Microscience Manual

Chemistry Students' Manual

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

United Nations
Educational, Scientific and
Cultural Organization

Funded by UNESCO in collaboration with the Ministry of Education and the University of Guyana

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Contents

The Ministry of Education wishes to acknowledge the work of the consultations on selecting the Microscience Experiments for Biology, Chemistry and Physics which are relevant to the national curriculum.

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A Message from the Minister of Education

‘The steady decline of enrolment of young people in science is cause for concern, and it is in this endeavour that UNESCO’s work in Science Education aims to make a difference. In a world that is increasingly shaped by science and technology, the team recognizes this and has made it its mission to not only spread education but to make an interest in the Sciences a prominent and lasting feature wherever it is offered’.(UNESCO, 2011). One approach used by UNESCO is its **Global Micro-science Experiments Project** which provides developed and developing countries alike with new teaching tools. This Global Micro-science Experiments Project is a hands-on science education project that gives primary and secondary school students as well as university students the opportunity to conduct practical work in physics, chemistry and biology, using kits that come with booklets. The project thus contributes to capacity building, in areas where limited/no laboratory facilities are available. The experimental techniques that can be covered on a micro-scale include everything from separating the components of mixtures to measuring rates of reactions between chemicals.

The Ministry of Education, Guyana collaborated with UNESCO to initiate the Global Micro-science Experiments project as a pilot for fifteen secondary schools in 2012. Ninety-five percent (95%) of secondary schools are now equipped with the micro-science kits and supporting manuals. This project was embraced to support the Ministry’s drive to improve enrolment in the single sciences. A twenty percent (20 %) increase in student enrolment was recorded since the introduction of this programme. We remain committed to transforming Guyana through Science and Technology in Education.

Guyana now leads UNESCO’s Global Microscience Experiments Project in the Caribbean and is willing to partner CXC territories in providing assistance.

It is my sincere hope that this manual will be used to encourage interactive learning which fosters the development of critical thinking skills by students.

Hon. Dr. Priya D. Manickchand
Minister of Education
Guyana
April 2015

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 micro-science experiments which are available on UNESCO's website and are free for all types of adaptations and modifications. The different types of micro-science 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 micro-science experiments, as a new methodology for hands on laboratory work by students, can work in conjunction with macro-science experiments. Furthermore the micro-science kits can be used by teachers for demonstration purposes. We hope, that the Science Teachers in Guyana will find the micro-science 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

EXPERIMENT 1 – ELECTROYSIS OF WATER
CSEC OBJECTIVE: Section A9, 9.6 – 9.8
9.6 – Predict the electrode to which an ion will drift
9.8 – discuss electrolysis of certain substances
Grade Level - 10

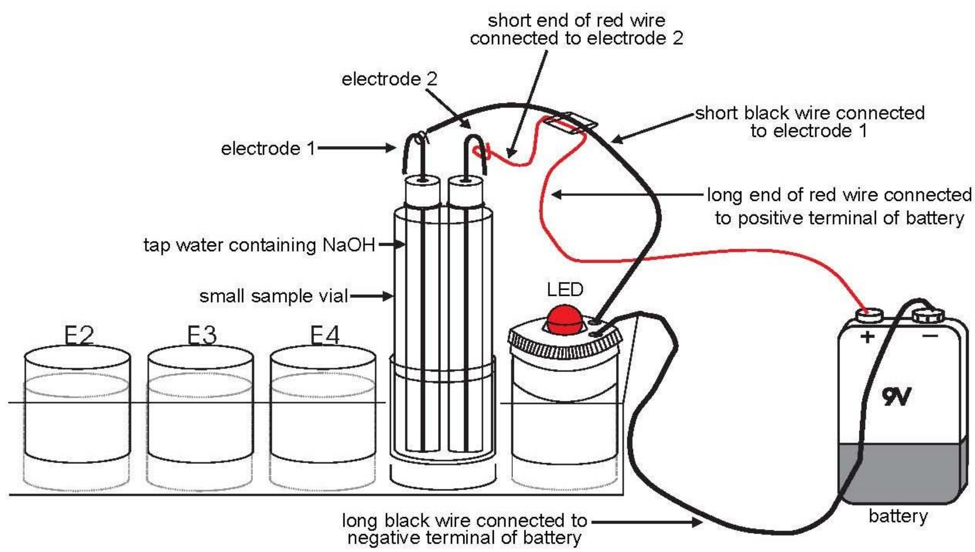
REQUIREMENTS

Apparatus: 1 x 9 V heavy duty battery (or 2 x 1.5 V cells); 1 x comboplate®;
1 x current indicator (LED) with wire connections; 2 x drinking straw electrodes; 1 x plastic microspatula;
1 x small sample vial; 1 x microburner; 1 x box of matches; 1 x thin stemmed propette;
2 x red coated copper wires (with exposed ends); 1 x black coated copper wire (with exposed ends).

Chemicals: Sodium hydroxide pellets (NaOH(s)); Tap water.

Note

Sodium hydroxide will be added to tap water in this experiment to increase the conductivity of the tap water.



