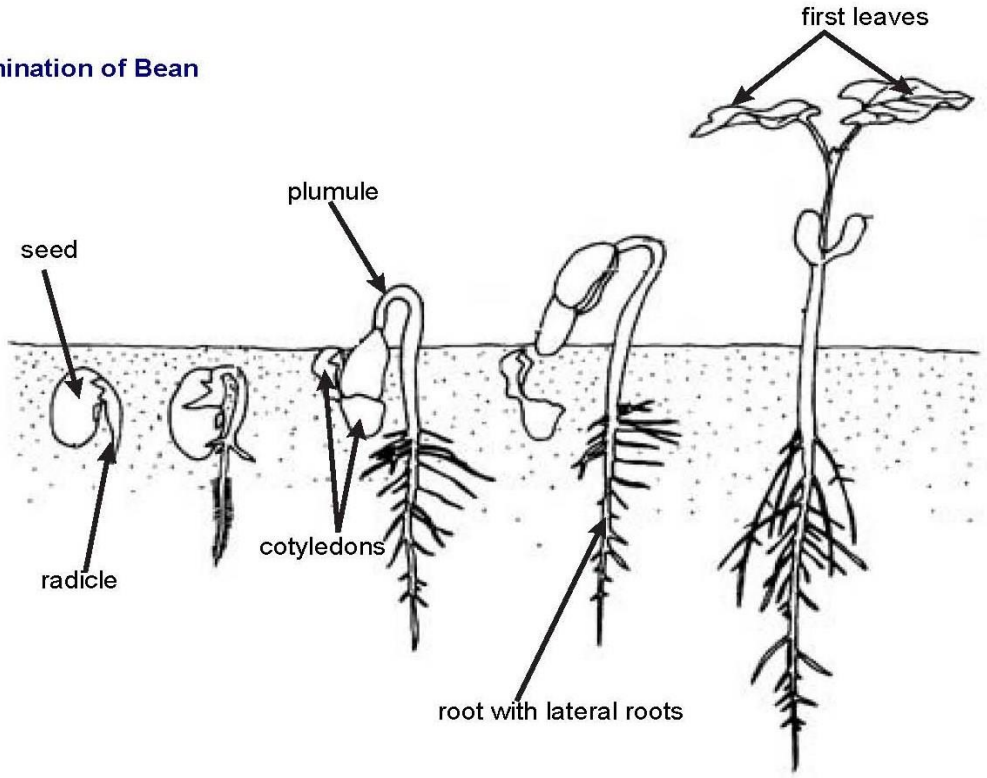
After about two weeks, carefully remove a seedling (young plant) from the soil and place it on damp newspaper.

1. Use the diagrams below to identify the named structures on your seedling. Your seedling will probably be at an early stage of development.
2. Obtain a larger planting pot from your teacher and plant the seedling in the pot with fresh potting soil OR plant the seedling in the soil outside. Take care not to damage the roots.

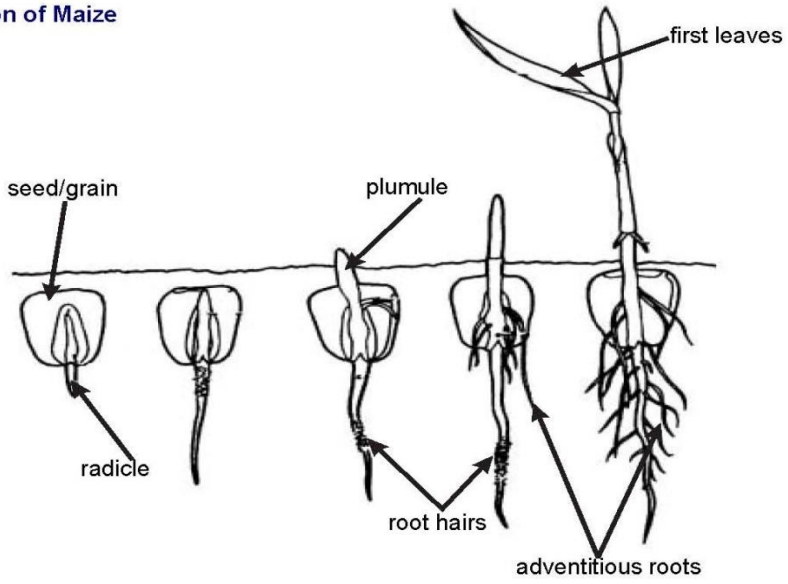
Continue examining the seedling at regular intervals in order to identify additional structures as they develop.

3. Copy the diagrams below. Use coloured pencils to show each part of the embryo (radicle and plumule) at first. Use the same colour for each structure in the later stages.
4. Look after your seedling and the plant which it later becomes. You will need it to continue the following parts of this series of activities (to come).

Germination of Bean



Germination of Maize



CSEC Objective (s) - Section B Unit 3 Objective 9

Describe the various navigation devices used at sea

CSEC Objective – (CXC 23/G/SYLL 09)

Experiment 36 CAN MAGNETISM PRODUCE ELECTRICITY?

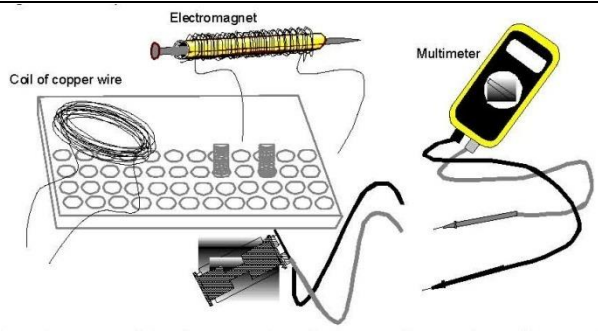
Grade Level – 10

Electricity produces magnetism. An electric current produces a magnetic field. Is the opposite true? Can magnetism produce electricity? Can a magnetic field produce an electric current?

What you need

micro-electricity kit, multimeter, magnadur magnet (optional)

To discuss before you start



Rashay, Nicolas and Alex are all grade 10 learners. In their group they discuss the question: **Can magnetism produce electricity?**

Rashay all excited, says: "If electricity produces magnetism, then I am absolutely certain that magnetism can produce electricity. In nature, everything happens in pairs .... positive and negative, north and south, action and reaction.... you name it!"

Nicolas is even more excited. He says: "And what is even better, having a strong magnet at home, will produce all the electricity we need! No more electricity bills! Electrical energy for free with a magnet!"

Alex is not very excited! He says: "Nicolas, I wonder why nobody has thought of this before! We also know that we can't get something out of nothing! Can a magnet, even a strong one, provide us with free energy?

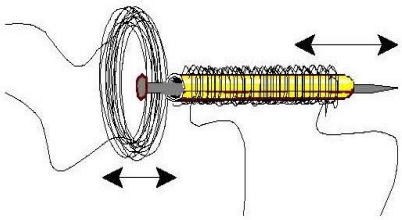
I find it hard to believe, it is against the laws of nature!"

So what do you think the answer is? Discuss the above comments with your group and add your own views. You can discuss this question again at the end of the Activity.

What to do

THE INVESTIGATION

1. Use a coil, an electromagnet (or a magnadur magnet), your multimeter, and any other component from your micro-electricity kit which you might think would be of some use. Your task is to investigate if there is a way to produce (induce) an electric current in the coil.



Hint: Compare what happens when:

- the electromagnet is stationary inside the coil
- the electromagnet moves inside the coil
- the coil moves along the length of the electromagnet

Explain how you will produce a magnetic field.

Explain how you will know if a current is induced in the coil.

Something to consider in your group: If you manage to induce a current in the coil, do you expect this current to be large or small? On which scale would you set your multimeter?

Try your plan out using your components.

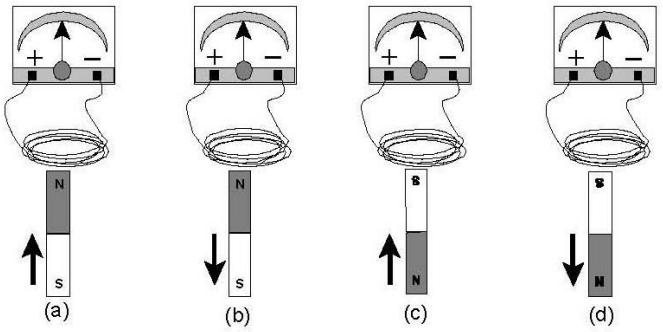
2. If you do not have a multimeter, is there any other way to test if a current is induced in the coil? (using equipment from your micro-electricity kit.) If you think yes, test this new way.
3. Summarise your conclusions and prepare a report back. In your report, mention ways (and test these ways if possible), to increase the induced current in the coil.
4. It took more than 10 years after Oersted's discovery, before two other scientists eventually succeeded to induce an electric current this way. These scientists were the American Joseph Henry and the Englishman Michael Faraday. Working independently, they both found that it was possible to produce an electric current from a magnetic field.
   This phenomenon is called electromagnetic induction.
   Why do you think it took them so long?
5. When Henry and Faraday made this discovery, many people were not impressed! "So what!" they said.
   Today, our electricity supply relies on electromagnetic induction!
   Most of the electricity we use at home, comes to us in wires. We know by the monthly bill we pay, that there is an electrical company at the other end of the wires. How does the electric company produce electricity? With "giant batteries"? Surely not! Electricity is produced in power stations.

a) From which power station does your community get its electrical supply of energy?
b) Discuss in your group, how electrical energy comes from the power station to your homes or school? (As far as you know).

THE CHALLENGE!

How do we find the direction of the induced current in the coil?
Lenz's law: The induced current in a coil has such a direction, so that its magnetic field opposes the change brought about by the external magnetic field.
The diagrams below, show a coil connected to a galvanometer and a bar magnet in the vicinity of the coil. The bar magnet moves, its movement is indicated by an arrow.

A galvanometer is an instrument that detects small currents and their direction. When the needle is in the middle, it means that there is no current in the circuit.



Use Lenz's law to find the direction of the induced current in each diagram.

