CHEMISTRY LABORATORY MANUAL

A MANUAL OF CHEMISTRY LABORATORY EXPERIMENTS AND MARK SCHEMES APPROPRIATE FOR CSEC

COMPILED BY:

THE CHEMISTRY TEACHERS AND THE MINISTRY OF EDUCATION, NATIONAL RECONCILIATION AND INFORMATION OF ST. VINCENT AND THE GRENADINES

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OVERVIEW OF THE LAB MANUAL DEVELOPMENT PROJECT

Recent CSEC SBA moderation reports revealed that teachers of Biology, Chemistry, Physics and Integrated Science continue to have challenges developing laboratory exercises and designing appropriate mark schemes.

In light of this, the Ministry of Education facilitated the development of moderator-approved lab manuals and mark schemes in each of the four disciplines.

This project involved 39 science teachers from schools across St. Vincent and the Grenadines, divided into four panels representative of the four (4) subject areas: Biology, Chemistry, Physics and Integrated Science. Workshops and meetings were held with the science teachers over a period of two weeks to facilitate the development of these resources.

Following the development of these resources, each manual was then vetted by local CSEC moderators to approve the content and validate the resource as one which is suitable for use in CSEC SBA preparations. Use of these manuals is expected to:

1. Improve overall SBA performance in Secondary Schools.
2. Aid teachers in preparations for CSEC moderation process.
3. Guarantee more favourable moderation reports in the future.

Teachers are encouraged to make use of this resource as they prepare for future SBA moderation exercises.

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INTRODUCING THE CHEMISTRY LAB MANUAL

The purpose of this manual is to provide Chemistry teachers with a resource of reliable laboratory experiments and mark schemes suitable for use in SBA preparation. This manual was prepared by a panel of Vincentian Chemistry teachers and approved by local CSEC SBA moderators.

2019 Chemistry Panel Members:

- Cyritha Harry
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- Amaala Muhammad
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The resource contains thirty-three laboratory experiments and sample marks schemes as well as tips for developing Planning and Designing SBAs. It is aligned with the current CSEC Chemistry syllabus and includes topics and skills as required for CSEC SBAs.

It is the hope of the panel that this resource will improve confidence in preparing for the moderation process, as we work collectively to improve Science education in SVG.

Separation Techniques

Contributed by L. Harry & F. Snagg

LAB 1: PAPER CHROMATOGRAPHY

SUGGESTED SKILLS: ORR/MM/AI

TITLE: Paper Chromatography

AIM: To determine whether the ink/dye in three different brands of red permanent markers are the same.

APPARATUS/MATERIALS: three stirring rods, ruler, scissors, 2 pieces of filter paper, 70 cm^3 ethanol, 25 cm^3 measuring cylinder, three 150 cm^3 beakers, tape, three different brands of red permanent markers.

METHOD:

- Cut three strips of filter paper with the dimensions of 9 cm x 1.5 cm.
- On one strip, mark a line 1 cm away from one end and place a dot of one permanent marker ink in the centre of the line. Repeat with the remaining strips, using the other markers.
- Measure out 20 cm^3 of ethanol and pour it into each beaker.
- Tape the unmarked end of each filter paper to a stirring rod and gently place the filter paper into the ethanol. Make sure that the dot does not touch the ethanol and then allow the experiment to run until the dyes are separated. Mark the furthest point on the paper the ethanol rises.
- Allow the paper to dry and then mark the points at which all the dyes separated. Label each separated component using letters, starting with A being the ink component which separated closest to starting point.

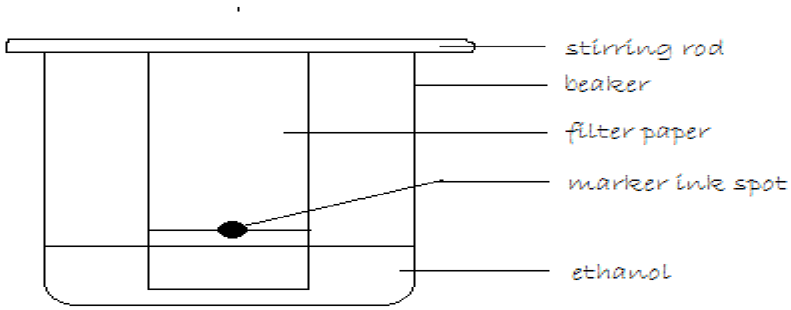


DIAGRAM SHOWING SEPARATION OF MARKER INK USING PAPER CHROMATOGRAPHY

OBSERVATION:

Stick the chromatograms into your book and label the chromatogram belonging to each marker. Compare the three chromatograms and record observations made in terms of colours and number of dyes separated. Also, note the distances travelled by the components of each chromatogram.

DISCUSSION:

Background:

- Define paper chromatography and describe how paper chromatography is used as a separation technique.
- Outline how paper chromatography is useful in this particular experiment.

Explanation:

- Compare the separated ink components of each marker. (Note similarities and differences observed of distance travelled and colour where applicable.)
- Account for the differences observed among the separated components of the markers' inks.

Limitation, assumption, source of error or precaution:

- Give one of each where applicable.

CONCLUSION:

- Answer aim using relevant observational data.

REFLECTION: Reflect briefly on the lab.

LAB 1: SAMPLE MARK SCHEME

SKILL: ORR (12 marks)

Observation (2)

- Relevant observations made:
    - All dyes (colours) in each chromatogram correctly identified - 2
    - Dyes (colours) in chromatograms only partially identified - 1
    - Dyes (colours) not identified - 0

Recording (5)

- All components of the lab are present – 1
- All lab components are correctly sequenced – 1
- Correct content is under each heading – 1
- All apparatus that is used is listed – 1
- All chromatograms are present – 1

Reporting (3)

- The table has an appropriate title – 1
- The columns of the table have appropriate headings – 1
- The table is neatly drawn with pencil and ruler – 1

LAB 1: SAMPLE MARK SCHEME

SKILL: AI (16 marks)

Background:

- Definition of paper chromatography (1)
- Brief description of how the process works to separate dyes/ inks (2)
    - Separation based on solubility of dye in solvent used – 1
    - Separation based on attraction of dye particles to chromatography paper - 1

Explanation:

- Compare the separated ink components of each marker. (2)
    - Note of similarities and differences observed of distance travelled where applicable – 1
    - Note of similarities and differences observed of colour where applicable – 1
- Account for the differences observed among the separated components of the markers' inks (5)
    - Markers are made of different components (dyes) which would result in different chromatograms - 2
    - The closer the dye component is to the datum line, the more attracted the particles are to the paper, or the less the particles are soluble in the ethanol – 2
    - The further the dye component is from the datum line, the less attracted the particles are to the paper, or the more the particles are soluble in the ethanol - 2

Limitation, assumption, source of error precaution:

- Discussion has (2)

- One feasible limitation – 1
- One feasible source of error – 1

Conclusion (2)

- Conclusion answered aim – 1
- Conclusion is based on results – 1

LAB 2: FILTRATION

SUGGESTED SKILLS: ORR/MM/AI

TITLE: Filtration

AIM: To separate chalk (powdered calcium carbonate) from a chalk and water suspension.

APPARATUS/MATERIALS: One stick of white chalk, mortar and pestle, one 25 ml measuring cylinder, two 100 ml beakers, one filter paper, one filter funnel, one retort stand and clamp, one stirring rod, one spatula.

METHOD:

- Place the clamp on the retort stand.
- Fold the filter paper into a quarter circle and insert into the filter funnel, dampening the paper to adhere it to the funnel.
- Place the filter funnel into the clamp to secure it to the retort stand.
- Place an empty beaker under the funnel.
- Break the chalk into small pieces and pulverize using the mortar and pestle.
- Observe the physical characteristics of the pulverized chalk.

- Measure out 30 ml of water and observe its physical characteristics.
- Place the chalk powder into an empty beaker, then fill the beaker with 30 ml of water using the measuring cylinder.
- Mix the contents vigorously, carefully noting the appearance of the mixture.
- Carefully pour all the contents into the filter funnel.
- Leave to filter then collect the filtrate and residue.
- Dry the residue and note the appearance of both filtrate and dried residue.

OBSERVATION:

Note observations of the physical aspects of the original components, the resultant mixture and the filtrate and residue.

DISCUSSION:

Background:

- Define filtration and describe how filtration is used as a separation technique.

Explanation:

- Explain why filtration is a suitable technique for the separation of the chalk suspension as opposed to another named separation technique.
- Account for the differences observed with the original components before mixing, when mixed and after separation.

Limitation, assumption, source of error or precaution:

- Give one of each. (Where applicable)

CONCLUSION:

Answer aim using relevant observational data.