PROCEDURE

1. Push the current indicator into well E6 of the comboplate®.
2. Mark each of the drinking straw electrodes into 1 cm units using a permanent marker pen. Let one of the electrodes be called electrode 1 and the other electrode 2.
3. Remove the lid from the small sample vial and fill half of the vial with tap water. Place the vial into well E5 next to the current indicator in well E6.
4. Use the plastic microspatula to place 1 pellet of sodium hydroxide into the small sample vial and stir until it has dissolved. Use an empty propette to suck up some of the solution from the vial.
5. Hold electrode 1 with the open end upwards and fill the electrode completely with the water from the propette.
6. Quickly turn electrode 1 the other way up and place it into the water in the small

	sample vial. Repeat this procedure for electrode 2. Return any remaining solution in the propette to the small sample vial. **Use tap water to thoroughly rinse your fingers free of the sodium hydroxide solution.** 7. Connect the end of the long black wire from the current indicator to the negative (-) terminal of the battery. Connect the end of the short black wire to electrode 1. *8.* Connect the one end of the red wire to the positive (+) terminal of the battery. Connect the other end of the red wire to electrode 2. *(See Question 1)* *9.* Disconnect the current indicator from the circuit. Reconnect electrode 1 directly to the negative (-) terminal of the battery with the loose red wire supplied. *(See Question 3)* 10. Let the substance produced in electrode 1 be called substance A. Let the substance produced in electrode 2 be called substance B. **(Periodically tap each electrode with your finger, to dislodge substances A and B which may build up in localised areas.)** *11.* When electrode 1 is full of substance A (at the end of the last pen marking on the electrode), disconnect the battery from the circuit. This may take approximately 10 minutes (or longer if you are using two 1.5 V cells). *(See Question 4)* 12. Light the microburner. Carefully remove electrode 1 from the water, sealing the open end with your finger when it is out of the water. Bring electrode 1 very close to the flame of the microburner. **Do not burn yourself or the straw!** *13.* Remove your finger from the opening, allowing substance A to escape. **When you have observed what happens, thoroughly rinse your fingers with tap water.** *(See Question 5)* **Rinse the vial out with clean water.**
	QUESTIONS Q 1. What effect is there on the current indicator when the battery is connected to the electrodes ? Q 2. What is the reason for your observation in question 1 ? Q 3. What do you observe at the different electrodes ? Q 4. When electrode 1 is full of substance A, how much of substance B is there in electrode 2 ? Q 5. What happens when substance A is exposed to the flame ? Q 6. What is the name given to substance A ? Q 7. What is the name of substance B ? Q 8. What test would you do to prove substance B is what you say it is ? Q 9. Why was a greater volume of substance A produced than of substance B ? Q10. Write a summary of what happens when water is electrolysed. Q11. From question 10, would you say that tap water is a compound, an element or a mixture? Explain your answer.

EXPERIMENT 2 - THE ELECTROLYSIS OF A COPPER (II) CHLORIDE SOLUTION

CSEC OBJECTIVE: Section A9, 9.6 – 9.8

9.6 – Predict the electrode to which an ion will drift

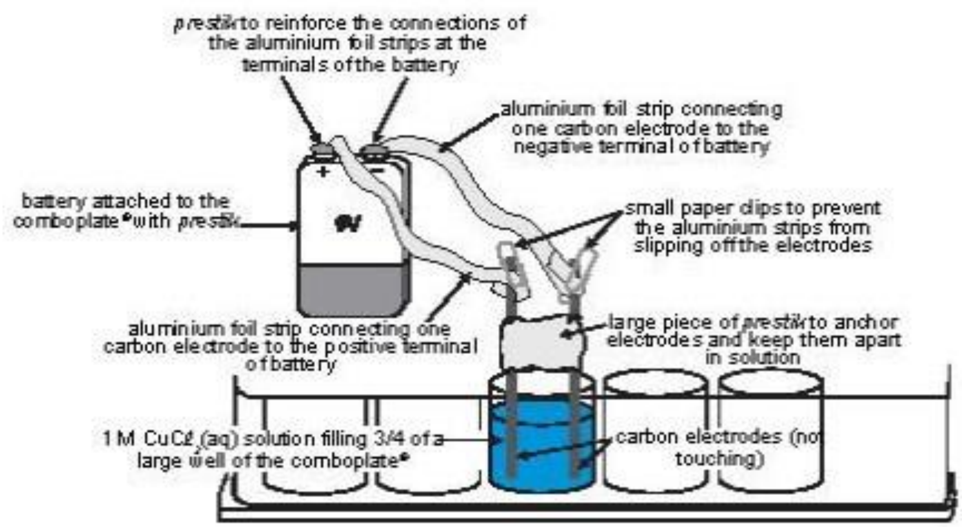
9.8 – discuss electrolysis of certain substances

Grade Level - 10

REQUIREMENTS

Apparatus: 1 x comboplate®; 1 x 9V battery; 2 x strips aluminium foil - 3 cm x 15 cm (or 2 x connecting wires with crocodile clips); 1 x graphite pencil or 2 x graphite rods (approximately 2 mm x 5 cm); 2 x plastic coated paper clips (optional); *prestik*.

Chemicals: Copper(II) chloride solution (CuCl2(aq)) [1 M]; Indicator paper; Tap water.



PROCEDURE

1. Use a piece of prestik to stick the 9V battery to the comboplate®. This will prevent the battery moving around during the experiment so that the aluminium foil connectors are not pulled away from the electrodes.
2. Break open the pencil carefully and remove the graphite/carbon rod. Make two carbon electrodes by breaking or cutting the rod into two shorter pieces of approximately 5 cm each in length. Alternatively, ready-made carbon rods can be used.
3. Push one of the carbon electrodes into a large piece of prestik. Push the other electrode into the same piece of *prestik*. Make sure that the electrodes are far apart from one another so that they do not touch when placed into the copper chloride solution.
4. Use a clean propette to fill about ¾ of one of the large wells of the comboplate® with the 1 M copper(II) chloride solution.
5. Place the carbon electrodes in the solution as shown in the diagram above. The electrodes do not need to be held in the upright position. They can be rested at an

angle against the wall of the large well.