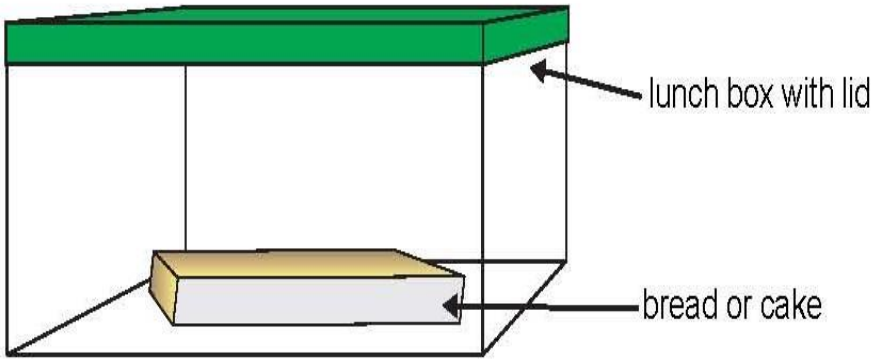
a) What will be the deflection of the galvanometer in each diagram?
b) What does this indicate?
c) Explain how you find the direction of the induced current.

CSEC Objective (s) - Section B Unit 4 Objective 1

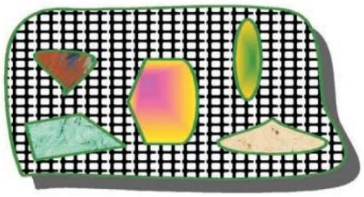
Describe the conditions which promote the growth of microorganisms

Experiment 37 WHAT MOULDS WILL GROW ON BREAD?

Grade Level - 10

	INFORMATION When bread becomes mouldy it is being consumed by saprotrophs. These are organisms that feed off dead or decaying matter, including dead animals and plants. Many fungi, moulds, and bacteria are saprotrophs. Saprotrophs play a very important role in any ecosystem - including the ecosystem in our own homes. The chemical components of dead organisms are recycled and therefore can be reused by plants and animals.
	You Need • Plastic lunch box with lid • Forceps • Hand lens • Old, stale bread or cake which is not too dry • Paper towel
	What to do **Stage 1 Colonies of Moulds** The following preparation must be carried out at least one week before the observation stage of the investigation. 1. Work in groups so that each group uses a different piece of bread or cake. Note the manufacturer or baker, date of purchase or baking, and any other information; for example whether the bread is brown, wholewheat, white or rye - and so on. 2. Sprinkle a few drops of water on the food and place it in the lunch box with the lid on as shown below.  3. Examine the bread after about one week. 4. Observe the following using a hand lens to help you: • how much of the bread is covered in mould (see below) • how many different types of mould are present • what colours the moulds are.

5. Draw a plan of your bread using squared paper. Indicate the colonies of mould present, what colours they are and what areas they occupy. Use the example below to help you



Count the total number of squares covered by the bread and record your finding.
Count the total number of squares covered by each type of fungus and record your finding.
Now calculate the percentage of bread surface covered by each type of fungus.

Example calculation:

Number of squares covered by bread = 50
Number of squares covered by mould = 18
% bread covered by mould = 18/50 x 100
= **36 %**

6. Compare your findings with those of other groups. Tabulate the combined results in a table like the one below:
   Example

Type of Substrate	Age of Substrate	% Coverage	Number of Different Colonies
brown bread	3 days	50%	3
chocolate cake	1 week	80%	1

QUESTIONS

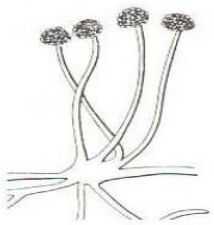
You will have to analyse the information in your table in order to answer some of these questions.

1. Which type of mould did you identify most frequently?
2. Did you notice that any type of mould was more common on any of the substrates?
3. What is happening to the bread or cake as the mould gets bigger?

Stage 2 Detailed Study of Bread Mould (Mucor / Rhizopus)

What to do

1. Select an example of mould which looks like the example given below. Use a hand lens to observe the hyphae, sporangia and the spores. (If a light microscope is available, you can also use this to observe the parts mentioned.)



	EXTENSION ACTIVITY 1. Leave the mould with its substrate in the lunch box with the lid on. Examine the contents of the lunch box every day for the following two weeks. Record all your findings. Pay careful attention to the increase or decrease in the size of any of the colonies. Use the squared paper method to help you obtain more accurate results.
	Stage 3 Examining a section of fungal mycelium - *Optional Activity* **You Need** • Light microscope • Dissecting needle • A few of the fungal threads which you grew in your comboplate • Glass slide • Coverslip • Propette • Water • White paper
	What to do 1. Make a temporary microscope slide*. 2. Place the slide under the lens of the light microscope and focus. 3. Identify fungal threads (hyphae), sporangia and spores. 4. Draw what you see. See the example alongside. ** Ask your teacher about preparing temporary microscope slides*.

CSEC Objective (s) - Section B Unit 6 Objective 3

Describe the reaction of metals with oxygen, acid, alkali, water and steam

Experiment 38 THE REACTION OF COPPER WITH OXYGEN

Grade Level - 10

REQUIREMENTS

Apparatus: 1 x comboplate®; 1 x 2 ml syringe; 1 x thin stemmed propette; 2 x plastic microspatulas; 1 x lid 1; 1 x lid 2; 1 x glass tube; 2 x silicone tubes (4 cm x 4 mm); 1 x microburner; 1 x box of matches.

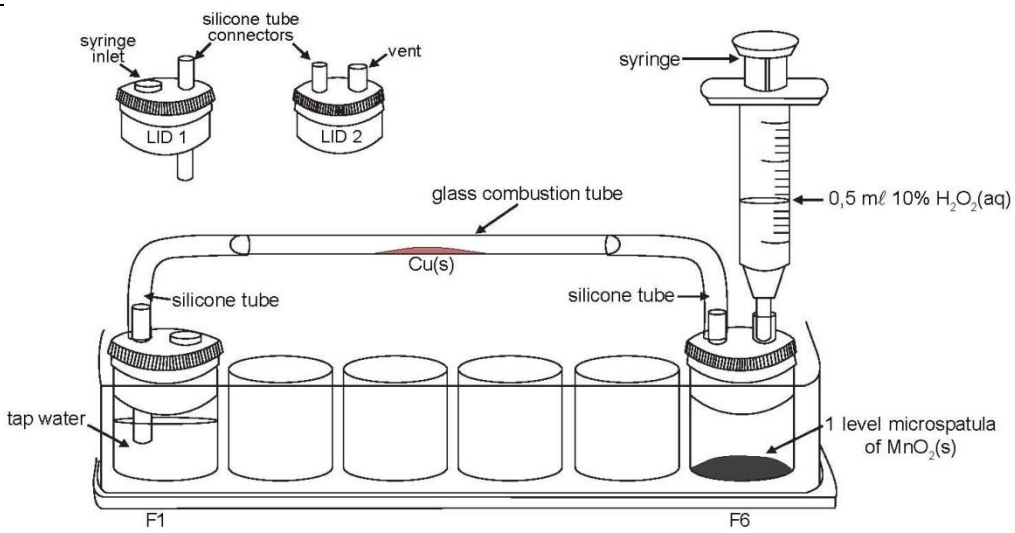
Chemicals: Manganese dioxide powder ($MnO_2(s)$); Fresh hydrogen peroxide solution ($H_2O_2(aq)$) [10 %]; Methylated spirits; Copper powder (Cu(s)); Tap water.

Note

The hydrogen peroxide solution should be fresh, otherwise the results will not be as described below.

CAUTION

The methylated spirits used in the microburner is poisonous. Do not inhale the vapour or drink the liquid. If any hydrogen peroxide is spilt on the skin, thoroughly rinse the affected area with water.



PROCEDURE

1. Add 1 level spatula of manganese dioxide powder into well F6, using the spooned end of a microspatula.
2. Fill ¾ of well F1 with tap water. Seal well F1 with lid 2, making sure the vent hole faces inwards. Seal well F6 with lid 1.
3. Connect one silicone tube to the tube connector on lid 1. Connect the other silicone tube to the tube connector on lid 2.
4. Hold the glass tube in a horizontal position. Use the narrow end of a clean microspatula to place a small quantity of copper powder in the centre of the glass tube. *(See Question 1)*
5. Keep the glass tube in a horizontal position and attach one end to the silicone tube on lid 1. Connect the other end to the silicone tube on lid 2.

Note

Note	**Keep the glass tube horizontal at all times otherwise the copper powder might spill into well F6.** 6. Fill the syringe with 0,5 ml of 10% H_2O_2(aq). Fit the nozzle of the syringe into the syringe inlet on lid 1 in well F6. 7. Light the microburner and place it on one side away from the comboplate®. *8.* Add the 0,5 ml of H_2O_2(aq) very slowly from the syringe into well F6. *(See Question 2)* *9.* When a few bubbles have come through the water in well F1, bring the flame of the microburner to the middle of the glass tube where the copper powder has been placed. Observe what happens in the glass tube while heating. *(See Question 4)* **Keep the flame of the microburner directly beneath the copper in the tube. Do not move the microburner from side to side.** 10. Stop heating the copper after 5 minutes, or after the copper has changed in appearance. Blow out the microburner flame. 11. If you see water being sucked back from well F1 into the glass tube, disconnect lid 2 from well F1. **Thoroughly clean the comboplate® as manganese dioxide leaves a residue in the well.**
	QUESTIONS Q1. Describe the appearance of the copper powder. Q2. What happens when 10% hydrogen peroxide solution is added to well F6 ? Q3. Why was it necessary to wait for the first few bubbles to come through before heating the glass tube ? Q4. What is happening to the copper powder during heating ? Describe any other changes in the glass tube. Q5. From your observations of the powder in the glass tube, would you say a chemical reaction occurred ? Explain your answer. Q6. What product is formed when copper burns in oxygen ? Q7. Write a word equation for the combustion of copper in oxygen. Q8. Write a balanced chemical equation for the combustion of copper in oxygen. Q9. How would you try to prove that the product formed in this experiment is indeed copper(II) oxide ? Suggest an experimental set-up to perform this experiment.