REFLECTION:

LAB 2: SAMPLE MARK SCHEME

SKILL: ORR (12 marks)

Observations (5)

- Chalk: white and powdery – 1
- Water: colourless liquid – 1
- Chalk & water: White, cloudy, opaque suspension forms (chalk suspended in the water) until settling occurs – 1
- Residue: white solid remains in filter paper – 1
- Filtrate: colourless liquid passes through filter paper – 1

Recording (5)

- Correct lab format – 1
- All lab components are present – 1
- Correct content is under each heading – 1
- The aim is clearly stated – 1
- All apparatus that is used is listed – 1

LAB 2: SAMPLE MARK SCHEME

SKILL: AI (17 marks)

Background:

- Correct definition of filtration (1)
- Brief description of how the process works to separate suspensions (2)
    - Separation based on differences in size of solid particles vs water particles – 1
    - Separation based on action of filter paper mesh spaces as a separator - 1

Explanation:

- Explanation of why filtration is a suitable technique for the separation of the chalk suspension as opposed to another named separation technique. (2)
    - Preferred technique for separating suspensions where the solid particles are suspended in the liquid – 1
    - Significant differences in size of solid particles vs liquid particles allow for separation based on particle size – 1
- Account for the differences observed with the original components before mixing, when mixed and after separation. (6)
    - The water is transparent due to absence of large particles which could prevent the passage of light – 1
    - The chalk is a dull, white powder due to the uneven reflection of light from the surface of the chalk and the reflection of the majority of light wavelengths to produce a white colour – 1
    - The opacity of the suspension is due to the chalk particles preventing light rays from passing through the water particles – 1
    - The transparency of the filtrate is due to the removal of the chalk dust particles as the suspension passes through the filter paper – 1

- The water molecules pass through the filter paper since they are small enough to pass through the spaces in the fibre mesh of the filter paper – 1
- The filter paper removes the chalk dust particles due to their being too large to be passed through the spaces in the fibre mesh of the filter paper, hence it forms the residue – 1

Limitation, assumption, source of error precaution:

- Discussion has (4)
    - One feasible limitation – 1
    - One feasible assumption – 1
    - One feasible source of error – 1
    - One feasible precaution – 1

Conclusion (2)

- Conclusion answered aim – 1
- Conclusion is based on results – 1

LAB 3: SOLUBILITY

SUGGESTED SKILLS: ORR/MM/AI

Title: Solubility

Aim: To investigate the effect of temperature on the solubility of potassium nitrate (potassium chlorate).

Apparatus/Materials: 6 boiling tubes, thermometer, hot water bath, 10 cm^3 measuring cylinder, electronic balance, potassium nitrate (potassium chlorate), watch glass, spatula, stirring rod.

Method:

- Measure out 4 g of the salt on the balance into the watch glass.
- Transfer the solid to a boiling tube.

- Measure out 10 cm^3 of water in a measuring cylinder and transfer to the boiling tube with the salt.
- Stir the mixture as much as possible to dissolve as much potassium nitrate as possible.
- Insert a thermometer and heat the solution in a water bath, constantly stirring, until all the potassium nitrate is dissolved.
- Remove the boiling tube from the heat and stir the solution gently as it cools, not removing the thermometer.
- Record the temperature at which recrystallization of the salt occurs.
- Repeat the experiment using different masses of potassium nitrate and tabulate results.

Observations:

Record any relevant observations in a paragraph.

Results:

Tabulate the results as shown below:

TABLE SHOWING THE TEMPERATURES AT WHICH SPECIFIC SOLUTIONS OF POTASSIUM NITRATE RECRYSTALLIZED

Temperature /°C						
Mass of KNO_3 soluble in 10g of water/g	4.0	6.0	8.0	10.0	12.0	14.0

Discussion:

Calculation of solubility:

(Write one example showing the working of how to calculate solubility)

For 4.0 g of potassium nitrate:

If 4 g of KNO_3 dissolves in 10 g of water

Then x g of KNO_3 dissolves in 100 g of water

$$x = \frac{4\text{ g} \times 100}{10} = 40\text{ g}$$

(Calculate the solubilities for all and fill out the following table which must be drawn in the discussion section)

TABLE SHOWING THE SOLUBILITY OF POTASSIUM NITRATE AT DIFFERENT TEMPERATURES

Temperature /°C						
Mass of KNO_3 soluble in 10 g of water/g	4.0	6.0	8.0	10.0	12.0	14.0
Solubility of KNO_3 / g per 100 g of water	40					

Draw a graph plotting Solubility of KNO_3 (y-axis) vs. Temperature (x-axis)

Then continue the discussion

Background info:

- What is solubility?
- How does temperature affect solubility of ionic compounds?

Explanation of results

- How does temperature affect the solubility for potassium nitrate? Give reasons for your answer.
- Explain how this information about solubilities of ionic compounds is important.

Limitations, assumptions, sources of error

- Give one each.

Conclusion: Answer aim.

Reflection:

LAB 3: SAMPLE MARK SCHEME

SKILL: MM (18 marks)

Mark Scheme

CRITERIA	MARKS
BUNSEN BURNER	
Tubing placed securely over gas outlet	**1**
Air hole closed before lighting	**1**
Match lit before gas was turned on	**1**
Air hole opened to obtain blue flame	**1**
Height of flame adjusted by use of gas tap	**1**
ELECTRONIC BALANCE	
Balance zeroed before use	**1**
Excessive motion and talking avoided around balance	**1**
Steadying of reading allowed before recording	**1**
Accurate measurement of the mass of KNO_3	**1**
Watch glass placed in middle of pan	**1**
Balance zeroed after use	**1**
THERMOMETER	
Whole bulb immersed in liquid	**1**
Bulb not touching sides of boiling tube	**1**
Stirring to evenly distribute heat throughout liquid	**1**
Reading of thermometer done at eye level	**1**
Correct reading of temperature	**1**
CFL	
Workstation is kept free of unnecessary materials when working with Bunsen burner	**1**
Apparatus washed and put to drain after results obtained	**1**

LAB 3: SAMPLE MARK SCHEME

SKILL: ORR (12 marks)

Mark Scheme

CRITERIA	**MARKS**
OBSERVATION	
General Increase in solubility as temperature increased	**2 (one outlier 1 mark, more than one 0 marks)**
RECORDING	
Complete table	**1**
Appropriate column headings of table	**1**
Appropriate table title in appropriate format (title capitalized and underlined)	**1**
Graph title present and appropriate	**1**
Axis labels (1 mark per axis)	**2**
Smooth curve taking up approximately 2/3 of graph paper	**1**
REPORTING	
All sections of report present	**1**
Report written in correct tense (past tense and passive voice)	**1**
Aim clearly stated	**1**

LAB 4: SOLUBILITY

SKILL: P&D

Title: Separating a Mixture of Solid Sodium Chloride and Zinc Powder

Observation:

While organizing his workstation, Mark, a student, accidentally caused some solid sodium chloride to fall into some zinc powder. Mark wants to separate the mixture into its original components but but is not sure which solvent he should use. He has two solvents to choose from: Acetone and Water.

Plan and design an experiment to help him determine which solvent would be better to separate the mixture.

LAB 4: SAMPLE MARK SCHEME

SKILL: P&D (16 marks)

Hypothesis (3)

- Dependent and independent variables are identifiable – 1
- Clearly stated – 1
- Testable – 1

Aim (1)

- Related to the hypothesis – 1

Materials/Apparatus (2)

- All materials are appropriate for performing the experiment – 1
- No more than one essential apparatus is omitted – 1

Procedure/ Method (4)

- Suitable/ feasible – 1
- Written in instruction format – 1

- At least 1 dependent or independent variable mentioned – 1
- Attempt made to set up control – 1

Variables (3)

- At least one controlled variable – 1
- At least one dependent variable – 1
- At least one independent variable – 1

Expected result(s) (2)

- Reasonable – 1
- Linked to hypothesis and method – 1

Assumptions, Precautions, Sources of error, Limitations (1)

- At least one stated

Contributed by S. Abbott & I. LaBorde

LAB 5: INVESTIGATING INDICATORS

SUGGESTED SKILLS: ORR/AI

Title: Experimenting with Some Common Indicators

Aim: To observe the effect of acidic, alkaline and neutral solutions on four common indicators.

Apparatus and **Materials**: Solution of A,B and C, phenolphthalein, screened methyl orange, red and blue litmus paper in petri dishes, test tubes, beakers, droppers.

Method/Observations/Results:

Using Solution A, complete the following table. Thoroughly rinse each tube and repeat the tests using Solutions B and then C. Tabulate the results for Solutions B and C as shown with Solution A.

<u>TABLE SHOWING METHOD, OBSERVATIONS AND INFERENCES MADE AFTER TESTING SOLUTION A WITH VARIOUS INDICATORS</u>

Test	Observation	Inference
1. Place 1-2 drops of Solution A onto blue litmus paper. Observe the indicator and record before and after observations.		
2. Place 1-2 drops of Solution A onto red litmus paper. Observe the indicator and record		

before and after observations.		
3. Place approximately 2 cm^3 of Solution A in a clean, dry test tube. Add 2-3 drops of phenolphthalein to Solution A. Observe the indicator and record before and after observations.		
4. Place approximately 2 cm^3 of Solution A in a clean, dry test tube. Add 2-3 drops of screened methyl orange to Solution A. Observe the indicator and record before and after observations.		

Discussion:

Identify which solution is acidic, alkaline and neutral. Support your answer using your knowledge of each indicator.

Conclusion: Relate to the aim

Reflection:

LAB 5: SAMPLE MARK SCHEME

SKILL: ORR (22 marks)

Criteria	Total Marks
Both Date & Title displayed (2) Date but no title or vice versa (1 mark only) Neither shown (0)	2
All sections displayed are being used appropriately (1)	1
All apparatus and materials used are listed (2) List is only partially complete (1) List is absent (0)	2
Observations: 1. Correct observations of each indicator in Solution A. (1 mark per indicator = 4 marks) 2. Correct observations of each indicator in Solution B. (1 mark per indicator = 4 marks) 3. Correct observations of each indicator in Solution C. (1 mark per indicator = 4 marks)	12
Each table is neatly constructed (1)	1
Title is correctly stated on each table (2 marks)	2

Only one or two tables with correct titles (1) No tables have correct titles (0)	
Conclusion states the colour changes of each indicator in acidic, alkaline and neutral solutions (2) Conclusion only partially states these observations (1) Conclusion does not relate to the aim (0)	2
Total	**22**

LAB 6: REACTION OF ACIDS

SUGGESTED SKILLS: ORR/AI/MM

Title: Reactions of Acids

Aim: To investigate the action of dilute sulfuric acid on metals, carbonates, hydrogen carbonates and bases.

Apparatus and Materials: Test tubes, test tube rack, delivery tube, rubber bung, Bunsen burner, splint, magnesium ribbon, cooper (II) carbonate, sodium hydrogen carbonate, copper (II) oxide, copper, dilute sulfuric acid, lime water.