6. Fold one of the strips of aluminium foil about three times to form a narrow but sturdy connector as shown in the diagram above. Fold the other aluminium foil strip in the same way.
7. Attach each one of the aluminium foil connectors to separate terminals of the battery. *Prestik* can be used to reinforce the connections to the battery. Alternatively, small crocodile clips can be used to make sure that the foil strips are properly connected to the battery terminals.
8. Connect the battery to the electrodes by attaching the aluminium foil strips from the terminals of the battery to separate carbon electrodes, as shown in the diagram. (*See Question 1*)

Note

Small, plastic-coated paper clips can be used to attach the ends of each foil strip to the electrodes. This helps to prevent the foil from slipping off the electrodes during electrolysis.

9. After about one or two minutes, lift the comboplate® gently upwards towards your chin. (*See Question 2*)

CAUTION

Do not inhale the fumes directly!

10. Moisten a small piece of indicator paper (either litmus or universal indicator paper in the kit) with tap water.
11. Hold one corner of the paper at the electrode where there is bubbling taking place. (*See Question 3*)
12. Look closely at the other electrode in the solution and observe any changes taking place. (*See Question 4*)
13. Allow the electrolysis to continue for another 5 to 10 minutes. Disconnect the foil from the electrode where no bubbling was observed.
14. Lift the electrode out of the copper (II) chloride solution and examine its appearance. (*See Question 5*)

Clean all apparatus thoroughly.

QUESTIONS

Q1. What do you notice as soon as the battery has been connected to the electrodes?

Q2. Describe the odour coming from the well.

Q3. What happens to the section of the litmus paper that is held close to the electrode at which bubbling takes place?
Is this electrode connected to the positive or negative terminal of the battery?

Q4. Describe the change in appearance of the other electrode (i.e the electrode where no bubbling occurs). Is this electrode connected to the positive or negative terminal of the battery?

Q5. What has happened to the electrode after the electrolysis of the copper(II) chloride solution has been allowed to continue for 5 to 10 more minutes?

Q6. What was happening at the electrode where you saw bubbling taking place? Use your answers to Questions 2 and 3 to support your explanation.

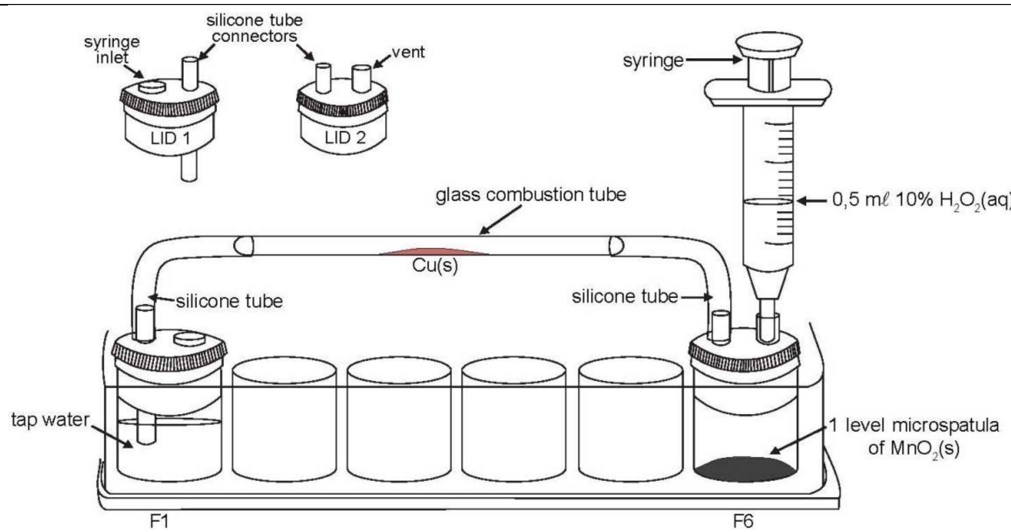
Q7. What was happening at the electrode where no bubbles were observed?

Q8. Describe the appearance of the copper(II) chloride solution before electrolysis took place. Do the products formed at each electrode have the same properties as the original solution? Explain your answer by referring to observations made during the experiment.

Q9. From your answer to Question 8, describe the effect of an electric current on a copper(II) chloride solution.