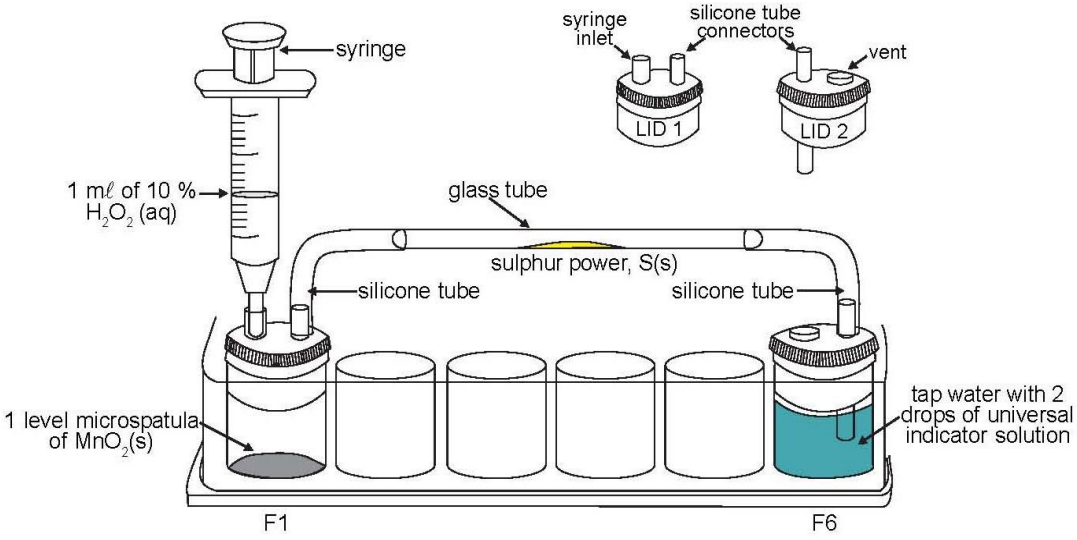
Experiment 39 THE REACTION OF SULPUR WITH OXYGEN

Grade Level - 10

REQUIREMENTS

Apparatus: 1 x comboplate®; 1 x syringe; 1 x lid 1; 1 x lid 2; 2 x plastic microspatulas; 2 x silicone tubes (4 cm x 4 mm); 1 x glass combustion tube; 2 x propettes; 1 x microburner.

Chemicals: Manganese dioxide powder ($MnO_2(s)$); Fresh hydrogen peroxide solution ($H_2O_2(aq)$)[10 %]; Universal indicator solution; Sulphur powder (S(s)); Methylated spirits; Tap water.



PROCEDURE

1. Use the spooned end of a plastic microspatula to place one level spatula of manganese dioxide powder into well F1.
2. Fill ¾ of well F6 with tap water using a propette.
3. Use another propette to place 2 drops of the universal indicator solution into the tap water in F6. (*See Question 1*)
4. Push lid 1 securely into well F1. Attach one of the silicone tubes to the tube connector on the lid as shown in the diagram.
5. Push lid 2 securely into well F6. Make sure that the vent in the lid faces inwards.
6. Attach the other silicone tube to the tube connector on lid 2 as shown in the diagram.
7. Fill the syringe with 1 ml of the 10% hydrogen peroxide solution.
8. Fit the syringe into the syringe inlet on lid 1 in well F1.
9. Hold the glass tube in a horizontal position. Use the narrow end of a clean microspatula to place a small quantity of sulphur powder in the centre of the glass tube.
10. Keep the glass tube in a horizontal position and attach one end of the glass tube to the silicone tube on lid 1.
    Connect the other end of the glass tube to the silicone tube on lid 2.

Note

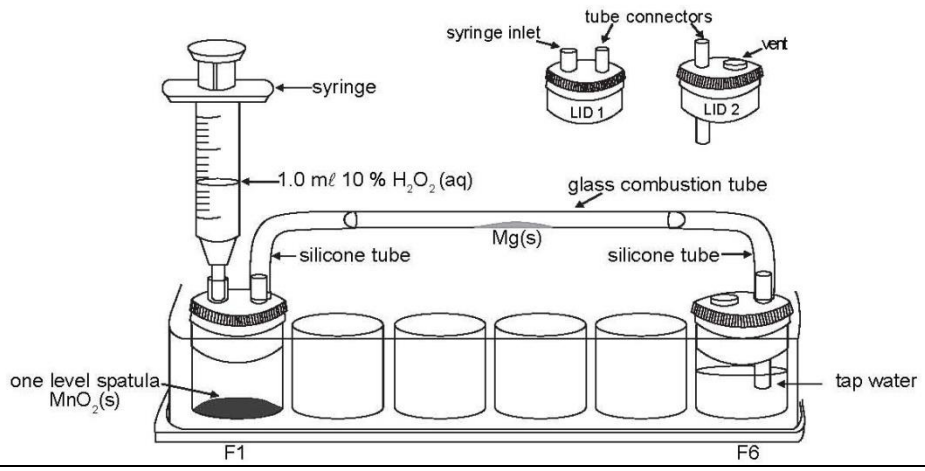
Do not move well F1.

11. Light the microburner and move it away from the comboplate®.

Note CAUTION	12. Slowly add about 0,4 ml of the 10% H_2O_2(aq) from the syringe into well F1. Wait for a steady stream of bubbles to appear in the water in well F6, then begin heating the sulphur powder in the glass tube with the microburner. (*See Question 2*) **Keep the flame of the microburner directly beneath the sulphur in the tube. Do not move the flame from side to side.** 13. If the bubbles stop flowing in F6, add more of the H_2O_2(aq) dropwise to F1 while continuing to heat the sulphur. 14. After all the sulphur has burned, blow out the microburner flame. Hold the comboplate® up and wave your hand over well F6 towards your nose. **Do not inhale the fumes directly!** (*See Question 3*) 15. If you see water being sucked back from F6 into the glass tube, disconnect lid 2 from F6. **Clean all apparatus thoroughly.**
	QUESTIONS Q1 Write down the colour of the indicator in the tap water. Describe the water as acidic, basic or neutral. Q2. What do you observe in the glass tube while heating the sulphur ? Q3. Describe the smell that comes from the vent in well F6. Q4. What is the colour of the indicator solution in well F6 after the experiment ? Q5. Why did the indicator change colour ? Q6. Write a word equation for the combustion of sulphur in oxygen. Q7. Some carbon fuels, such as coal, contain sulphur as an impurity. When these fuels burn they form sulphur dioxide. Using the observations in the above experiment with the universal indicator, explain how the burning of sulphur in the environment can contribute to the problem of acid rain.

Experiment 40 THE REACTION OF MAGNESIUM WITH OXYGEN

Grade Level - 10

Note	**REQUIREMENTS** **Apparatus:** 1 x comboplate®; 1 x 2 ml syringe; 1 x thin stemmed propette; 2 x plastic microspatulas; 1 x lid 1; 1 x lid 2; 1 x glass tube; 2 x silicone tubes (4 cm x 4 mm); 1 x microburner; 1 x box of matches. **Chemicals:** Manganese dioxide powder ($MnO_2(s)$); Fresh hydrogen peroxide solution ($H_2O_2(aq)$) [10 %]; Methylated spirits; Universal indicator solution; Magnesium powder (Mg(s)); Tap water. **The hydrogen peroxide solution should be fresh, otherwise the results will not be as described below.**
	
Note	**PROCEDURE** 1. Use the spooned end of a plastic microspatula to place one level spatula of manganese dioxide powder into well F1. 2. Push lid 1 securely into well F1. Attach one of the silicone tubes to the tube connector on the lid. 3. Fill ¾ of well F6 with tap water using a propette. 4. Push lid 2 securely into well F6. Make sure that the vent in the lid faces inwards. Attach the other silicone tube to the tube connector on lid 2. 5. Fill the syringe with 1 ml of the 10% hydrogen peroxide solution. Fit the syringe into the syringe inlet on lid 1 in well F1. 6. Hold the glass tube in a horizontal position. Use the narrow end of a clean microspatula to place a small quantity of magnesium powder in the centre of the glass tube. *7.* Keep the glass tube in a horizontal position and attach one end to the silicone tube on lid 1. Connect the other end to the silicone tube on lid 2. *(See Question 1)* **Do not move the glass tube from the horizontal position as some of the magnesium powder may fall into well F1.** 8. Light the microburner and place it on one side. 9. Slowly add about 0,4 ml of the 10% $H_2O_2(aq)$ from the syringe into well F1. Wait for a steady stream of bubbles to appear in the water in well F6, then begin heating the magnesium powder in the glass tube with the microburner.

Note	**Keep the flame of the microburner directly beneath the magnesium in the tube. Do not move the microburner from side to side.** *10.* When the bubbles stop flowing in well F6, add the rest of the H_2O_2(aq) very slowly to well F1 while continuing to heat the magnesium. Observe what happens in the glass tube while heating. *(See Question 2)* 11. After the magnesium has changed in appearance, blow out the microburner flame. 12. If you see water being sucked back from well F6 into the glass tube, disconnect lid 2 from well F6. 13. When the glass tube has cooled, remove it from the set-up. Tap the tube gently in well E3 to dislodge as much of the solid product in the tube as possible. 14. Add 10 drops of water to well E3 and stir the solid vigorously in the water. *15.* Use a clean propette to add one drop of universal indicator solution to well E3. *(See Question 4)* 16. Leave the comboplate® to stand for about 5 – 7 minutes. Observe the colour of the indicator in well E3 after this time. **Rinse the comboplate® and shake dry.** **Rinse the glass tube and scrape out any remaining residue with a toothpick.**
	QUESTIONS Q1. Describe the appearance of the magnesium powder. Q2. What did you observe in the glass tube while heating the magnesium in oxygen ? Q3. What do you see inside the glass tube after heating ? (Note: it is usual for a black residue to form at the bottom of the glass tube where the microburner was held, but this is not part of the product.) Q4. What is the colour of the universal indicator solution in well E3 ? Q5. What is the colour of the indicator solution in well E3 after about 5 minutes ? Q6. Is the solution of the product acidic or basic ? Q7. What product is formed when magnesium burns in oxygen ? Q8. Why did the indicator in well E3 change colour ? Q9. Write a word equation for the combustion of magnesium in oxygen. Q10. Write a balanced chemical equation for the combustion of magnesium in oxygen.

CSEC Objective (s) - Section B Unit 7 Objective 2

Distinguish among acids, bases and salts.