Method:

1. In a clean test tube, add approximately 2 cm^3 dilute sulfuric acid to a small strip of magnesium ribbon, and then insert a lit splint into the test tube to test for gas.

2. Add 2 cm^3 dilute sulfuric acid to half a spatula of sodium hydrogen carbonate powder. Observe and record relevant observations. Repeat using Copper (II) Carbonate.

Test for any gas formed by attaching a delivery tube to the test tube and bubbling the gas through lime water.

3. Add 2 cm^3 dilute sulfuric acid to half a spatula of copper (II) oxide. Observe and record relevant observations.

4. Add 2 cm^3 dilute sulfuric acid to copper metal. Observe and record relevant observations.

5. Construct a suitable table to display the observations and inferences for each test carried out.

Observations/Results:

Discussion: In each inference section ensure to explain the observation and write an appropriate balanced equation for the reaction taking place.

Conclusion: Relate to the aim

Reflection:

LAB 6: SAMPLE MARK SCHEME

SKILL: AI (15 marks)

Inference Section includes the following points:

1. Acids react with reactive metals (like Mg) to form salt and hydrogen gas. (1)
2. Balanced chemical equation of the reaction between sulfuric acid and magnesium is shown (2)
    a. Equation is correct but not balanced (1)
    b. Equation is absent or incorrect (0)
3. Acids react with carbonates and hydrogen carbonates to form salt, water and carbon dioxide gas. (2)
    a. Only reaction of carbonate explained (1)
    b. Only reaction of hydrogen carbonate explained (1)
    c. Neither reaction explained (0)
4. Balanced equations for carbonate and hydrogen carbonate included (2 marks per equation = 4 marks)
    a. Equation is correct but not balanced (1)
    b. Equation is absent or incorrect (0)
5. Acids react with bases to form salt and water. (1)
6. Balanced equation of above reaction is included (2)
    a. Equation is correct but not balanced (1)
    b. Equation is absent or incorrect (0)
7. Unreactive metals (like copper) do not react with dilute acids (1)
8. Conclusion correctly states the reaction of acids investigated in this lab. (2)
    a. Conclusion only partially states the reactions of acids (1)
    b. Conclusion does not state the reactions of acids. (0)

LAB 7: PREPARATION OF COPPER (II) SULFATE CRYSTALS

SUGGESTED SKILLS: ORR/AI/MM

Title: Preparation of Copper (II) Sulfate Crystals

Aim: To make hydrated Copper (II) Sulfate crystals from copper (II) carbonate powder.

Apparatus and Materials: 250 cm^3 beaker, Bunsen burner, tripod stand, spatula, stirring rod, filter funnel, filter paper, conical flask, evaporating dish, 1M sulfuric acid, copper (II) carbonate powder.

Method:

1. Add 20 cm^3 of 1M sulfuric acid to a beaker.

2. Add a spatula at a time of copper (II) carbonate powder and stir until no more can be dissolved.

3. Filter to remove the undissolved solid then pour solution into an evaporating dish and heat gently to allow to evaporate slowly and gently.

4. When crystals start to appear on the sides of the dish, stop evaporating.

5. Place a filter paper over the dish and leave it to cool and crystallize.

6. After the crystals have formed, pour off the excess liquid and dry the crystals by blotting them between filter paper.

7. Ensure to collect your crystals and show them to the instructor.

Observations:

Record relevant observations here in a paragraph form.

Discussion:

In your discussion include the following:

1. The name of the method used to prepare the salt and explain why this method was chosen?

2. The reason why excess carbonate was added to the acid.

3. Why was the mixture filtered and heated?

4. Explain your observations.

5. Write a balanced equation for the reaction taking place.

LAB 7: SAMPLE MARK SCHEMES

SKILL: MM (13 marks)

USE OF BUNSEN BURNER

- Attaches hose securely to gas tap (1)
- Closes air hole on Bunsen burner before lighting (1)
- Lights splint/match before turning on the gas (1)
- Adjusts gas tap to control height of flame (1)
- Adjusts air hole after lighting to control intensity of flame (1)
- Turns off gas completely when finished (1)

USE OF MEASURING CYLINDER:

- Places cylinder on a flat surface to read (1)
- Reads cylinder at eye-level (1)
- Reads cylinder correctly (using bottom of meniscus) (1)
- Pours solution slowly to avoid spillage (1)

CFL Skills:

- Carefully handles equipment to avoid breakage/spills (1)
- Leaves workstation clean at end of experiment (1)
- Uses all equipment provided appropriately (1)

Here is another MM sample mark scheme (9 marks)

Use of appropriate measuring cylinder to measure the volume of the acid [1]
Use of appropriate apparatus (glass rod) to stir the mixture [1]
The hot mixture was poured into the filter paper without spillage/overflow[1]
Copper (II) Carbonate was added into the beaker, a little at a time, with stirring and without spillage. [1]
The Copper (II) Carbonate was added until no more dissolved/no more bubbles were seen.[1]
Filtration was properly done (filter paper was folded properly; no prodding of filter paper in funnel; check that filtrate is clear.[1]
Flame was turned off when the filtrate was saturated (saturation: when the crystals appear on the filtrate surface/at the side of the dish[1]
Proper control of the flame when filtrate was being evaporated to prevent spluttering [1]
Googles were worn[1]

LAB 8: PREPARATION OF LEAD (II) IODIDE & CALCIUM CHLORIDE

SUGGESTED SKILLS: ORR/AI/MM

Title: Preparation of Lead (II) Iodide and Calcium Chloride

Aim: To prepare the salts lead (II) iodide and aalcium chloride.

Apparatus and Materials: Potassium iodide solution, lead (II) nitrate solution, beaker, measuring cylinder, stirring rod, filter paper, filter funnel, wash bottle, mass balance, calcium carbonate and dilute hydrochloric acid.

Method:

Lead Iodide-

(Ask students to give the method and steps they would use, then let them execute their method)

1. Add 5 cm^3 of lead (II) nitrate into a beaker followed by 5 cm^3 of potassium iodide and stir the mixture.

2. Filter the mixture and wash the residue with distilled water.

3. Allow the residue to dry in air.

4. Collect the dried sample.

Calcium Chloride -

1. Measure 10 cm^3 of hydrochloric acid in a measuring cylinder.
2. Weigh 3g of calcium carbonate using a mass balance and add to a beaker.
4. Pour the hydrochloric acid into the beaker containing the calcium carbonate.
5. Observe the mixture that forms after combination and after mixing.
6. Filter the mixture (if necessary) and collect the filtrate.
7. Heat the filtrate to saturate the solution then allow it to cool and crystallise.
8. Filter the mixture to collect the salt crystals and rinse with cold distilled water.
9. Observe the residue and leave it to dry in a Petri dish.

Results: *Title CAPS, underlined,* ***above*** *table*

Salt prepared	**Before combination**	**After combination**	**After mixing**	**Filtrate**	**Residue**
Lead Iodide					
Calcium Chloride					

Discussion: *Questions to guide discussion:*

1. Definition of salts and description of methods of salt preparation used in this lab.
2. Balanced **chemical** and **ionic** equations for both reactions.
3. Justification for the methods used.
4. How each salt is formed and discuss observations as it relates to the chemical reactions.
5. Limitations/sources of error.

Conclusion: Relate to the aim

Reflection:

Mark Scheme (AI)

CRITERIA	MARKS
EQUATIONS	
Full balanced equations for both reactions (2 marks each – ½ mark lost for: incorrect formula, lack of state symbols or incorrect balancing)	**4**
DISCUSSION	
Explanation of the process of ionic precipitation	**2**
Correct description of salts Barium sulfate insoluble and Calcium chloride soluble	**2**
Identify residue in both experiments	**2**
Statement of 2 reasonable limitations/ sources of error (1 mark each)	**2**
CONCLUSION	
Appropriate and related to aim	**1**
TOTAL	**13/10**

LAB 9: WATER OF CRYSTALLIZATION

SUGGESTED SKILLS: ORR/AI/MM

Title: Water of Crystallization

Aim: To determine the number of moles of water of crystallization in hydrated $CuSO_4.XH_2SO_4$ (or any hydrated salt)

Apparatus: Retort, Bunsen burner, boiling tube, balance, $CuSO_4$. XH_2O

Method:

1. Measure the mass of the boiling tube.

2. Add some hydrated $CuSO_4$ and measure the mass of tube and contents.

3. Firmly clamp at a downward slant in the retort and place above Bunsen.

4. Gently heat tube and contents to drive off water.

5. When no more water or steam is given off, remove, allow to cool and remeasure mass of tube and contents.

6. Reheat, cool and remeasure until a constant mass is achieved.

LAB 9: SAMPLE MARK SCHEME

SKILL: MM (14 marks)

<u>Measurement of mass(x2- before and after heating):</u>

Zero balance (1)

Place tube in center of balance (1)

Steady reading before recording (1)

Lighting of Bunsen

Ensure hole closed (1)

Strike match before gas turned on (1)

Turn on gas and light simultaneously (1)

Adjust flame (1)

Close hole and turn off gas to extinguish flame (1)

CFL Skills:

Careful use of equipment (1)

Leaves workstation tidy (1)

LAB 10: REACTIVITY OF METALS

SUGGESTED SKILLS: ORR/AI/MM

Title: Reactivity of metals

Aim: To deduce the reactivity of metals by the reaction with dilute HCl

Apparatus/Materials: Magnesium ribbon (one 2cm strip), Iron filings (half-a-spatula), Copper turnings/powder (half-a-spatula), splint, test tubes, stoppers, dilute HCl

Method:

1. Place about 5 cm^3 of acid into a test tube.
2. Place the magnesium ribbon into the test tube of acid and insert stopper. Observe.
3. Remove stopper and immediately place a lighted splint at the mouth of the tube.
4. Repeat procedure using other metals.
5. Record all observations in a table.