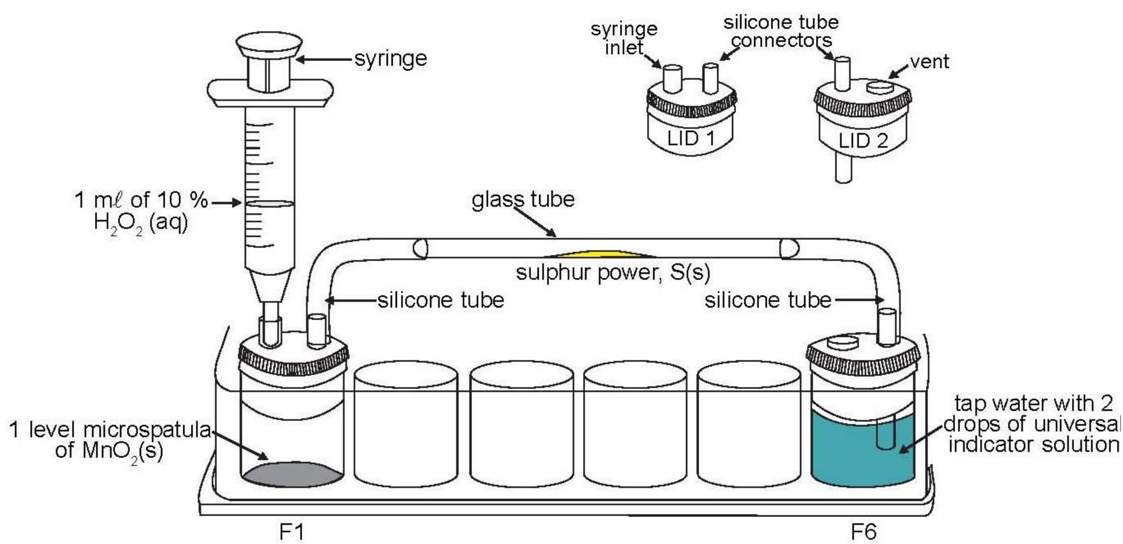
	Q10.	The carbon rods or electrodes are required for carrying current into and out of the copper(II) chloride solution. Each electrode has a special name. The electrode connected to the positive terminal of the battery is called the anode, while the electrode connected to the negative terminal of the battery is called the cathode.
	i.	At which electrode did chlorine gas form? (See your answer to Question 3)
	ii.	At which electrode did copper metal deposit? (See your answer to Question 4)
	Q11.	An electric current can only flow if the solution contains charged particles that are able to move through the solution. Write down the formulae of the charged particles which exist in a copper(II) chloride solution. Name the charged particles.
	Q12.	Recall what you observed at the anode. Which charged particles in the copper(II) chloride solution moved towards the anode?
	Q13.	Which charged particles moved towards the cathode? Explain by referring to the product you observed at this electrode.
	Q14.	Write down a balanced equation to show the reaction taking place in the well during electrolysis. What type of reaction is this? Explain your answer with reference to the observations made at each electrode.
	Q15.	What kind of half-reaction occurs at the anode? Write an equation for this half-reaction. (See your answers to Q10i and Q14)
	Q16.	What kind of half-reaction occurs at the cathode? Write an equation for this half-reaction. (See your answers to Q10ii and Q14)

EXPERIMENT 3 - THE REACTION OF COPPER WITH OXYGEN
CSEC OBJECTIVE: Section C2 - 2.1
2.1 Discuss the reactivity of metals
Grade Level - 10

Note CAUTION	**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 (MnO2(s)); Fresh hydrogen peroxide solution (H2O2(aq)) [10 %]; Methylated spirits; Copper powder (Cu(s)); Tap water. **The hydrogen peroxide solution should be fresh, otherwise the results will not be as described below.** **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	**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)*
Note	**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 4 – THE REACTION OF SULPUR WITH OXYGEN
CSEC OBJECTIVE: Section C5 - 5.1
5.1 Describe the physical and chemical properties of non-metals
Grade Level - 10

<table>
<tr><td></td><td>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 (MnO2(s)); Fresh hydrogen peroxide solution (H2O2(aq))[10 %]; Universal indicator solution; Sulphur powder (S(s)); Methylated spirits; Tap water.</td></tr>
<tr><td></td><td>
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<tr><td></td><td>PROCEDURE
Use the spooned end of a plastic microspatula to place one level spatula of manganese dioxide powder into well F1.
Fill ¾ of well F6 with tap water using a propette.
Use another propette to place 2 drops of the universal indicator solution into the tap water in F6. (See Question 1)
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.
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 as shown in the diagram.
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.
Hold the glass tube in a horizontal position. Use the narrow end of a clean</td></tr>
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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.

Do not move well F1.

11. Light the microburner and move it away from the comboplate®.
12. Slowly add about 0,4 ml of the 10% H2O2(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 H2O2(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.

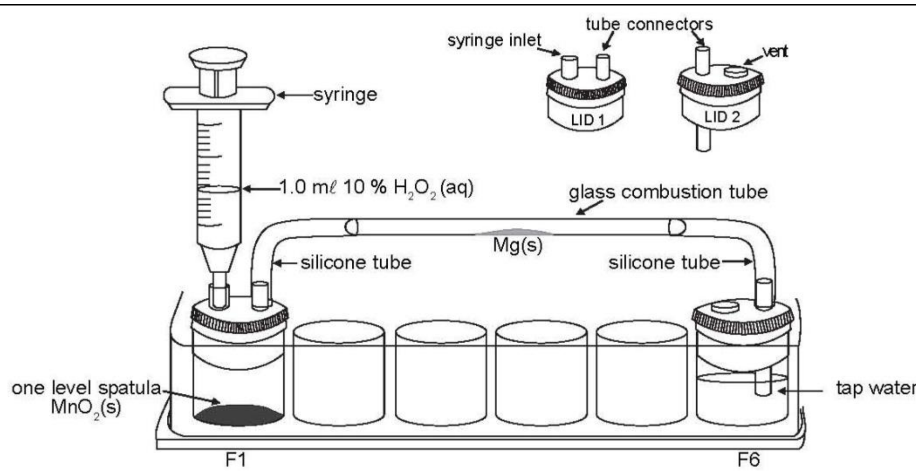
Q7. Some carbon fuels, such as coal, contain sulphur as an impurity. When these fuels burn they form sulphur dioxide. Using the observations in the above experiment with the universal indicator, explain how the burning of sulphur in the environment can contribute to the problem of acid rain.