Experiment 41 THE EFFECT OF DILUTE ACIDS AND BASES ON INDICATORS

Grade Level - 10

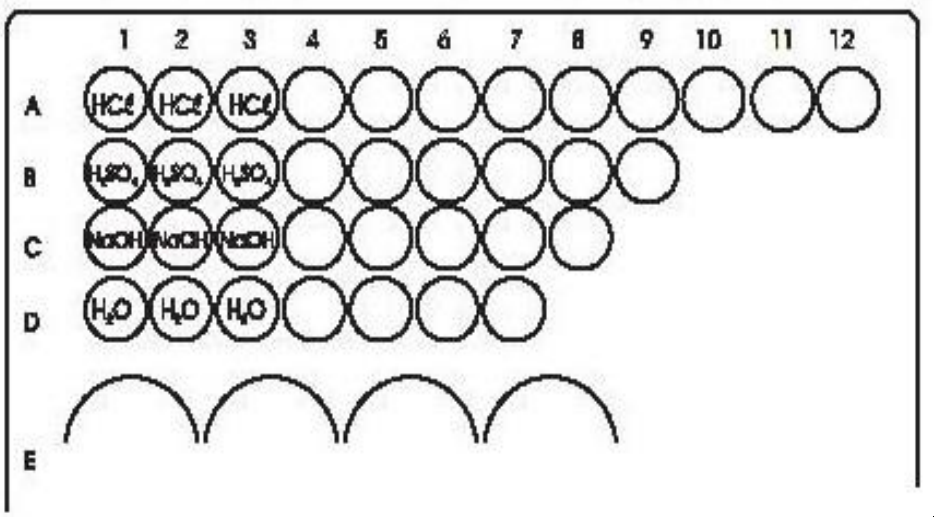
	REQUIREMENTS **Apparatus:** 1 x comboplate®; 6 x thin stemmed propettes; a sheet of white paper; pH indicator strip. **Chemicals:** Hydrochloric acid (HCl(aq)) [1 M]; Sulphuric acid (H_2SO_4(aq)) [1 M]; Sodium hydroxide solution (NaOH(aq)) [1 M]; Tap water; Universal indicator solution; Methyl orange solution; Universal indicator paper.
	
	PROCEDURE 1. Place the comboplate® on the sheet of white paper. *(See Question 1)* 2. Use a clean propette to place 10 drops of hydrochloric acid (1 M) in each of the wells A1, A2, and A3. 3. Use a clean propette to place 10 drops of sulphuric acid (1 M) in each of the wells B1, B2 and B3. 4. Use a clean propette to place 10 drops of sodium hydroxide solution (1 M) in each of the wells C1, C2 and C3. 5. Use a clean propette to place 10 drops of tap water in each of the wells D1, D2 and D3. 6. Use a clean propette to place 1 drop of universal indicator solution into each of the wells A1, B1, C1 and D1.*(See Question 2)* 7. Use a clean propette to place 1 drop of methyl orange solution into each of the wells A2, B2, C2 and D2.*(See Question 2)* 8. Tear two strips of universal indicator paper in half. Fold each half lengthwise, and place inside wells A3, B3, C3 and D3. *(See Questions 2, 3)* **Rinse the comboplate® and propettes with water.**
	QUESTIONS Q1. Prepare a table like the one shown below. Q2. Complete the table.

Table 1

	In HCl(aq)	In H_2SO_4 (aq)	In NaOH(aq)	In Tap Water
Colour of Universal Indicator				
Colour of Methyl Orange				
Colour of Universal Indicator Paper				

Q3. What did you see happen in this experiment?

Q4. Use the information on the pH indicator strip to classify the substances as "acidic", "neutral" or "alkaline".

Q5. Discuss in your group: What do the words "indicator" and "to indicate" mean in everyday use? Think of some everyday examples of where we use the words.

Q6. Discuss in your group: Based on the experiment you have completed, formulate a definition for an indicator.
An indicator is .....

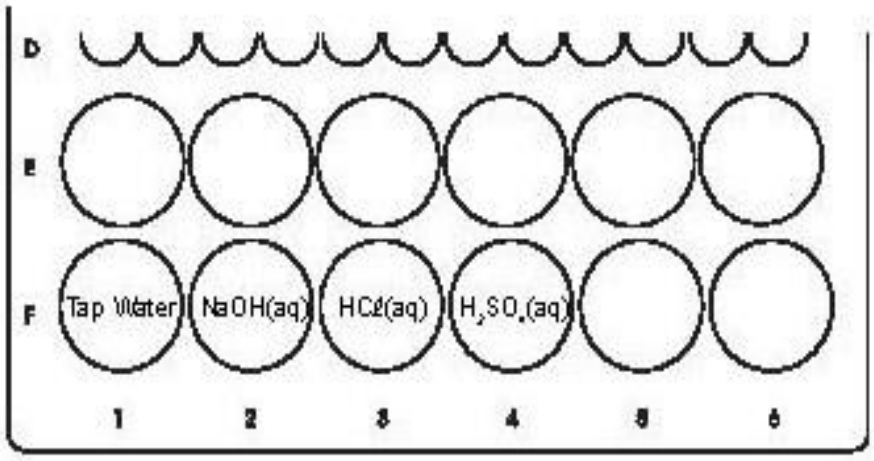
Experiment 42 REACTIONS WITH ACIDS AND SODIUM HYDROXIDE

Grade Level - 10

REQUIREMENTS

Apparatus: 1 x comboplate®; 4 x propettes; 2 x plastic microspatulas; 1 x syringe; a sheet of white paper.

Chemicals: Hydrochloric acid (HCl(aq)) [0.1 M]; Sulphuric acid (H_2SO_4(aq)) [0.1 M]); Universal indicator solution;
Tap water; Sodium hydroxide solution (NaOH(aq)) [0.1 M].



PROCEDURE

1. Place the comboplate® on the sheet of white paper.
2. Use a clean dry propette and add tap water to well F1 to half-fill it. *(See Question 1)*
3. Use a clean dry propette and add 10 drops 0.1 M sodium hydroxide solution to F2.
4. Use a clean dry syringe and add 0,5 ml of 0.1 M hydrochloric acid to well F3.
5. Rinse the syringe in clean tap water and shake dry. Use the clean syringe to add 0,5 ml of 0.1 M sulphuric acid to well F4.
6. Use a clean dry propette and add 1 drop of universal indicator solution to wells F1, F2, F3 and F4.
7. Note the colour in the different wells. *(See Questions 2, 3, 4 and 5)*
8. Use a clean dry propette and add 1 drop of the sodium hydroxide (NaOH) solution to well F3. Stir the solution in well F3 with a microspatula. Keep adding the sodium hydroxide drop-by-drop and stirring between adding, until the colour of the solution in well F3 is close to that in well F1.
9. Repeat the same process in well F4: add the sodium hydroxide drop-by-drop to the sulphuric acid in well F4, stirring in between each drop, until the colour in well F4 is close to the colour in well F1. *(See Question 6)*

Clean all apparatus thoroughly.

QUESTIONS

Q1. What chemical substance is in well F1?

Q2. What is the colour of the universal indicator in well F1?

Q3. Use the pH indicator strip to explain the meaning of the colour of the solution in well F1.

	Q4.	Write down the name of the chemical substance, the colour of the universal indicator, and the meaning of the colour in well F2.
	Q5.	What was the colour of the indicator in the dilute sulphuric acid and hydrochloric acid in wells F3 and F4 before you started adding the sodium hydroxide solution? Use the pH indicator strip to explain the meaning of this colour.
	Q6.	What happens when you add the sodium hydroxide to the acidic solutions?
	Q7.	Explain in your own words what this means.
	Q8.	A wasp sting injects an alkaline chemical into the skin. What household chemical could be used to relieve the pain from the wasp sting? Explain why.
	Q9.	A solution of bicarbonate of soda brings some relief when it is applied to a bee sting on the skin. Explain why this is so.
	Q10.	Why does "Milk of Magnesia" relieve indigestion?

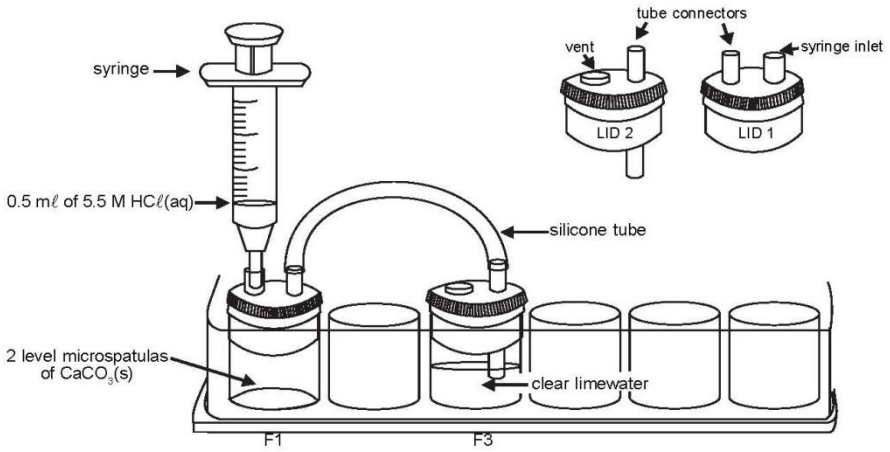
Experiment 43 PREPARATION OFA SALT: THE REACTION BETWEEN AN ACID AND A METAL CARBONATE

Grade Level - 10

REQUIREMENTS

Apparatus: 1 x comboplate®; 1 x lid 1; 1 x lid 2; 1 x propette; 1 x plastic microspatula; 1 x 2 ml syringe; 1 x silicone tube (4 cm x 4 mm); 1 x microburner; 1 x glass rod; 1 x box of matches.

Chemicals: Hydrochloric acid (HCl(aq)) [5.5 M]; Calcium carbonate powder ($CaCO_3(s)$); Clear limewater ($Ca(OH)_2(aq)$); Methylated spirits.



PROCEDURE

1. Place 2 level microspatulas of calcium carbonate powder into well F1 of the comboplate®.
2. Cover well F1 with lid 1.
3. Use a clean dry propette and fill ¾ of well F3 with clear limewater.
4. Cover well F3 with lid 2.
5. Join well F1 to well F3 by connecting the silicone tube to the tube connectors on lids 1 and 2.
6. Fill the syringe with 0,5 ml of 5.5 M hydrochloric acid.
7. Fit the syringe into lid 1 on well F1.
8. Add the acid SLOWLY to well F1. *(See Questions 1 to 6)*
9. When the reaction in well F1 seems to have stopped, remove the syringe and silicone tube from lid 1. Remove lid 1 from well F1.
10. Set up the microburner. Light the burner.
11. Carefully heat the tip of the glass rod in the flame - move the tip in and out of the flame for a short while.
12. Heat the contents of well F1 by stirring well F1 with the hot end of the glass rod.
13. Repeat this heating process until the volume of the mixture in well F1 has been reduced by half.
14. Leave the mixture in well F1 overnight. *(See Question 7)*

Clean all apparatus thoroughly.

QUESTIONS

Q1. What do you see happening in well F1 when you add the acid?

Q2. What do you see happening in well F3 after a short while?