Observations:

TABLE SHOWING ____

Metal	**Observations**	**Equations**

Discussion:

Include in your discussion:

Relevant background information of the reactivity of metals

Explain your observations, in terms if reactivity of metals

State the order of reactivity of the metals from highest to lowest

State any Sources of Error/Precautions/Assumptions with regards to this experiment.

Conclusion: Relate to the aim

Reflections: How has doing this investigation impacted you?

Redox Reactions and Electrolysis

Contributed by A. Bowman & S. Shallow

LAB 11: ELECTROLYSIS

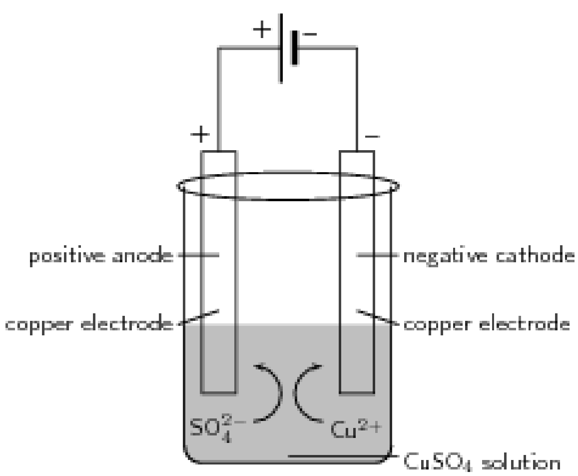
SUGGESTED SKILLS: ORR/AI

Title: Electrolysis

Aim: To investigate electroplating using copper electrodes and copper (II) sulfate solution.

Materials/Apparatus: $100cm^3$ beaker, 6V battery, connecting wires (crocodile clips), 1mol dm^3 copper (II) sulfate solution, pure copper wires (wrap these wires around a pencil to form coils to be used as the electrodes), ammeter, balance, scotch tape, Stop watch

Diagram of Apparatus:



Method:

1. Label the copper coils anode and cathode.
2. Using the balance find the mass of the two copper coils and record their masses.
3. Connect the coils using the connecting wires to the battery so that the anode is connected to the positive terminal end of the battery and the cathode to the negative end.
4. Using the scotch tape fix the coils inside the beaker opposite each other. Ensure they are pointing downwards and are not touching each other and the sides of the beaker.
5. Pour approximately $80cm^3$ of the copper(II) sulfate solution into the beaker containing the coils. Ensure that the coils are covered with the solution.
6. Close the circuit by connecting the two ends of the connecting wires to the battery terminals using scotch tape and start the stopwatch. Ensure the ammeter is placed in series in the circuit. Measure and record the current in the circuit
7. After ten (10) minutes remove the coils from the solution and turn the circuit off. Measure and record the mass of the coils .Record all other observations.

Observation/Results

Electrodes	Mass before placed in the cell (g)	Mass after placed in the cell (g)	Difference in mass (g)	Observations of the electrodes
Anode				
Cathode				

Treatment of Results:

1. What are the ions in the electrolyte?
2. Which ions would be discharged? Explain
3. Explain the process that took place at the cathode
4. Write half ionic equations for the reactions occurring at the anode and cathode
5. Calculate the difference in masses of the anode and cathode before and after it was placed in the solution with the circuit turned on.
6. Using the current and time calculate the mass of copper expected to be deposited. Compare this mass to the actual mass of copper that was deposited. Account for the differences.
7. Give all limitations and errors in the lab

LAB 11: SAMPLE MARK SCHEME

SKILL: ORR (14 marks)

Reporting:

Logical sequence of report , i.e. all sections included and in correct order (1)

Correct content under headings (1)

Report written in past tense (1)

Method clearly described , i.e. correct sequence of steps (1)

Few (<3) grammatical error (1)

Diagram:

Diagram of apparatus neatly drawn (1)

Diagram of apparatus correctly labelled (1)

Diagram appropriately titled (1)

Table:

Table closed (1)

Units in column heading (1)

All numeric values to the same number of decimal places (1)

Table appropriately titled (1)

Observations:

Thinness at anode (1)

Deposit at cathode (1)

LAB 11: SAMPLE MARK SCHEME

SKILL: AI (11 marks)

SKILL: AI

Calculate the difference in mass at cathode (1)

Calculate the difference in mass at anode (1)

Define electrolysis (1)

Identify ALL the ions in the electrolyte (2)

- Identify 2 or less (1)

Identify the ions discharged and explain why (2)

Write the half equation at the cathode (1)

Write the half equation at the anode (1)

Limitations noted (1)

Suitable conclusion (1)

LAB 12: INVESTIGATING CONDUCTIVITY

SUGGESTED SKILLS: ORR/AI

Title: Investigating Conductivity

Aim: To investigate the electrical conductivity of various substances.

Materials/Apparatus:

Substances to be tested: copper wire, magnesium ribbon, aluminum foil, zinc rods, iron rods, wooden ruler, plastic ruler, copper(II) sulfate salt, copper(II) sulfate solution, sodium chloride salt, sodium chloride solution, ethanol, kerosene, sugar and sugar solution.

Materials to make the circuit: 6V battery, connecting wire, ammeter, beaker, graphite rods, bulb

Diagram of Apparatus: (Teacher may insert appropriate diagrams here)

Method:

1. Make a table with four (4) columns headed 'Substances Tested', 'Type of Bonding', 'Prediction of Electrical Conductivity' and 'Electrical Conductivity'
2. Set up two circuits as shown in the diagram above. Use apparatus 1 for the solid substances and apparatus 2 for the liquid substances
3. Test the substances using the appropriate circuit an record the observations

Observations/Results:

Substances Tested	Type of Bonding	Prediction of Electrical Conductivity	Electrical Conductivity X If bulb did not light √ If bulb light

Discussion:

1. Compare your results with your predictions
2. Define metallic and electrolytic conduction
3. Classify the substances tested as having metallic conduction or electrolytic conduction. Explain your answer

Conclusion: Relate to the aim

Reflections:

LAB 12: SAMPLE MARK SCHEME

SKILL: AI (11 marks)

Define metallic conduction (1)

Define electrolytic conduction (1)

Classify the substances as conductors or non-conductors (5)

13-15 correct – 5

10-13-4

7-9-3

4-6-2

Classify the conductors as metallic or electrolytic (3)

5 or more-3

3 to 5- 2

1 to 2- 1

Limitations noted (1)

Suitable conclusion (1)

Qualitative Analysis

Contributed by K. Lynch, S. De Freitas & R. Frederick

LAB 13: IDENTIFYING CATIONS

SUGGESTED SKILLS: ORR/AI

TITLE: IDENTIFYING CATIONS

AIM: To identify cations

APPARATUS/MATERIALS: salts containing calcium, aluminium, zinc, lead (II), iron (II), iron (III), copper (II) and ammonia ions, sodium hydroxide solution, aqueous ammonia, potassium iodide solution, a piece of red litmus paper and test tubes

METHOD:

- Carefully place a very small spatula of each salt into a separate test tube. Add 2cm3 of distilled water to each tube and shake to dissolve the salt.
- Label the tube with the symbol of the cation it contains.
- Add a few drops of sodium hydroxide solution to each tube. Observe the colour of the precipitate.
- Add excess sodium hydroxide solution to each tube and see if the precipitate dissolves.
- If no precipitate forms, gently heat the contents of the test tube and test for ammonia gas by placing a piece of red litmus paper across the mouth of the test tube.

- Record your results in a table using the following headings for columns: cation, colour of precipitate on addition of sodium hydroxide dropwise, ionic equation for the reaction occurring, solubility of the precipitate on adding excess sodium hydroxide solution.
- Repeat the steps replacing sodium hydroxide with aqueous ammonia.
- Place small spatulas of the salts containing aluminium and lead (II) ions in two separate test tubes. Add 2cm3 of distilled water to each and shake to make solutions.
- Add a few drops of potassium iodide solution to each and look for a precipitate forming. Record the colour of the precipitate.

DISCUSSION:

1. Explain why some of the cations' precipitate dissolved when excess sodium hydroxide was added while others did not.
2. Explain why the precipitates dissolved when excess aqueous ammonia was added.
3. State which cation(s) do not form a precipitate with sodium hydroxide then state if ammonia is given off and why.

CONCLUSION: Relate to the aim

LAB 13: SAMPLE MARK SCHEME

SKILL: ORR (30 marks)

Cation	Observations				Total marks
	NaOH (drop wise)	**NaOH (excess)**	**NH_4^+ (drop wise)**	**NH_4^+ (excess)**	
Ca^{2+}	White precipitate (1)	Precipitate is insoluble in	No precipitate (1)	-	3

		excess (1)			
Al^{3+}	White precipitate (1)	Soluble in excess (1)	White precipitate (1)	Insoluble in excess so it remains (1)	4
Pb^{2+}	White precipitate (1)	Soluble in excess (1)	White precipitate (1)	Insoluble in excess so it remains (1)	4
Fe^{2+}	Dirty green precipitate, turns brown on standing (1)	Insoluble in excess (1)	Green precipitate, turns on standing (1)	Insoluble in excess (1)	4
Fe^{3+}	Red brown precipitate (1)	Insoluble in excess (1)	Red brown precipitate (1)	Insoluble in excess (1)	4
Cu^{2+}	Blue precipitate (1)	Precipitate is soluble (1)	Blue precipitate (1)	Soluble in excess to form a deep blue solution (1)	4
NH_4^+	No precipitate formed. NH_3 gas produce- turns red litmus blue. (2)				2
RECORDING					
Neatly constructed with four distinct sides Any side missing					1 0
REPORTING					
Report in logical sequence Incorrect sequence					1 0
Apparatus and materials listed					1
Grammar (3) -subject verb agreement (no more than three errors) -correct tense (no more than three errors) -correct sentence structure (no more than three errors)					 1 1 1

Total = 30 marks
Final mark = $\frac{mark\ obtained}{30}$ x 10

LAB 14: IDENTIFYING ANIONS

SUGGESTED SKILLS: ORR/AI

TITLE: Identification of Anions

AIM: To identify the halides in unknown solutions A, B and C.