EXPERIMENT 5 – THE REACTION OF MAGNESIUM WITH OXYGEN
CSEC OBJECTIVE: Section C 1, 1.1
1.1 Describe the physical and chemical properties of metals
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 (MnO2(s)); Fresh hydrogen peroxide solution (H2O2(aq)) [10 %]; Methylated spirits; Universal indicator solution; Magnesium powder (Mg(s)); Tap water.

Note

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



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)*

Note

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% H2O2(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 H2O2(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.

EXPERIMENT 6 – DECOMPOSITION OF COPPER CARBONATE

CSEC OBJECTIVE: Section C 1, 1.2

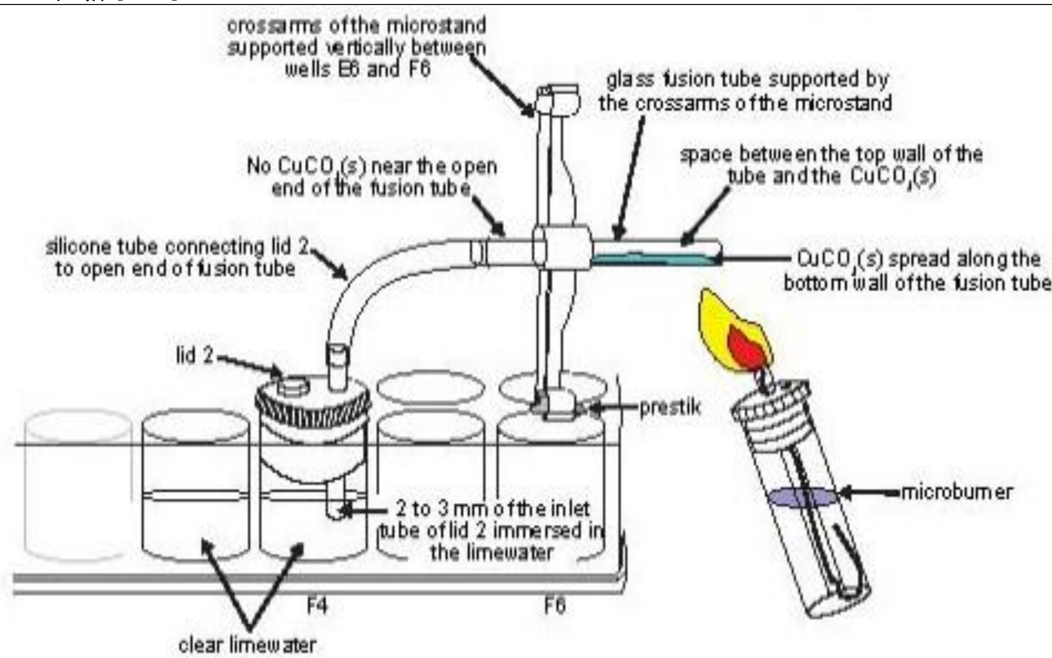
1.2 Describe the reactions of metal oxides, hydroxides, nitrates and carbonates

Grade Level - 10

REQUIREMENTS

Apparatus: 1 x comboplate®; 1 x glass fusion tube; 1 x silicone tube; 1 x crossarms for the microstand; 1 x plastic microspatula; 2 x propette; 1 x lid 2; 1 x microburner; small piece of prestik.

Chemicals: Copper(II) carbonate powder (CuCO3(s)); Clear limewater; Sulphuric acid H2SO4(aq)) [1 M].



PROCEDURE

1. Hold the fusion tube in a horizontal position. Use the narrow end of a plastic microspatula to fill about ½ of the fusion tube with copper(II) carbonate powder.
2. Keep the tube in the horizontal position and gently tap the sealed end of the fusion tube so as to spread the powder on the floor of the tube, taking care not spread the powder all the way to the open end of the fusion tube.
   Leave about 5 mm from the open end of the tube free of copper carbonate powder as shown in the diagram above. *(See Question 1)*
3. Place a level microspatula of the CuCO3(s) powder into well A1. Add 1 drop of 1 M sulphuric acid to the powder. *(See Question 2)*
4. Use a clean propette to half fill well F4 of the comboplate® with limewater. Make sure that the limewater is clear.
5. Fit lid 2 into well F4. Make sure that about 2 to 3 mm of the tip of the inlet tube of the lid is immersed in the limewater in well F4. (If not, add more limewater.)
6. Examine the diagram above carefully and set up all apparatus as shown, except the

	microburner.
	7. Light the microburner. Hold the flame beneath the fusion tube and start heating, waving the flame gently below the $CuCO_3(s)$.
Note	**Avoid the $CuCO_3$ moving into the silicone tube by ensuring that there is space between the top wall of the fusion tube and the $CuCO_3(s)$ powder (as shown in the diagram). Be careful when heating and stop heating if $CuCO_3(s)$ powder moves towards the mouth of the fusion tube. Tap the $CuCO_3(s)$ back towards the closed end gently.**
	8. Continue heating this way during the next steps. *(See Question 3)*
	9. Continue heating until there are no more bubbles coming out in well F4. *(See Question 4)*
	10. Discontinue heating and wait for the fusion tube to cool.
Note	**The limewater will rise up the silicone tube as cooling takes place. Allow this to happen. However, make sure that the liquid does not get into the fusion tube by disconnecting the fusion tube from the silicone tube as soon as the liquid is close to the mouth of the fusion tube.**
	11. Allow the liquid in the silicone tube to go back into well F4. *(See Question 5)*
	12. When the fusion tube has cooled, tap some of the remaining solid into well A2 and add a drop of 1 M sulphuric acid. *(See Question 7)*
	Clean all apparatus thoroughly.
	QUESTIONS Q1. What colour is $CuCO_3(s)$? Q2. What happens in well A1? Explain your observation. Q3. What do you observe in well F4? Q4. What colour is the solid remaining in the fusion tube? Q5. What happens in well F4? Q6. What is responsible for your observation in well F4? Q7. What happens in well A2? Q8. What is the name of the solid remaining in the fusion tube after heating? Q9. Explain why your observation in Q7 is different from your observation in Q2. Q10. Write a word equation for the reaction that took place in this experiment. Beneath each substance write the colour. Q11. Write a chemical formula equation for the reaction in Q10 above.