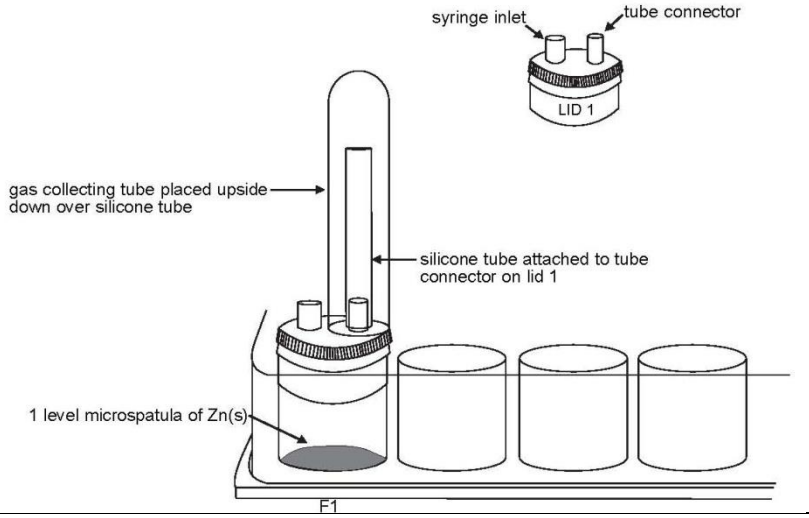
	Q3. What does this tell us about the gas that formed in the reaction in well F1? Read the following information carefully. Use this to answer Q4 - Q6. **Clear limewater is an aqueous solution of calcium hydroxide. When carbon dioxide reacts with the limewater, insoluble calcium carbonate and water are formed.** Q4. Write down a word equation for the reaction between carbon dioxide and limewater. Q5. Write down a balanced chemical equation for the reaction between carbon dioxide and limewater. Q6. to Use the equation above to identify the substance that caused the clear limewater become milky. Explain your answer. Q7. What do you notice in well F1 after leaving the comboplate® overnight? Q8. What is this substance in F1? Q9. left The other product in this reaction evaporated when you heated the solution and the comboplate® overnight. What could this possibly be? Q10. Write a word equation for the chemical reaction that took place in well F1. Q11. Write a balanced chemical equation for this reaction in well F1. Q12. This part Look at the name of the crystals that formed in this reaction. It is called a SALT. salt was prepared by the reaction between an acid and a metal carbonate. What of the name of the salt comes from the metal carbonate? Q13. What part of the name of the salt comes from the acid used in the reaction? Q14. What difference would it make if you had used nitric acid instead of hydrochloric acid in the reaction? Q15. What chemicals would you use to prepare sodium chloride from the reaction between an acid and a carbonate? Q16. Write a balanced chemical equation for the reaction in your answer to Q15. Q17. calcium In this experiment you looked at the reaction between hydrochloric acid and carbonate. Complete the general chemical equation: acid + metal carbonate →

Experiment 44 PREPARATION OF A SALT: THE REACTION OF A METAL WITH AN ACID

Grade Level - 10

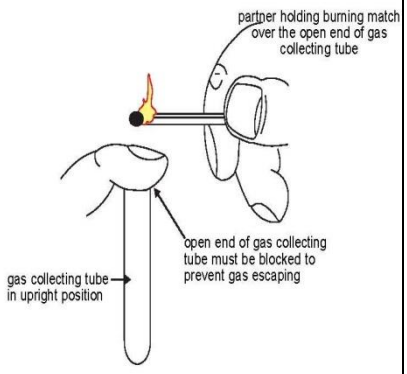
REQUIREMENTS

Apparatus: 1 x comboplate®; 1 x lid 1; 1 x 2 ml syringe; 1 x gas collecting tube; 1 x silicone tube;
1 x plastic microspatula; 1 x box of matches.
Chemicals: Hydrochloric acid (HCl(aq)) [5.5 M]; Zinc powder (Zn (s)); Tap water.



PROCEDURE

1. Place one level microspatula of zinc powder into well F1.
2. Place lid 1 on well F1. Make sure that the lid fits tightly onto the well.
3. Attach the silicone tube to the tube connector of lid 1 on well F1.
4. Place the gas collecting tube upside down over the silicone tube.
5. Fill the syringe with 0,5 ml of 5.5 M hydrochloric acid, and fit the syringe to the syringe inlet on lid 1 of well F1.
6. Slowly add 0,2 ml of the acid to the zinc in well F1. Wait for a short while until the reaction in well F1 subsides, and then slowly add the rest of the acid in the syringe. Wait for a few seconds. *(See Questions 1 to 5)*
7. Work with a partner: One person should carefully lift the gas collecting tube from the silicone tube. KEEP THE GAS COLLECTING TUBE UPSIDE DOWN. DO NOT TILT IT. Place the index finger of one hand over the open end of the gas collecting tube to seal it. Now turn the gas collecting tube the right way up, STILL KEEPING YOUR FINGER OVER THE OPEN END. Move the comboplate® well away from you and from any open flames.



8. Let the second person light a match, and hold it above the gas collecting tube (It should be fairly close to the top of the tube, but be careful not to burn your partner's finger!). Remove your finger from the open end of the gas

	collecting tube when the match is in place above the gas collecting tube. *(See Question 6)* 9. Place the comboplate® in the sun on a window sill and leave the mixture in well F1 overnight. *(See Question 10)* **Clean all apparatus thoroughly.**
	QUESTIONS Q1. What happens in well F1 when the acid is added? Q2. What does this tell us about one of the products of the reaction? Q3. What, if anything, is in the gas collecting tube at the start of the experiment? Q4. What, if anything, collects in the gas collecting tube as the reaction takes place in well F1? Q5. Why does the gas not escape from the upside-down gas collecting tube? Q6. Describe what happens when you remove your finger from the open end of the gas collecting tube with the burning match in place. Q7. Explain your answer to Q6. Q8. What gas was formed during the reaction? Q9. Explain why it was necessary to move the comboplate® away from any open flames. Q10. What do you see in the microwell after leaving the comboplate® overnight? Q11. Explain your observation. Q12. What were the reactants in well F1? Q13. What were the products of the reaction in well F1? Q14. Write a word equation for the reaction that occurred in well F1. Q15. Write down a balanced chemical equation for the reaction that occurred in well F1. Q16. What chemicals would you use to prepare magnesium sulphate using a similar procedure? Q17. Write down a balanced chemical equation for the reaction that you propose in question 16.

CSEC Objective (s) - Section C Unit 1 Objective 1

Discuss the use of good and poor conductors of electricity

Experiment 45 GET TO KNOW YOUR MICRO-ELECTRICITY KIT

Grade Level - 9

Nowadays everything is going “micro”, which of course means “small”. This micro fever, ranges from computers and Hi-Tech equipment to laboratory equipment. Micro-things become more and more affordable, they are easy to carry and easy to store.
In schools all over the world, micro-equipment invades the classrooms and changes the way of teaching and learning. Work with your micro-electricity kit and you will find out why.

What you need

micro-electricity kit, an A4 sheet of white paper

WHY DO WE USE ELECTRIC CIRCUITS?

1 We use electric circuits to transfer electrical energy to various electrical devices. These devices transform the electrical energy into other forms of energy, which we find useful!
   a) a Make a list of five devices which you can find at home, or you see in the shops, which work with electricity.
   b) What are these devices used for?
   c) What energy transformation/s take place in these devices?

WHAT IS AN ELECTRIC CIRCUIT?

2 An electric circuit is a **closed** path or “loop”, made out of materials which are good conductors of electricity.
But this is not enough!

a) Phoka is a learner in your group. He takes a piece of wire. He connects the ends of the wire together. He says: “*This is an electric circuit!*”.
Is Phoka right? Is there an electric current in Phoka’s wire loop?

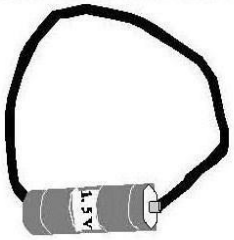
Phoka’s wire-loop



b) What must Phoka do to have an electric current in his loop? Explain to him.

c) Phoka connects a 1,5 V cell across his wire. Did he make an electric circuit?

Phoka’s second wire-loop



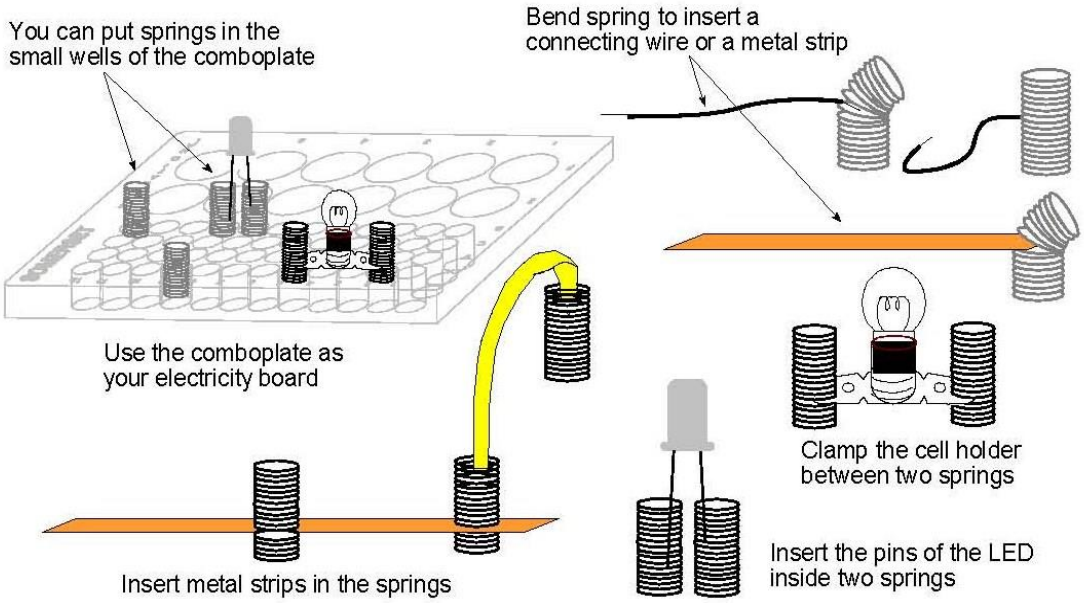
d) Andile, who is also a learner in your group, has her doubts about Phoka’s circuit. She says: “This is the most useless circuit I have ever seen! It is of no use!”
Is Andile right? Is Phoka’s circuit a “useless“ circuit? Explain.

e) So finally, what is an electric circuit and what parts does it need to be made of to make it “useful”?

What to do: Work steps 1 to 4 below, individually.