APPARATUS/ MATERIALS: clean, dry test tubes, test tube holder and rack, silver nitrate, dilute ammonia, dropper, unknown solutions A, B and C.

METHOD:

1. Collect the unknown solutions A, B and C.
2. Place a small amount of unknown solution A into a test tube.
3. Place 3 drops of silver nitrate into the test tube A.
4. Observe precipitate and expose to sunlight.
5. Add dilute ammonium to test tube A and observe.
6. Repeat experiment for unknown B and C.
7. Record observations in a table format and identify the unknown solutions. Give the ionic equation for each halide.

DISCUSSION:

Complete the deductions section of the table.

CONCLUSION: Relate to aim

REFLECTION:

LAB 14: SAMPLE MARK SCHEME

SKILL: ORR (15 marks)

Unknown Solution	Silver Nitrate	Dilute Ammonium	Marks
A (Cl^-)	White precipitate Turns light purple in sunlight.	Precipitate dissolves	2
B (Br^-)	White to off-white precipitate	Precipitate partially dissolves	2
C (I^-)	Pale yellow precipitate	Precipitate remains	2
RECORDING			
-Table neatly constructed with four distinct sides -Table title clear and self-explanatory -Table title underlined. -Table title capitalized.			1 1 1 1
REPORTING			
Report in logical sequence Incorrect sequence			1 0
Apparatus and materials listed			1
Grammar (3) -subject verb agreement (no more than three errors) -correct tense (no more than three errors) -correct sentence structure (no more than three errors)			 1 1 1
Total = 15 marks Final mark = $\frac{mark\ obtained}{15}$ x 10			

LAB 14: SAMPLE MARK SCHEME

SKILL: AI (9 marks)

Identification of Anions A/I

Unknown Solution	Inference	Ionic Equation	Marks
A	Chlorine is present (1)	$Ag^+ (aq) + Cl^- (aq) \rightarrow AgCl(s)$ Correct ionic equation (1) Correct state symbols (1)	3
B	Bromine is present (1)	$Ag^+ (aq) + Br^- (aq) \rightarrow AgBr(s)$ Correct ionic equation (1) Correct state symbols (1)	3
C	Iodine is present (1)	$Ag^+ (aq) + I^- (aq) \rightarrow AgI(s)$ Correct ionic equation (1) Correct state symbols (1)	3
Total = 9 marks Final mark = $\frac{mark\ obtained}{9}$ x 10			

LAB 15: IDENTIFYING GASES

SUGGESTED SKILLS: ORR/MM/AI

TITLE: IDENTIFYING GASES

AIM: To identify gases

APPARATUS/MATERIALS: ammonium carbonate, magnesium nitrate, lime water, red and blue litmus, dry cobalt paper, tweezers, wooden splint, test tubes, test tube with cork and delivery tube

METHOD:

- Place a spatula full of ammonium carbonate into a dry test tube and place the cork with the delivery tube into the test tube. Place about 2cm3 of lime water into another test tube.
- Heat the test tube gently using a Bunsen flame. While heating, hold a piece of moist red litmus paper across the end of the delivery tube using the tweezers. Observe the change in colour of the paper.
- While still heating the tube, place a piece of dry cobalt chloride paper across the end of the delivery tube. Observe the change in colour of the paper.
- While still heating the tube, bubble the gas into the lime water. Observe what happens in the lime water.
- As you are heating, observe what happens to the ammonium carbonate in the test tube.
- Identify the three gases that are produced when ammonium carbonate is heated. Hence, write an equation for the decomposition of ammonium carbonate.
- Place a small spatula full of magnesium nitrate into another dry test tube.
- Heat the test tube gently using a Bunsen flame and as soon as a brown gas is seen, slowly insert a glowing splint into the tube. Observe what happens to the splint.
- While still heating, place a piece of moist blue litmus paper into the brown gas. Observe the change in the colour of the paper.

QUESTIONS:

1. Explain why the quantity of ammonium carbonate decreased as it was heated and possibly disappeared completely.
2. Identify the two gases produced when magnesium nitrate is heated. Given that the solid remaining is magnesium oxide, write a balanced equation for the reaction.

LAB 15: SAMPLE MARK SCHEME

SKILL: MM (9 marks)

Apparatus	Marks
Bunsen Burner	
-Tubing placed securely over gas outlet - Air hole closed before lighting - Match lit before gas turned on - Air hole opened to obtain a non-luminous flame - Flame controlled by adjusting gas tap	1 1 1 1 1
Measuring Cylinder	
-Measuring cylinder is on a flat surface -Measurement is read at eye level -Value is taken from the bottom of the meniscus - Measurement value is correct	1 1 1 1
Total mark = 9 Final mark = $\frac{mark\ obtained}{9}$ x 10	

LAB 15: SAMPLE MARK SCHEME

SKILL: ORR (9 marks)

Salt	Observation	Marks
Ammonium Carbonate - Red Litmus - Cobalt Chloride - Lime water	 - Turns red litmus blue -Turns cobalt chloride paper pink -Lime water turns milky	 1 1 1
Magnesium Nitrate - Splint test - Blue Litmus	 - Relights splint - Turns blue litmus red	 1 1
RECORDING		
-Table Neatly constructed with four distinct sides -Table title clear and self-explanatory -Table title underlined.		1 1 1

-Table title capitalized.	1
REPORTING	
Report in logical sequence Incorrect sequence	1 0
Apparatus and materials listed	1
Grammar (3) -subject verb agreement (no more than three errors) -correct tense (no more than three errors) -correct sentence structure (no more than three errors)	 1 1 1
Total = 14 marks Final mark = $\frac{mark\ obtained}{14}$ x 10	

LAB 15: SAMPLE MARK SCHEME

SKILL: AI (11 marks)

Salt	Observation	Inference	Marks
Ammonium Carbonate - Red Litmus - Cobalt Chloride - Lime water	- Turns red litmus blue -Turns cobalt chloride paper pink -Lime water turns milky	NH_4+ present H_2O present CO_2 present	1 1 1
Magnesium Nitrate - Splint test - Blue Litmus	- Relights splint - Turns blue litmus red	O_2 present NO_2 present	1 1
Equation for decomposition of ammonium carbonate	$(NH_4)_2CO_3(s) \rightarrow 2NH_3(g) + CO_2(g) + H_2O(l)$ 1 mark for correct formula 1 mark for balanced equation		2
Equation for decomposition of	$2Mg(NO_3)_2(s) \rightarrow 2MgO(s) + 4NO_2(g) + O_2(g)$ 1 mark for correct formula		2

magnesium nitrate	1 mark for balanced equation	
Equation for reaction of carbon dioxide with lime water	$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$ 1 mark for correct formula 1 mark for balanced equation	2
Total = 11 marks Final mark = $\frac{mark\ obtained}{11}$ x 10		

LAB 16: IDENTIFYING GASES

SUGGESTED SKILLS: ORR/MM/AI

TITLE: QUALITATIVE ANALYSIS

AIM: (*Create a suitable aim for this section)*

APPARATUS AND MATERIALS: Acidified silver nitrate solution, acidified Barium chloride solution, sodium hydroxide solution, red litmus paper, blue litmus paper Splint, aqueous ammonia, test tubes, test tube holder, matches, Bunsen burner, distilled water,
potassium iodide solution
Compound M

METHOD:
1. Heat a sample of M in a dry test tube.
2. Add a few drops of sodium hydroxide to Solid M and heat.
   Dissolve a sample of M in distilled water and divide the solution into 5 parts.
3. To one part add acidified silver nitrate solution.
4. To another add acidified barium chloride solution.
5. To another add sodium hydroxide solution until in excess.
6. To another add aqueous ammonia until in excess.
7. To another add a few drops of potassium iodide solution.

RESULTS: *Create a suitable table to record your tests, observations and inferences.*

NB: *There is no need for a discussion for a qualitative analysis, since you should have an inference column where you analyze your observations.*

CONCLUSION: Identify the three aqueous solutions.

REFLECTION:

LAB 16: SAMPLE MARK SCHEME

SKILL: ORR (15 marks)

(M = Aluminium ammonium sulfate)

	Test	**OBSERVATION**	ORR
a	Heated sample of M	White sublimate , gas given off turned moist red litmus paper blue	(1) (1)
b	M + acidified silver nitrate	No precipitate	(1)
c	M + $NaOH$, then in "xs"	White precipitate, soluble in excess	(1) (1)
d	M + $BaCl_2$(aq)	White precipitate	(1)
e	M + $NH_3(aq)$, then in "xs"	White precipitate , insoluble in excess	(1) (1)
f	M + $KI(aq)$	No yellow precipitate	(1)
	RECORDING		
g	Neatly constructed with four (4) distinct sides Any side missing		(1) (0)
h	Appropriate title		(1)
	REPORTING		
i	Report in a logical sequence (title, aim..) Wrong sequence		(1) (0)
j	Apparatus and material listed		(1)
k	Write up (2 marks) - Past tense - No pronouns		 (1) (1)
	Total = 15 marks Final mark = $\frac{mark\ obtained}{15}\ x\ 10$		

Volumetric Analysis

Contributed by R. Frederick

LAB 17: VOLUMETRIC ANALYSIS (Experiment 1)

SUGGESTED SKILLS: ORR/MM/AI

Title: Volumetric Analysis - Experiment 1

Aim: To find the concentration of a solution of sodium hydroxide by a titration method, using hydrochloric acid.