EXPERIMENT 7 – DECOMPOSITION OF AMMONIUM CARBONATE

CSEC OBJECTIVE: Section C1, 1.2

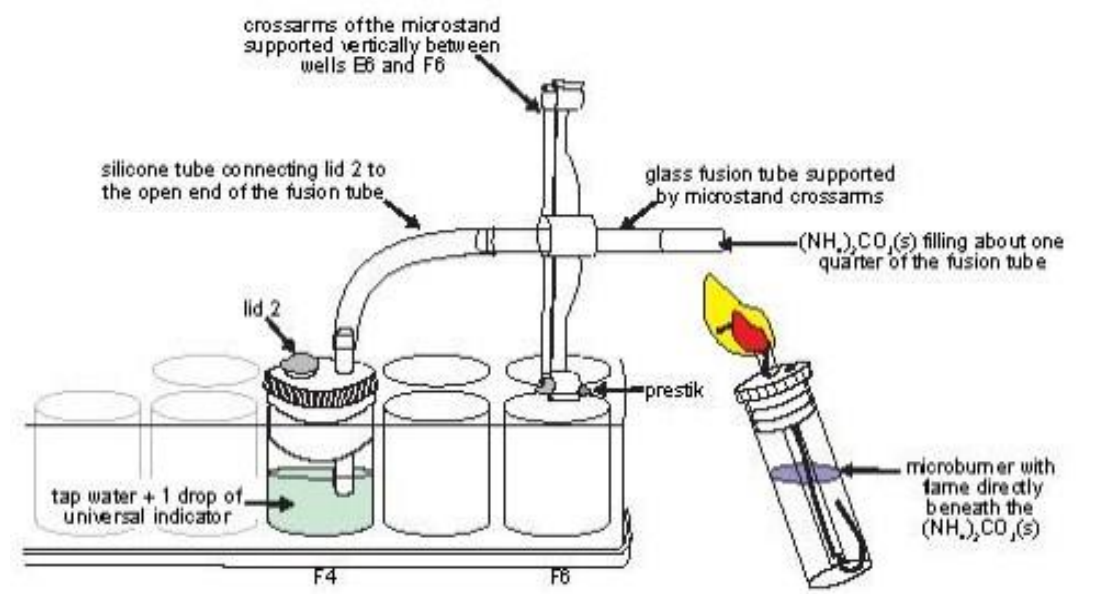
1.2 Describe the reactions of metal oxides, hydroxides, nitrates and carbonates

Grade Level - 10

REQUIREMENTS

Apparatus: 1 x comboplate®; 1 x glass fusion tube; 1 x silicone tube; 1 x crossarms for the microstand; 1 x plastic microspatula; 1 x propette; 1 x lid 2; 1 x microburner; small piece of prestik.

Chemicals: Ammonium carbonate crystals ($(NH4)2CO3(s)$); Universal indicator solution; Tap water.



PROCEDURE

1. Hold the fusion tube in a horizontal position. Use the narrow end of the microspatula to carefully fill about ¼ of the fusion tube with ammonium carbonate crystals. Tap the sealed end of the tube to make the crystals fall to the bottom of the tube.

Note

The ammonium carbonate crystals are big and sticky, handle them with care.

2. Use a clean propette to fill half of well F4 with tap water. Add a drop of universal indicator solution to the water in well F4. *(See Questions 1, 2)*
3. 3. Examine the diagram above carefully and set up all apparatus, except the microburner.
4. 4. Light the microburner. Hold the flame beneath the $(NH4)2CO3(s)$ in the fusion tube and start heating. *(See Questions 3,4)*
5. 5. Continue heating until no more bubbles are produced in well F4. *(See Questions 5,*

	6) 6. Disconnect the apparatus. Cautiously smell the solution in well F4 and the open fusion tube. *(See Question 8)* **Clean all apparatus thoroughly.**
	QUESTIONS Q1. What colour is the universal indicator before adding it to the water? Q2. What colour is the universal indicator after adding it to the water? Q3. What happens in well F4 as heating is continued? Q4. What happens in the fusion tube as heating is continued? Q5. What colour is the mixture in well F4? Q6. Is the mixture in well F4 acidic or basic after heating? Q7. Why did the mixture in well F4 go basic? Q8. What do you smell? Q9. What remains in the fusion tube? Q10. Write a formula equation for the reaction in this experiment.