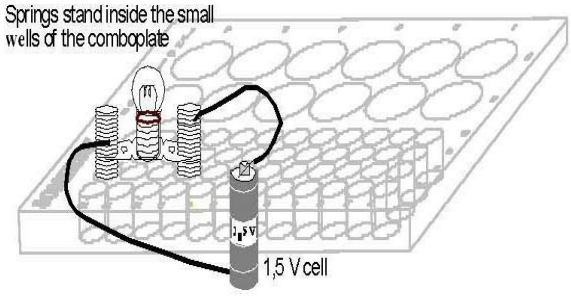
1. Put the A4 sheet of paper flat on your desk in front of you. Put your micro-electricity kit on the A4 paper.
2. Empty the contents of the kit on the white paper, one by one.

3. Look at the diagram of all the components in the kit. Find the name of each component in the diagram.
4. Divide your components into four parts/categories,
   I. the power sources and any other accessories which you think go with them.
   II. i the electrical devices, which you think "will do something" when you connect them in a circuit.
   III. components which you think you can use for the connections, i.e. which you can use to connect a power source to an electrical device to complete a closed conducting path.
   IV. components which do not belong in any of the above three categories. Think of ways you can use these components with your kit.
5. Look at how the other members of your group have divided their components. Discuss any differences.
   Here are some ideas of how to use some of the components in the kit. But of course, you may have better ones. You must try your ideas!



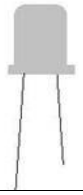
TASK 1 - MAKE YOUR OWN CIRCUIT

6. The following diagram, shows a simple electric circuit - for inspiration!
   Your task is to make a bulb glow, using components from your micro-electricity kit. Each learner in your group must make a **different** circuit. And each circuit must be different from the one shown in the diagram.
   When you have finished, discuss the circuits you and your group have made. Discuss which connections or components you found the easiest to use. Discuss which type of connection/s you found more firm or sturdy.



TASK 2 - FIND OUT HOW IT WORKS

7. In your micro-electricity kit, you will find a little red bulb, the LED. This is a diode. Diode is a Greek word for “Two-Way”.
   Your task is to find out how it works. How can you make it glow? Why is it called “Two-Way”?



Experiment 46 LIGHTEN UP, PREDICT AND EXPLORE

Grade Level - 9

What is electricity? What is an electric current? These are not easy questions, yet electricity is so much part of our lives. The more we learn about it, the more we learn to respect nature and the energy it provides us!

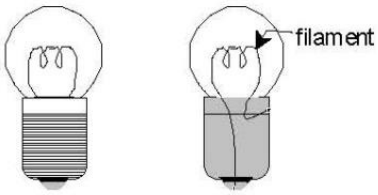
In the past you made simple circuits and you learned how to light up a bulb. This Activity is nothing new, but hopefully it will challenge you to think, and refresh your memory ..... not bad for starters!

What you need

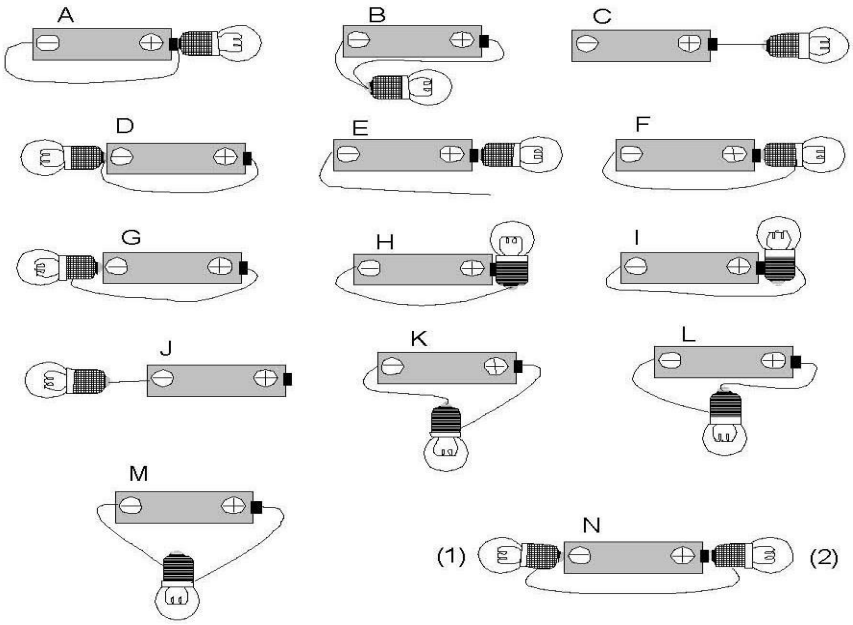
a micro-electricity kit

PART A

1. The diagram alongside, shows what a bulb looks like inside.
2. Predict which of the bulbs in the following figures will light up. Work on your own.



a) Record your predictions in the table on the next page.



b) Compare your predictions with those of other members of your group. Where you differ explain the reason for your prediction. Make a group prediction and record it in the table on the next page.

PART B

3. Test your group predictions using the micro-electricity kit equipment.

a) Record your observations in the table on the next page.

b) Compare your observations with your predictions. Explain the results you observe. Add your comments in the table on the next page.

4. To conclude, what is necessary to make a bulb light up?

TABLE

Bulb	Your Prediction	Group's Prediction	Observation	Comments
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N1				
N2				

Experiment 47 CAR HEADLIGHTS

Grade Level - 9

To use the electrical energy in cells or batteries to make light bulbs glow we need a closed circuit. There are two common types of circuits, the *series circuits* and the *parallel circuits*. In a series circuit, all the parts of the circuit are connected, one after the other, so there is only one path for the transfer of electrical energy. In a parallel circuit, the parts are connected so that there is more than one path.



Organise yourselves in pairs or groups of three. Select one person to take notes. Discuss the following factors about the main headlights of a car (or taxi):

- during which part of the day are the headlights of a car used?
- the importance of passenger safety when designing car headlights
- what would happen if one of the car headlights was broken for example, by a stone thrown up from another car?
- the electric circuit in a car which connects the car battery to the two headlights.

After you have noted down your answers to the above points, draw a diagram representing an electric circuit which consists of the two headlights of a car, the car battery (source of electrical energy) and the wires that connect the headlights to the car battery.

What you need

a micro-electricity kit

What to do

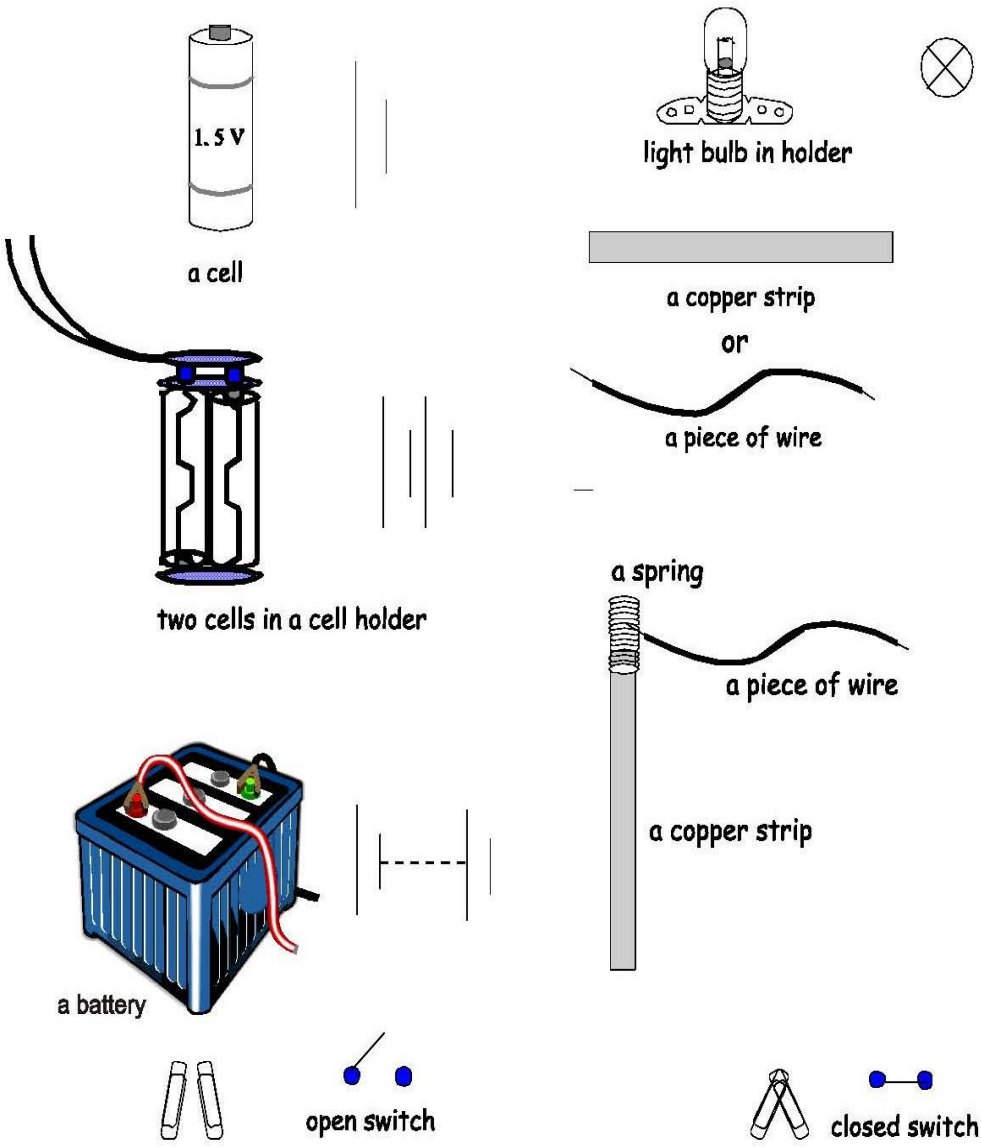
Select parts of the micro-electricity kit and set up a circuit to represent your circuit drawing of the headlights of a car.



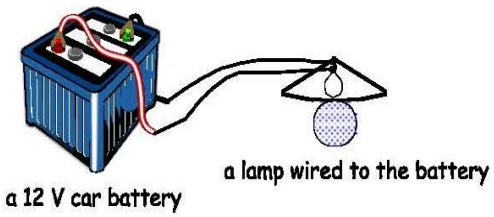
When you have finished the above Activity get together with your group and work through this section.