Apparatus and materials:

- Solution containing approximately 4 g dm^{-3} sodium hydroxide
- 0.1 mol dm^{-3} hydrochloric acid, accurately standardized
- Methyl orange or screened methyl orange indicator
- Conical flasks
- 50 cm^3 burette
- 25 cm^3 pipette

Procedure:

(a) Wash the burette thoroughly with a liquid detergent. Wash it with tap water, then with distilled water and finally rinse it with the hydrochloric acid solution. Fill the burette to a convenient graduation mark with hydrochloric acid. Record this reading.

(b) Pipette 25.0 cm^3 of the sodium hydroxide solution into a conical flask, add 1 – 2 drops of indicator, and add hydrochloric acid from the burette until the end-point is reached. Record the burette reading.

(c) Repeat the titration as many times as convenient, until consecutive burette readings differ by no more than ± 0.10 cm^3.

Treatment of results

(a) Tabulate your results as follows:

Burette readings/ cm³	Rough	1	2
At end of titration			
At start of titration			
Volume of HCl used/cm³			

(b) Using the values for the accurate titration only, find the average volume of hydrochloric acid that just neutralizes 25.0 cm^3 of the sodium hydroxide solution:

Average titration: V cm^3 of HCl (aq) = 25.0 cm^3 of NaOH (aq)

(c) Find the number of moles of hydrochloric in the average volume used

No. of mol of HCl = (Vol. of HCl (aq) x Concentration) / 1000

(d) From the equation, one mole of HCl reacts with one mole of NaOH. Use this information to find the number of moles of NaOH in 25.0 cm^3 of the solution.

(e) Using your answer to (d), find the concentration of the NaOH(aq) in both mol dm^{-3} and g dm^{-3}.

References:

Norman Lambert, Marine Mohammed. 1987. Practical Chemistry for CXC. England. Heinemann

LAB 17: SAMPLE MARK SCHEME

SKILL: MM (20 marks)

Use of pipette:

a) Rinse pipette with distilled water then solution with which it is to be filled (1)
b) Keep tip below level of liquid (1)
c) Pipette solution ensuring to avoid air bubbles (1)

d) Adjust level of meniscus with forefinger (1)
e) Hold pipette by stem and not by bulb (1)
f) Read at eye level and ensure bottom of meniscus is level with mark (1)
g) Remove all clinging drops by touching tip to beaker (1)

Use of burette:

a) Rinse burette with liquid with which it is to be filled, throw away the rinse(1)
b) Filling – use the funnel (1)
c) Filling – remove funnel immediately after use (1)
d) Ensure tip is full of liquid (1)
e) Ensure there are no air bubbles (1)
f) Reading – ensure burette is erect/not tilted (1)
g) Read at eye level (1)
h) Read bottom of meniscus for all readings (1)
i) Manipulating – correctly position fingers and thumbs around the tap (1)

Care for laboratory skills (1 mark each):

a) Care taken when using apparatus

b) Maintains a clean work station

c) Keeps workstation and writing station separate

d) Adheres to laboratory protocols

Total marks = 20 marks

Some additional points which may be assessed are:

- Correct reading of burette
- Ability to deliver one drop of solution

LAB 17: SAMPLE MARK SCHEME

SKILL: AI (10 marks)

MARK SCHEME (AI)

(a) Find the average of volume of hydrochloric acid (2)
- Selecting the appropriate volume of acid used, readings differ by no more than $\pm$ 0.10 cm^3(1)
- Average of acid (1)

(b) Find the number of moles of hydrochloric acid in the average volume used (2)
- Correct working (1)
- Correct unit (1)

(c) Write balanced chemical equation with state symbols (2)
- Correct reactants and products (1)
- Correctly balanced (1)

(d) Find the number of moles of NaOH in 25.0 cm^3 of the solution. (2)
- Working (1)
- Answer with unit (1)

(e) Find the concentration of sodium hydroxide in mol dm^{-3} (1)

(f) Find the mass concentration of sodium hydroxide g/dm^3 (1)

Total marks = 10 marks

LAB 18: VOLUMETRIC ANALYSIS 2

SUGGESTED SKILLS: ORR/MM/AI

Title: Volumetric Analysis 2

Aim: To find the concentration of sodium carbonate solution

Apparatus and materials:

- Solution containing approximately 5.3 g dm^{-3} anhydrous sodium carbonate

- 0.1 mol dm^{-3} hydrochloric acid, accurately standardized
- Methyl orange or screened methyl orange
- 250 cm^3 conical flasks
- 50 cm^3 burette
- 25 cm^3 pipette

Procedure

(a) Rinse a clean burette with hydrochloric acid, then fill it with the same solution to a convenient graduation mark. Record the burette reading.

(b) Rinse a clean 25 cm^3 pipette with sodium carbonate solution, then fill it to the mark with the same solution. Transfer the sodium carbonate solution to a 250 cm^3 conical flask and add 1 – 2 drops of indicator.

(c) Titrate the sodium carbonate solution against the hydrochloric acid until the end-point is reached.

(d) Repeat the titration until consecutive burette readings differ by no more than ± 0.10 cm^3.

Treatment of results

(a) Tabulate your results as follows:

Burette readings/ cm^3	Rough	1	2
At end of titration			
At start of titration			
Volume of HCl used/cm^3			

(b) Using the values for the accurate titration only, find the average volume of hydrochloric acid that just neutralizes 25.0 cm^3 of the sodium carbonate solution:

Average titration: V cm^3 of HCl (aq) = 25.0 cm^3 of Na_2CO_3 (aq)

(c) Find the number of moles of hydrochloric in the average volume used

No. of mol of HCl = (Vol. of HCl (aq) x Concentration) / 1000

(d) From the equation find the number of moles of Na_2CO_3 (aq) in 25.0 cm^3 of the solution.

(e) Using your answer to (d), find the number of moles of Na_2CO_3(aq) in 1000 cm^3 of solution.

References:

Norman Lambert, Marine Mohammed. 1987. Practical Chemistry for CXC. England. Heinemann

LAB 18: SAMPLE MARK SCHEME

SKILL: MM (10 marks)

MARK SCHEME (MM)

(see mark scheme for Lab 17 MM)

LAB 18: SAMPLE MARK SCHEME

SKILL A(10 marks)

(a) Find the average of volume of hydrochloric acid (2)
- Selecting the appropriate volume of acid used, readings differ by no more than $\pm$ 0.10 cm^3(1)
- Average of acid (1)

(b) Find the number of moles of hydrochloric acid in the average volume used (2)
- Correct working (1)
- Correct unit (1)

(c) Write balanced chemical equation with state symbols (2)

- Correct reactants and products (1)
- Correctly balanced (1)

(d) Find the number of moles of Na_2CO_3 in 25.0 cm^3 of the solution. (2)

- Working (1)
- Answer with unit (1)

(e) Find the concentration of sodium carbonate in mol dm^{-3} (1)

(f) Find the mass concentration of sodium carbonate g/dm^3 (1)

Total marks = 10 marks

LAB 19: VOLUMETRIC ANALYSIS 3

SUGGESTED SKILLS: ORR/MM/AI

Title: Volumetric Analysis 3

Aim: To find the concentration of potassium manganate (VII) solution

Apparatus and materials:

- Solution containing 35.0 g dm^{-3} of ammonium iron (II) sulfate, made by dissolving the salt in 200 cm^3 of 2 mol dm^{-3} sulfuric acid, then making up to 1 dm^3 with distilled water
- Potassium manganate (VII) solution, about 3.2 g dm^{-3}
- 2 mol dm^{-3} sulfuric acid
- Burette
- Pipette
- Conical flasks

Procedure:

(a) Pipette 25.0 cm^3 of ammonium iron (II) sulfate solution into a conical flask. Add an equal volume of 2 mol dm^{-3} sulfuric acid (using a measuring cylinder) and titrate the mixture against the potassium manganate (VII) to the first permanent pink end-point.

Note: Because of the intense colour of the manganate (VII) solution, it may be necessary to read the top of the meniscus in the burette.

(b) Repeat the titration until consecutive burette readings differ by no more than 0.10 cm^3

Treatment of Results

(a) Display your titration results in a table and find the average volume of potassium manganate (VII) required to oxidize 25 cm^3 of the iron (II) solution in the presence of dilute sulfuric acid.

(b) Calculate:

$$1\ mol\ MnO_4^- \equiv 5\ mol\ Fe^{2+}$$

(i) The number of moles of ammonium iron (II) sulfate, $(NH_4)_2Fe(SO_4)_2.6H_2O$, in 1 dm^3 of solution.

(ii) The number of moles of ammonium iron (II) sulfate used in the titration.

(iii) The number of moles of potassium manganate (VII) in the average volume used.

(iv) The number of moles of the potassium manganate (VII) in 1 dm^3 of the solution.

(v) The mass concentration of the potassium manganate (VII) solution,

(vi) The volume in dm^3 of the potassium manganate (VII) solution which contains 15g of $KMnO_4$;

(vii) The number of moles of potassium ions present in the solution of potassium manganate (VII).