EXPERIMENT 8 – REDUCTION OF COPPER (II) OXIDE

Section A8. Objective 8.4

8.4 Identify oxidation and reduction reactions including reactions at electrodes

Grade Level - 10

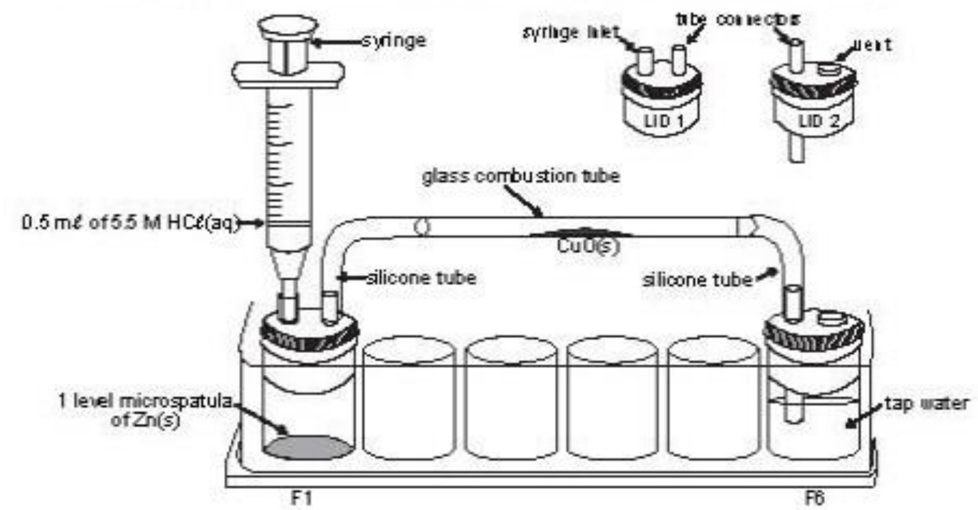
REQUIREMENTS

Apparatus: 1 x comboplate®; 1 x 2 ml syringe; 1 x glass tube (6 cm x 4 mm); 1 x lid 1; 1 x lid 2; 2 x plastic microspatulas; 1 x propette; 2 x silicone tubes (4 cm x 4 mm); 1 x microburner;
1 x box of matches.

Chemicals: Hydrochloric acid (HCl(aq)) [5.5 M]; Zinc powder (Zn(s)); Copper(II) oxide powder (CuO(s)); Methylated spirits.

CAUTION

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



PROCEDURE

1. Use the spooned end of a clean microspatula to add one level spatula of zinc powder to well F1.
2. Fill b of well F6 with tap water from a propette.
3. Seal well F1 with lid 1. Seal well F6 with lid 2 so that the vent hole faces outwards.
4. Connect one end of a silicone tube to the tube connector on lid 1. Connect one end of the other silicone tube to the tube connector on lid 2.
5. Hold the glass tube in a horizontal position. Use the narrow end of a clean microspatula to place a small quantity of copper(II) oxide powder in the centre of the glass tube.
6. Keep the glass tube horizontal and attach one end to the silicone tube on lid 1. Connect the other end to the silicone tube on lid 2.

Keep the glass tube horizontal at all times otherwise the powder might spill into wells F1 or F6.

Note

7. Fill the syringe with 0.5 ml of 5.5 M HCl(aq). Fit the nozzle of the syringe into the syringe inlet on lid 1 in well F1.
8. Light the microburner and place it on one side away from the comboplate®.
9. Add the HCl(aq) very slowly from the syringe into well F1. *(See Question 1)*
10. When a few bubbles have come through the water in well F6, bring the flame of the microburner to the middle of the glass tube where the CuO(s) has been placed. Hold the microburner in this position.

Do not bring the flame of the microburner near the silicone tubes (as they will melt) or the vent of well F1 (as hydrogen is explosive).

CAUTION

11. Stop heating the CuO(s) after about 2 minutes or after it has changed in appearance. Blow out the microburner flame. *(See Questions 3 and 4)*
12. If you see water being sucked back from well F6 into the glass tube, disconnect lid 2 from well F6.

Remove the glass tube from the set-up when it has cooled.

Rinse the comboplate® and syringe thoroughly.

QUESTIONS

Q1. What happens when 5.5 M HCl(aq) is added to well F1?

Q2. Why was it necessary to wait for the first few bubbles to come through before heating the glass tube?

Q3. What has happened to the CuO(s)?

Q4. Describe any other changes in the glass tube.

Q5. From your observations of the solid in the glass tube, would you say a chemical reaction occurred? Explain your answer.

Q6. What do you think the products of this reaction are?

Q7. Write down the equation for the chemical reaction in which hydrogen was formed, starting with Zn(s) and HCl(aq).

Q8. How could we test if hydrogen gas (H2(g)) is really being produced?

Q9. Write down the chemical equation for the reaction of copper oxide (CuO(s)) which you think occurred.

Q10. Suggest how you could prove that water is a product of the reaction.

EXPERIMENT 9 – ACID/BASE TITRATION – AN INTRODUCTION

Section A7. Objective 7.11

7.11 Use results from volumetric analysis to calculate:

(I) The number of reacting moles

(ii) the mole ratio in which reactant combine

Grade Level - 10

REQUIREMENTS

Apparatus: 1 x plastic microspatula; 5 x thin stemmed propettes.

Chemicals: Acid A [0.10 M]; Acid B [0.10 M]; Sodium hydroxide solution (NaOH(aq)) [0.10 M];

Methyl orange indicator; Tap water.

Note

The microspatula should be cleaned before each use.

CAUTION

If any acid or base is spilt on the skin, thoroughly rinse the affected area with water.