1. Which circuit, series or parallel, describes the circuit you have constructed? Explain.
2. You can spend a lot of time drawing the real parts (components) of a circuit. It is much easier to use symbols to represent the components of a circuit.

On the next page there are some of the symbols used to draw circuit diagrams.



2.a Use some of the symbols to draw a circuit diagram of the circuit below.



2.b Use the circuit symbols and draw a circuit diagram to represent your circuit of car headlights.

Experiment 48 MAKING AN ELECTRIC CURRENT DETECTOR

Grade Level - 9

In Grade 7 you met the concept of electrical energy and some of its many uses. Think of a torch for example.
Energy stored in the cells of the torch, transfers to the bulb and the bulb glows.
To transfer electrical energy we need an electrical circuit. An electrical current transfers energy in a circuit. There are some substances which allow an electric current in them (conductors) and other substances which do not allow an electric current (insulators).

What you need

a micro-electricity kit

What to do

Work in pairs. Use different parts of the micro-electricity kit to construct a device that can detect the presence of an electric current. The following criteria (things you need to do) must be considered when designing your detector.

- the device must be easy to use
- the device must show whether a current is present or not.

When you have constructed your device, test it on as many objects around you as possible. Before you test an object, predict whether it is a conductor or insulator. Enter your results in the table below.

TABLE

Tested object	Current Prediction Y yes ¥no	Confirmed Prediction Y right ¥ wrong	Explanation
eg. a nail	Y	Y	metals conduct

What to discuss

1. Describe each part of your current detector and how it contributes to the working of the detector.
2. The objects that you tested today were all solids. Discuss whether some gases and liquids can conduct electricity? If they do, could your detector be used to test these substances? Explain.
3. How do conductors and insulators make our day to day living easier and safer? Give at least four examples.

Experiment 49 THE CURRENT IN A SERIES CIRCUIT

Grade Level - 9

In a series circuit there is only one closed path for the current. The strength of the current is the same anywhere in the circuit.

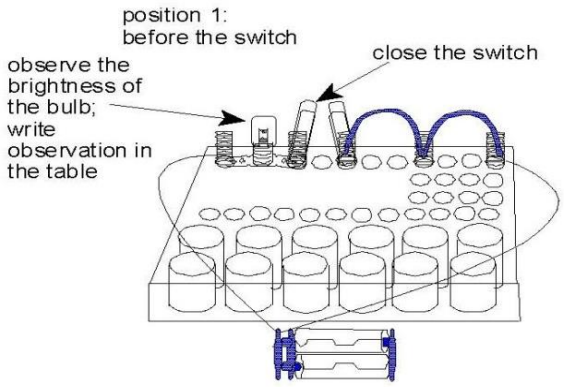
What you need

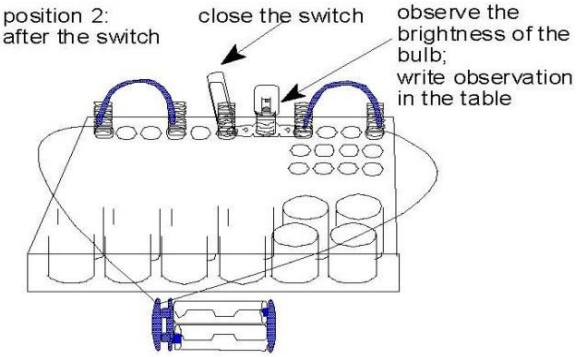
a micro-electricity kit

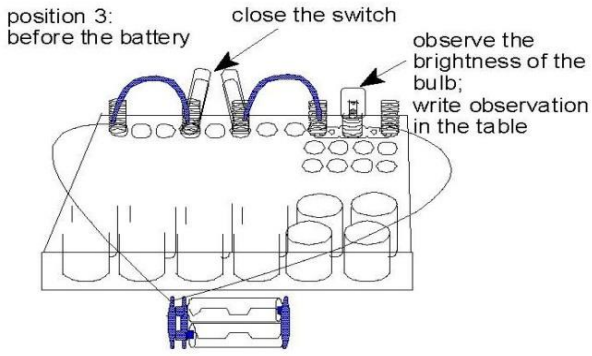
What to do

Work in pairs or groups of three. Use the micro-electricity kit to construct the series circuits given in the figures below. Complete the given table. Remember to predict the brightness of the bulb before you close the switch.

Bulb's position	Brightness Prediction	Bulb brightness
Before switch		
After switch		
Before battery		







What to discuss

1. Thando is a Grade 8 learner. When he was asked by his teacher to describe the current in a series circuit he said the following:
   "The strength of the current before the light bulb is bigger. This is because the current goes through the light bulb and gets used up."
   Discuss Thando's statement.
2. In your micro-electricity kit is a part called *a* **resistor**. 

A resistor is a specially designed device to reduce the current in a circuit. Some parts of a circuit cannot work properly if they have large currents in them. If you ever get the chance, look inside a radio or TV. You will see many, many resistors.
Predict the brightness of the light bulb in your series circuit if you were to replace one of the copper strips with a resistor. Set up such a circuit and test your prediction. (You may need to add an LED to your series circuit.)
How accurate was your prediction? Discuss.

Experiment 50 LIGHT BULBS IN SERIES

Grade Level - 9

In an earlier Activity you designed the circuit of a car's headlights. Let's see what would happen if we connected the following car lights in series: - two car headlights and one other car light, eg, an indicator light.

What you need

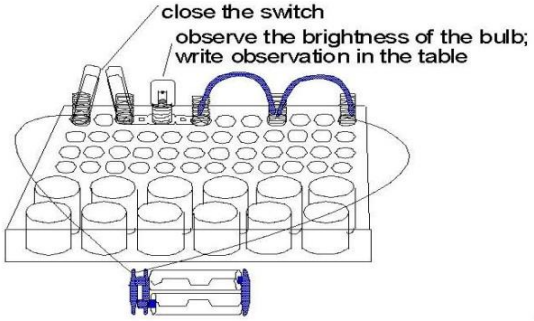
a micro-electricity kit

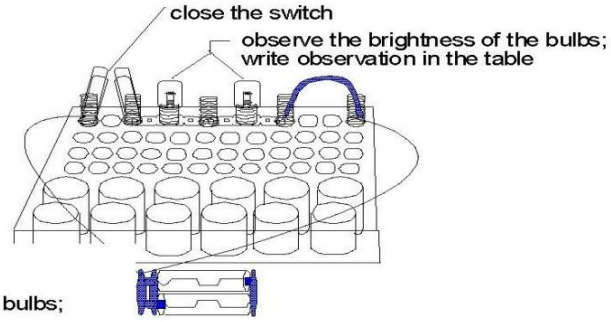
What to do

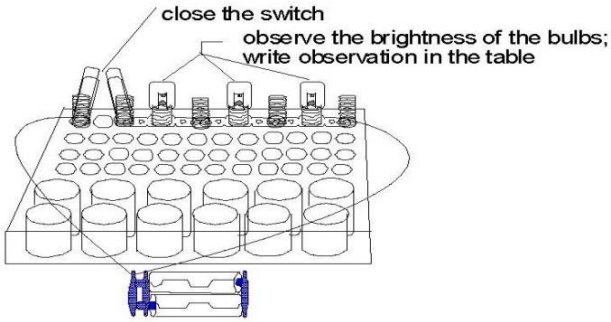
Work in pairs or groups of three. Use the micro-electricity kit to construct the series circuits given in the figures below. Complete the given table. Remember to predict the brightness of the bulb/s before you close the switch.

Note: Only pack away your circuits at the end of the Discussion section.

Bulbs Brightness	Prediction for each bulb	Brightness of each bulb
1		
1 and 2		
1, 2 and 3		







What to discuss

1. Describe the changes of the brightness of the bulbs, in terms of electrical current, each time another bulb is added in series.
2. In an earlier Activity you met an electrical device called a resistor.
   a) What similarities are there between the extra light bulbs added in series and the resistor. We call the property of a substance that reduces current strength, *resistance.*
   b) Each light bulb has a certain resistance. Discuss, in terms of resistance, how the addition of each light bulb affects the current in a series circuit.
3. Predict what will happen if you unscrewed the first light bulb in the last series circuit you set up. Test your prediction. Explain the result.
4. Let's consider the possibility of connecting two car headlights and an indicator light in series. What disadvantages and advantages would there be?

Experiment 51 LIGHT BULBS IN PARALLEL

Grade Level - 9

In an earlier Activity you met the circuit of car headlights. Car headlights are connected in parallel. Let's look at the advantages of connecting the headlights in parallel.

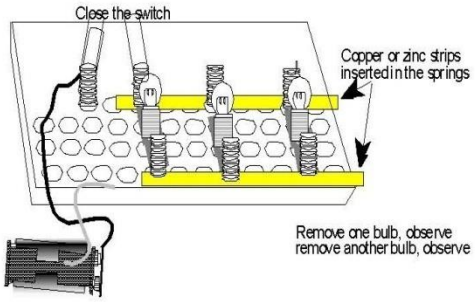
What you need

a micro-electricity kit

What to do

Work in pairs or groups of three.

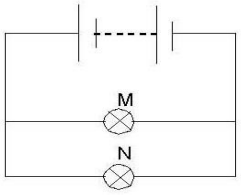
1. Use the micro-electricity kit to construct the parallel circuit as shown on the right.
2. Predict whether the other bulbs will glow if you unscrew one bulb.
3. Test your prediction.
4. Predict whether the other bulbs will glow if you unscrew two bulbs.
5. Test your prediction.
6. Complete the given table.



Bulbs	**'Glow' Prediction for each bulb**	**'Glow' of each bulb**
Remove 1 bulb		
Remove 2 bulbs		

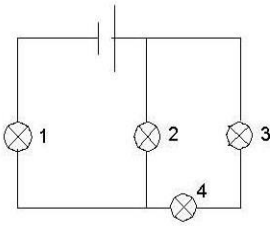
What to discuss

1. How do light bulbs connected in parallel differ to light bulbs connected in series?
2. You are given some examples of some common circuits below:
   Christmas tree lights, traffic lights (robots), torch, ceiling lights in the home, street lights;
   a) Which circuits are parallel and which are series?
   b) Give the reasons for your choices.
3. COMPLETE THIS QUESTION ON YOUR OWN. After everyone has finished the questions compare
   answers. If you disagree set up the circuits to check.
   You are given some circuit diagrams. Chose the correct multiple choice answer for each.
   a) If the light bulb M suddenly "burns out", what happens to light bulb N?
      A. It glows exactly as before
      B. It glows brighter
      C. It glows less bright
      D. It does not glow



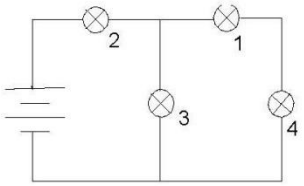
b) Which bulb/s will glow with the same intensity (same brightness)?
All the bulbs are identical.