References:

Norman Lambert, Marine Mohammed. 1987. Practical Chemistry for CXC. England. Heinemann

LAB 19: SAMPLE MARK SCHEME

SKILL: MM (16 marks)

MARK SCHEME (M&M)

See mark scheme for lab 17 MM

LAB 19: SAMPLE MARK SCHEME

SKILL: AI (8 marks)

MARK SCHEME (A&I)

a) The number of moles of ammonium iron (II) sulfate, $(NH_4)_2Fe(SO_4)_2.6H_2O$, in 1 dm^3 of solution. (1)

b) The number of moles of ammonium iron (II) sulfate used in the titration. (1)

c) The number of moles of potassium manganate (VII) in the average volume used. (1)

d) The number of moles of the potassium manganate (VII) in 1 dm^3 of the solution. (1)

e) The mass concentration of the potassium manganate (VII) solution. (2)

- Working (1)
- Correct unit (1)

f) The volume in dm^3 of the potassium manganate (VII) solution which contains 15g of $KMnO_4$; (1)

g) The number of moles of potassium ions present in the solution of potassium manganate (VII). (1)

Total marks = 8 marks

Rates of Reaction

Contributed by J. King & F. Snagg

LAB 20: PARTICLE SIZE & RATES OF REACTION

SUGGESTED SKILLS: ORR/MM/AI

Introduction:

Does particle size really affect the rate of a reaction? In this experiment we will explore this by using a 3cm strip of magnesium ribbon versus a 3cm strip of magnesium ribbon cut into several pieces.

Magnesium reacts with hydrochloric acid to produce hydrogen gas. By measuring the volume of gas evolved over regular time intervals we can determine the rate of this chemical reaction.

Note to teachers: The lab below is showing how the experiment can be done using either a gas syringe or measuring cylinder and trough. Choose the set-up which is more feasible based on the equipment available.

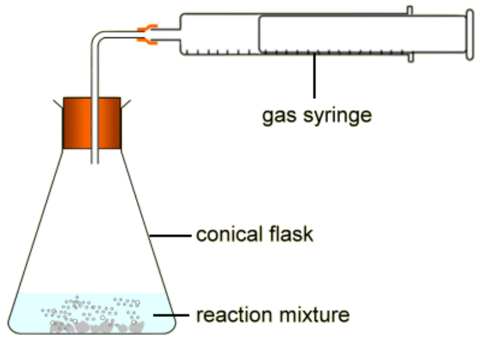
Title: Investigating how particle size affects the rate of reaction

Aim: To investigate how the particle size of magnesium affects the rate of its reaction with hydrochloric acid.

Apparatus/Materials for <u>diagram 1</u>: 100cm^3 conical flask, 100cm^3 measuring cylinder, single-holed rubber bung with delivery tube to fit, 100cm^3 gas syringe, two strips of magnesium ribbon (3cm each), dilute hydrochloric acid (1M), retort stand with clamp, stop clock.

Apparatus/Materials for <u>diagram 2</u>: 100cm^3 conical flask, single-holed rubber bung with delivery tube to fit, two 100cm^3 measuring cylinders, trough, two strips of magnesium ribbon (3cm each), dilute hydrochloric acid (1M), retort stand with clamp, stop clock.

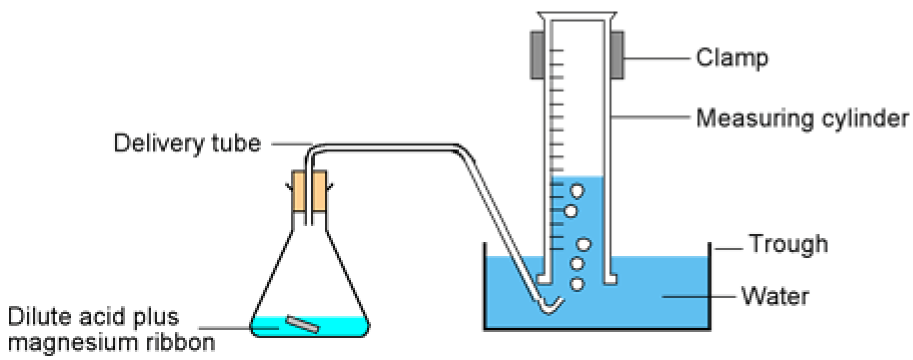
Diagrams:



(image source: SlidePlayer, LianiSudjarwadi)

DIAGRAM 1: SHOWING EXPERIMENTAL SET-UP USING A GAS SYRINGE

OR



(image source: Island Physics, Lee Page)

DIAGRAM 2: SHOWING EXPERIMENTAL SET-UP WITH MEASURING CYLINDER

Procedure:

1. Measure 50cm³ HCl (aq) using the measuring cylinder. Pour the acid into the clean conical flask.

2. Set up the apparatus as shown in the relevant diagram (1 or 2).

3. Add a 3cm strip of magnesium ribbon to the conical flask, quickly stopper the flask and start the stop clock.
4. Record the volume of gas given off at suitable time intervals (e.g. every 30s).
5. Continue timing and recording until no more gas is given off.
6. At the end of the experiment rinse the conical flask and repeat step 1.
7. Cut the second strip of magnesium ribbon into 10 pieces.
8. Repeat from step 3 onwards this time using the magnesium pieces.
9. Tabulate all relevant results.

Observations: Record relevant observations

Results: Show data collected in suitable forms (tables and a graph suggested).

Discussion:

1. Give brief background information on how particle size affects the rate of reaction.
2. Explain your observations briefly, including a suitable equation for the reaction taking place.
3. Interpret the shapes of the curves.
4. State and discuss possible sources of error (if any).

Conclusion: Relate to aim (i.e. How does particle size affect the rate based on your experimental findings?)

LAB 20: SAMPLE MARK SCHEME

SKILL: ORR (27 marks)

SUGGESTED POINTS FOR AN ORR MARK SCHEME

Observation (**4mrks**: 1 mk for any of the following or any other relevant observation)

Relevant before observation (max of 1 mk)

A colourless gas evolves

The reaction is vigorous

The magnesium dissolves completely

A colourless solution remains

Recording:

Table

Table is neatly constructed (i.e. completely boxed in with all sections distinct) **(1mk)**

Table has a self-explanatory title **(1mk)**

Table's heading show appropriate units **(1mk)**

Graph

Graph has a self-explanatory title (**1mk**)

Axes lines are drawn (**1 mk**)

Axes are labelled with units (**2mks**)

- Both labelled but without units (1mk)
- Only one labelled with units (1mk)
- No marks awarded for one label without unit or units with labels

Graph has a correct scale (**1mk**)

Graph has a clear key to distinguish the two curves **(1mk)**

Points are correctly plotted for both curves (**4 mks**: 2mks for each curve)

- Deduct 1 mk if over two points are incorrect per curve
- No marks awarded for over two points are incorrect per curve

Student has drawn smooth curves (**2 mks**: 1 mk each)

Curves are neatly drawn (i.e. using a well sharpened pencil) (**1mk**)

Reporting

All sections and headings are included **(1mk)**

The lab format is correct **(1mk)**

Each section is used appropriately **(2mks)**

- Over two sections used inappropriately, no marks
- Only one section used inappropriately (1mk)

The method is recorded in past tense (1mk) and is grammatically correct (1mk) **(2 mks)**

The lab report is concise **(1mk)**

LAB 21: THE RATE OF DIFFUSION

SUGGESTED SKILLS: ORR/MM/AI

Lab 17

Note to teacher: The grid provided is incomplete. Prior to experiment, measure the distance between the central dot and each circle in cm, have students write the value in space provided on grid.

Make KI solution of an appropriate concentration that the iodine pellet can be observed dissolving gradually.

Introduction: Diffusion is the movement particles from a region of high concentration to a region of low concentration until evenly distributed. The rate of diffusion may be affected by a number of factors. One such factor is temperature. In this experiment you will be investigating how temperature affects the rate of diffusion of iodine when dissolving in potassium iodide solution.

Title: The Rate of Diffusion

Aim:

Apparatus/Materials: One iodine pellet, dilute KI (aq), 400ml beaker, a straw, a pair of tweezers, thermometer, stop watch, 100ml measuring cylinder, concentric grid (provided below)

Diagram:

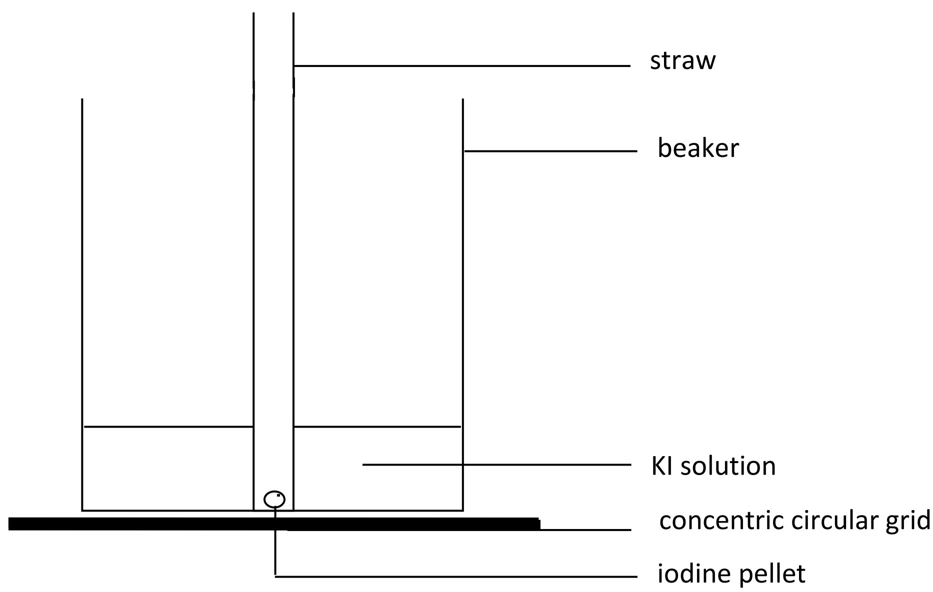


DIAGRAM SHOWING RATE OF DIFFUSION EXPERIMENTAL SET-UP

Method:

1. Measure $25cm^3$ of room temperature KI (aq) using a measuring cylinder and use a thermometer to record the temperature of the KI (aq).
2. Place empty beaker over circular grid provided, ensuring that the dot is central.
3. Place the straw into beaker and ensure that the straw's opening surrounds the dot.
4. Using the pair of tweezers add one iodine pellet into the beaker via the straw. DO NOT MOVE THE STRAW.
5. Slowly add the 25 cm^3 of the KI (aq) into the beaker.
6. Slowly remove the straw leaving behind the pellet at the centre. Immediately start the timer.
7. Measure the distance traveled by the iodine every 30s for a maximum of 5 minutes. Record the results in a suitable table.
8. Repeat the experiment using potassium iodide solution which has been heated to 40˚C.
9. Record all observations and results.