PROCEDURE

1. Add 5 drops of tap water into well A1.
2. Add 1 drop of methyl orange indicator into well A1. *(See Question 1)*
3. Repeat steps 1 and 2 above in well A2 using acid A instead of tap water. *(See Question 2)*
4. Add a sufficient number of drops of sodium hydroxide solution to well A2 to just cause the colour of the solution in well A2 to be the same as that in well A1.
   Use the plastic microspatula to stir the solution after each drop of sodium hydroxide added.
   Carefully count the number of drops of sodium hydroxide used. *(See Question 3)*
5. Repeat the titration you did in well A2 two more times, in wells A3 and A4. *(See Question 3)*
6. Repeat steps 3 and 4 above in wells A5, A6 and A7, this time using acid B instead of acid A.
7. Carefully count the number of drops of sodium hydroxide used. *(See Question 4)*

Rinse the comboplate® with tap water and shake dry.

QUESTIONS

Q1. Note the colour of the solution in well A1.

Q2. Note the colour of the solution in well A2.

Q3. Prepare a table like Table 1 below, and enter the number of drops.

TABLE 1.

Acid Used	Number of Drops of Acid A	Number of Drops of NaOH	Average No. of Drops NaOH
A	5 5 5	______ ______ ______	______

Q4. Prepare a table like Table 2 below, and enter the number of drops.

TABLE 2.

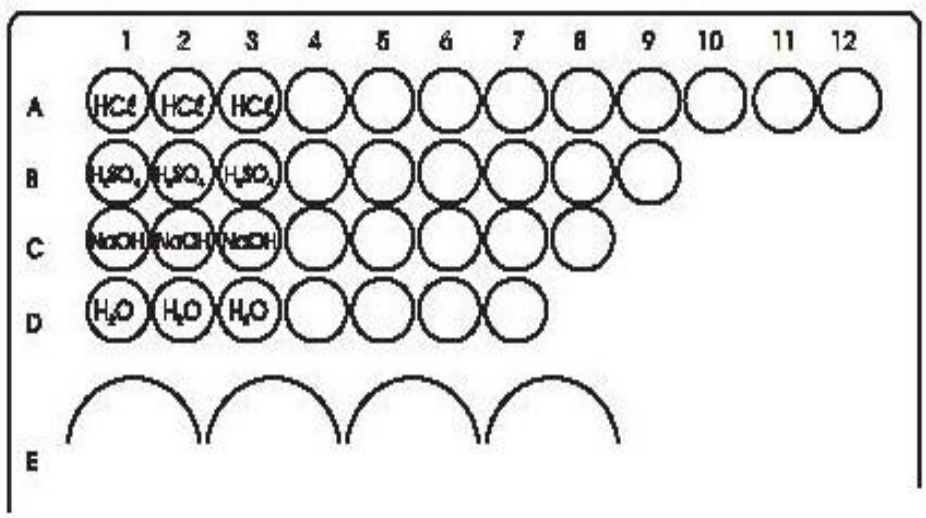
Acid Used	Number of Drops of Acid B	Number of Drops of NaOH	Average No. of Drops of NaOH
B	5 5 5	______ ______ ______	______

Q5. What is the volume ratio of NaOH/acid A in the titration of 0.10 M acid A?

Q6. What is the volume ratio of NaOH/acid B in the titration of 0.10 M acid B?

Q7. Compare your answers to questions 5 and 6 above and then explain these results.

EXPERIMENT 10 – THE EFFECT OF DILUTE ACIDS AND BASES ON INDICATORS CSEC OBJECTIVE: Section A7 – 7.2 **7.2 Relate acidity and alkalinity to the pH scale** Grade Level - 10

	REQUIREMENTS **Apparatus:** 1 x comboplate®; 6 x thin stemmed propettes; a sheet of white paper; pH indicator strip. **Chemicals:** Hydrochloric acid (HC*l*(aq)) [1 M]; Sulphuric acid (H2SO4(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 HC*l*(aq)	In H2 SO4 (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 11 – REACTIONS WITH ACIDS AND SODIUM HYDROXIDE

CSEC OBJECTIVE: Section A7 – 7.4

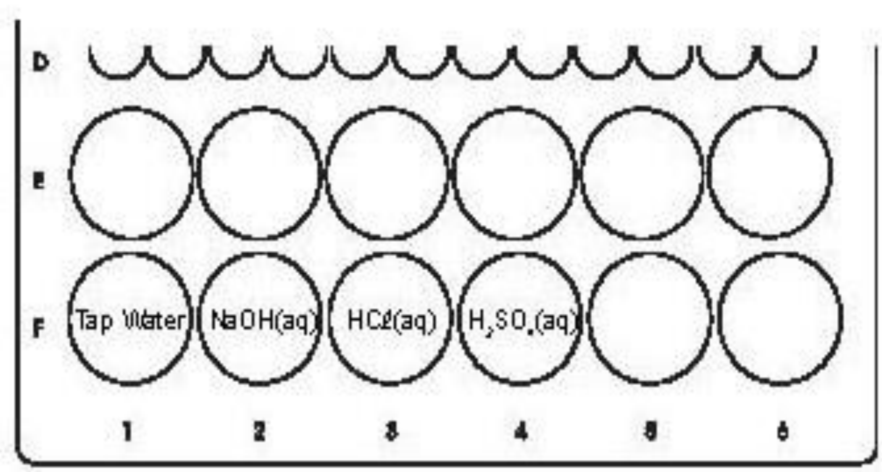
7.4 Investigate the reactions with non-oxidizing acids with:
(i) metals, (ii) carbonates, (iii) hydrogen carbonates (iv) bases

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?