A. 1 and 2
B. 2 and 3
C. 1, 2 and 3
D. 3 and 4

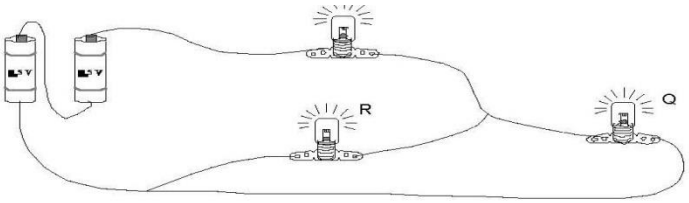


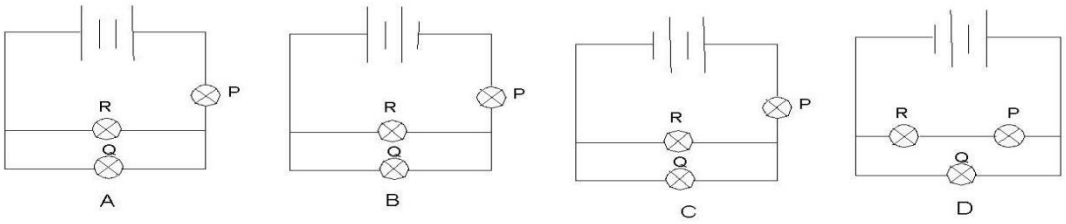
c)Which bulb must be removed from the circuit to make ALL the other bulbs go out?

A. 1
B. 2
C. 3
D. 4



d)Lebala, a Grade 8 learner connects three light bulbs called P, Q and R to two cells. Which circuit diagram corresponds exactly to the circuit she set up.





Experiment 52 ONE AFTER THE OTHER, CAUSING A GREAT BOTHER

Grade Level - 9

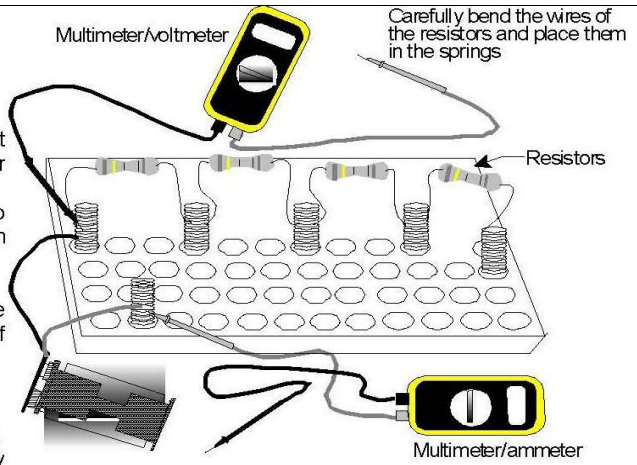
What you need

micro-electricity kit, two multimeters, graph paper

What to do

Work in groups of two or three. Set up one circuit per group and combine the components of your kits when necessary.

Use components from the micro-electricity kit, to connect four resistors in series, as in the diagram on the right.



1 First complete a circuit by including one resistor only (the first resistor on the left of the diagram).

a Measure:

X the current in the circuit and

X the potential difference across the resistor.

(Decide amongst your group, how to connect the ammeter and the voltmeter.)

b Record your measurements in Table 1.

2 Complete a circuit by including two resistors (the first two), then three and finally all four resistors. The diagram on the right may help you.

Each time,

a Measure:

X the current, (I), in the circuit and

X the potential difference, (V_x), across each connected resistor.

X the potential difference, (V), across all the connected resistors.

b Record your measurements in Table 1.

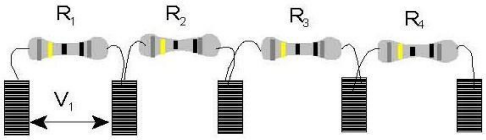




TABLE 1

Resistors connected in circuit	Current, I (mA)	Voltage across each resistor, V_x (volts)				Voltage across all resistors,	V (Volts)
		V1	V2	V3	V4		
1							
1+2							
1+2+3							
1+2+3+4							

3. On the graph paper, plot the potential difference across the first resistor (V1), versus the current (I) in the circuit. Then, draw a smooth (best fit) line.

What to discuss

In the following steps, you will discuss the sort of information you can get from:

i. Table 1, and
ii. the graph of V_1 vs I

4. Lebala, is a learner in your group. She has just drawn a nice, clear graph of V1 vs I.
   Lebala says: "Here is my graph, but so what? Why waste time drawing graphs*?*"
   The learners in your group must explain to Lebala the role of a graph. What information can she get from her graph of V_1 vs I? How can she use her graph?
   Examples of some points you can include in your discussion are:
   - What does the graph represent?
   - What type of relationship does the graph show?
   - Is it necessary to include the origin? Explain.
   - How can the graph be useful? Give examples.
5. What information can you get from Table 1? Make a list of all information which you consider important.
6. Lebala looks at Table 1. "We can get more information from Table 1, which I cannot see on the graph. See what the text-book says:
   POINT 1: The total voltage supplied by the source, is equal to the sum of the voltages across each resistor, i.e.
   $V_1 + V_2 + V_3 + ... = V$.
   POINT 2: The ratio Vx/I remains constant where, V_x is the voltage across a single resistor and I is the current in the circuit.
   Lebala says, "There was no need to draw a graph after all*!*"

a) Use your data in Table 1, to see if Points 1 and 2 in Lebala's text-book are verified by your experiment. Record your calculations in a table. Discuss your results with your group.
b) Lebala thinks that in this Activity, there is no need to draw a graph. What do you think? Explain.

7. The ratio of V1/I in Table 1, represents a constant quantity called the **resistance,** (**R**), of the resistor. Every electrical conductor, like the resistors you used in this Activity, has a resistance R. Discuss in your group and write down a few sentences on what you understand by the term "resistance". What does the ratio V/I mean?

$$R = \frac{V}{I}$$

CSEC Objective (s) - Section C Unit 1 Objective 2

Explain the relationship between voltage, current and resistance in circuit

Experiment 53 OHM'S LAW

Grade Level – 9

Many years ago a famous German physicist, Georg Simon Ohm (1787-1854), discovered the relationship between the current in a wire and the potential difference across the ends of the wire. When this relationship is expressed as
a ratio,

$$\frac{\text{potential difference}}{\text{current}}$$

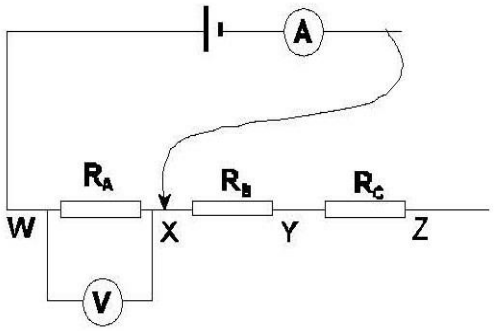
the ratio value is always the same. Because the ratio is constant it can be written as an equation. This constant is equal to the **resistance** (R) of the wire. This is known as **Ohm's law**.

To discuss before you start

Work with the other members of your group to discuss the following:

$$\text{resistance} = \frac{\text{potential difference}}{\text{current}} \qquad R = \frac{V}{I}$$

1. How are we changing the current in this circuit?
2. Across which points is the potential difference being measured?
3. Ohm's Law applies to a given conductor only when the temperature of the conductor remains constant. How can we keep the temperature of the resistor constant? Is it in fact necessary? Explain.
4. In this Activity, which is the independent variable, the current or the potential difference? Explain.
5. Plan a table in which to record your readings.



What you need: a basic micro-electricity kit and 2 multimeters.

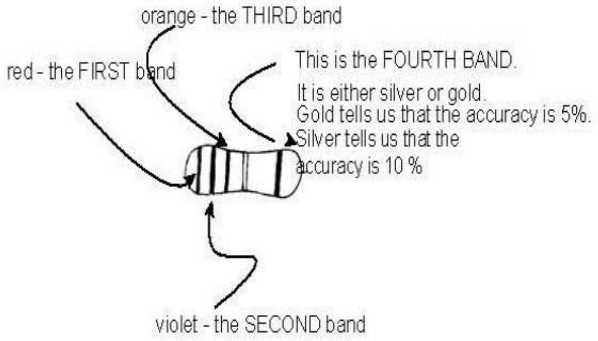
What to do

1. Set up the circuit using the micro-electricity kit as shown in the diagram.
2. Join W to the positive terminal of your battery.
3. Join the negative terminal of the battery to the ammeter at V.
4. Move the free lead on the ammeter from X to Y to Z in turn. Read the potential difference across R_A and the current in R_A each time.
5. Plot a graph which you can use to find the resistance (in ohms) of R_A between W and X on the graph paper supplied.
6. Use the coloured bands on R_A and the guidelines and the table next page to work out the resistance of R_A.
   How does this compare with the resistance you measured from your graph?

7. Use the multimeter as an ohmmeter to measure the resistance of R_A. How does this confirm with the resistance you measured from the graph?

HOW TO USE THE COLOURS ON YOUR RESISTOR TO WORK OUT ITS RESISTANCE (IN OHMS)

Your resistor is likely to show FOUR bands which may or may not be of different colours. The first three bands tell you what the resistance of your resistor is in ohms. The fourth band tells you how accurate this resistance is.



The GOLD or SILVER band tells us the **accuracy** to which the resistor was made.

If the resistor has a **gold** band, the accuracy is 5%. If the resistor has (according to the colours on the first three bands) a resistance of 20 Σ, then, its resistance will vary from 19 Σ, to 21 Σ,. If the resistor's colour code tells us that it has a resistance of 20 Σ with a **silver** band, its resistance will be in the range from 18 Σ to 22 Σ.

The table below shows the numerical values for each of the colours.

	0	black	5	green	
	1	brown	6	blue	
	2	red	7	violet	
	3	orange	8	grey	
	4	yellow	9	white	

The colour of the FIRST band gives you a number which you can read from the table. The colour of the SECOND band gives you a colour which you can read from the table. The colour of the THIRD band tells you how many zeros (0's) there are after the first two numbers. Use the table to work out the resistance (in ohms) of the resistor in the diagram above. (It is 27 000 Σ.)