Observations: Write a paragraph describing all relevant observations.

Results: Construct TWO tables, each having 3 columns showing the: Time (s); Diffusion distance(cm); Rate of diffusion (cm/s). The first table will show the results using KI (aq) at room temperature and the second table will show the results using KI (aq) at 40˚C.

Use your results to construct a graph of Diffusion Distance vs. Time. Plot the two graphs on the same graph paper. Use a key to differentiate between the two temperatures.

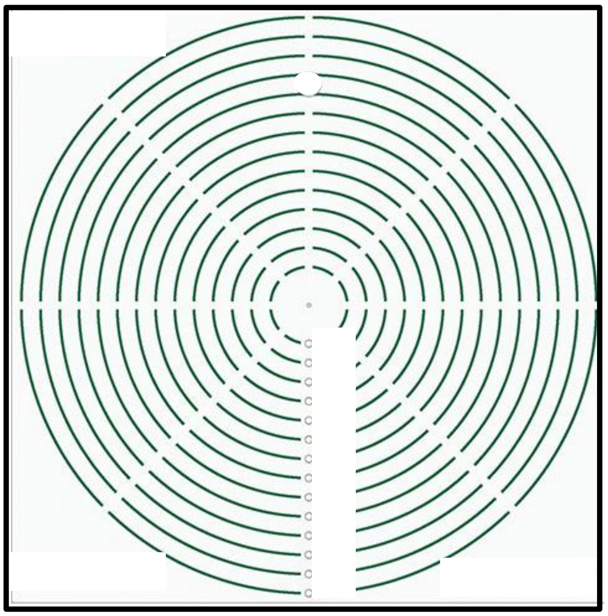
Discussion: Based on your experimental findings (observations, data and graphs), state how increasing the temperature affects the rate of diffusion.

Explain the above using your knowledge of kinetic energy and the movement of particles.

Suggest any possible source of error and how you could prevent this error.

Conclusion: State how increasing the temperature affects the rate of diffusion.

Write in the distance(cm) of each circle from the centre, then PLACE BEAKER OVER THIS GRID to carry out the experiment.



(image source: Circle Template Ruler Nifty Notions - 19)

LAB 21: SAMPLE MARK SCHEME

SKILL: AI (11 marks)

AI- Analysis & Interpretation

Aim (2mks)

To investigate how increasing the temperature affects the rate of diffusion. (2)

To investigate the rate of diffusion (1)

Discussion (7mks)

The movement of the iodine was observed because the particles moved from an area of high conc. to low concentration. **(1)**

The data shows that the rate is higher/less time is taken to reach a particular distance at 40°C than at rt. **(1)**

Graph is steeper at 40°C than graph at room temperature **(1)**

Iodine particles <u>move faster at 40°C than at rt</u> because they have <u>more kinetic energy</u>. **(2)**

Source of error **(2)**

Heat loss to the surroundings- use insulation to prevent heat loss

(2mks: 1mk-error; 1mk-prevention)

Any other relevant error and prevention (award the 2mrks)

Conclusion (2 marks)

As temperature increases the rate of diffusion increases. (2)

Temperature affects the rate of diffusion (1)

LAB 22: CONCENTRATION & THE RATES OF REACTION

SUGGESTED SKILLS: ORR/MM/AI

Introduction: When calcium carbonate chips react with hydrochloric acid, CO_2 gas is produced. Decreasing the concentration of the acid affects the rate of this reaction.

In this experiment we will be investigating how decreasing the concentration affects the rate of reaction by measuring the time taken for a specific volume of gas to be produced with different concentrations of hydrochloric acid.

Also consider the following during this experiment:

What are some of the variables that must be controlled during this experiment?

Why is it important to control these variables?

Note to teacher: This lab may be done as a demonstration with student volunteers or in large groups depending on the availability of resources and materials.

View lab here https://www.youtube.com/watch?v=E0bXd4zOXqA

Title: Investigating how Concentration Affects the Rate of Reaction

Aim: (insert)

Apparatus/Materials: Trough, 100cm^3 measuring cylinders (2), rubber tubing or delivery tube, retort stand and clamp, 250 cm^3 conical flask with single-holed rubber bung, marble chips (appr. 35g calcium carbonate in total), hydrochloric acid (2M), water, stop clock, scale or balance , watch glasses or beakers for weighing.

Diagram:

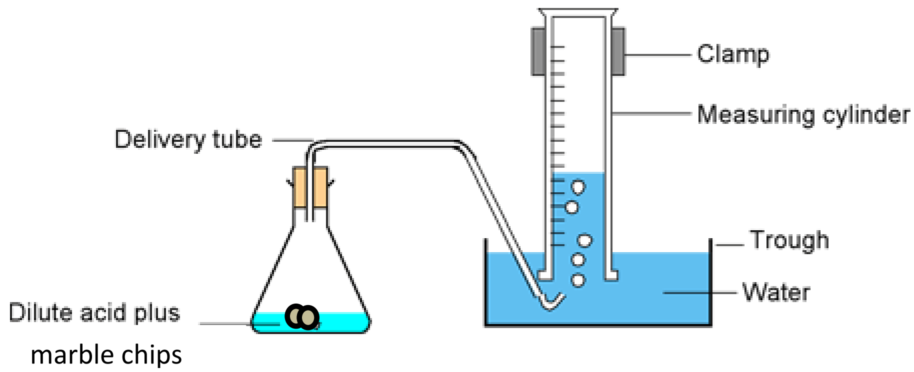


DIAGRAM SHOWING SET-UP OF APPARATUS USING A MEASURING CYLINDER

(image source: Island Physics, Lee Page)

Method:

1. Pre-weigh five batches of marble chips, each of approximately 7 grams.
2. Set up the apparatus as shown ensuring that the measuring cylinder is free of air bubbles.
3. Use a measuring cylinder to measure 50cm^3 of HCl (aq). Pour acid into a clean conical flask.
4. Add the first 7g of marble chips to the acid all at once, then quickly stopper the conical flask. Start the timer. Record how many seconds is taken for 100cm^3 of gas to evolve.
5. Rinse apparatus and repeat the experiment using the dilutions shown in the table below.
6. Tabulate all results.

TABLE SHOWING VOLUMES OF ACID AND WATER USED, INCLUDING THE TIME TAKEN FOR CO_2 GAS TO EVOLVE

Volume of Hydrochloric Acid/ cm^3	Volume of water/cm^3	Time Taken for 100cm^3 of gas to evolve/s

50	0	
40	10	
30	20	
20	30	
10	40	

Observations: state relevant observations here

Results: Construct and complete the above table

A suitable graph may also be constructed.

Discussion:

Give relevant background information. Include an equation for the reaction occurring.

Explain your experimental findings using your knowledge of the particulate theory, concentration and how reactions occur.

Discuss errors (if any).

Conclusion: How does deceasing the concentration affect the rate?

LAB 23: DISAPPEARING CROSS EXPERIMENT (Investigating Concentration)

SUGGESTED SKILLS: ORR/MM/AI

Title: The disappearing cross experiment

Aim: To investigate the effect of concentration on rate of reaction.

Apparatus: measuring cylinder, beaker, stop watch, 0.5 M sulfuric acid and 16.0 gdm-3 Sodium thiosulfate and sheet of paper with cross drawn on it.

Method:

Using a measuring cylinder, place 50cm3 of sodium thiosulfate solution into the beaker provided. Add 50 cm3 of sulfuric acid to this solution, noting the time that you do so. Place the beaker over the cross and record the time it takes for the cross to be no longer visible when viewed from above. Discard the mixture and wash the beaker. Repeat the procedure using the thiosulfate/water mixtures as outlined in the table below instead. Note in each case the time taken for the cross to be completely invisible. Plot a graph of volume of thiosulfate against time. Plot a second graph of thiosulphate against 1/time (rate).

Results:

Title of Table:____

Experiment number	Volume of Acid /cm^3	Volume of Thiosulfate /cm^3	Volume of water /cm^3	Time (t) /s	1/t /s^{-1}
1	50	50	0		
2	50	45	5		
3	50	40	10		
4	50	35	15		
5	50	30	20		
6	50	25	25		
7	50	20	30		

Discussion:

Define rate of reaction.

How is rate calculated?

Write a balanced equation for the reaction occurring.

How was volume used to manipulate concentration?

What is the effect of increasing concentration on rate of reaction? Explain why.

Comment on shape of graph.

State one possible error and limitation.

Conclusion: relate to aim

Reflection:

References:

Norman Lambert, Marine Mohammed. 1987. Practical Chemistry for CXC. England. Heinemann

LAB 23: SAMPLE MARK SCHEME

SKILL: ORR (10 marks)

Mark Scheme

CRITERIA	MARKS
OBSERVATION	
General increase in time taken for cross to be obscured as volume of water added increased	**2 (one outlier 1 mark, more than one 0 marks)**
RECORDING	
Complete table	**1**
Graph title present and appropriate	**1**
Axis labels (1 mark per axis)	**2**
Smooth curve taking up approximately 2/3 of graph paper	**1**
REPORTING	
All sections of report present	**1**
Report written in correct tense (past tense and passive voice)	**1**
Aim clearly stated	**1**

LAB 24: RATES OF REACTION

SUGGESTED SKILLS: P&D

Rates of Reaction- Planning and Designing Lab

Jackie suggests to the teacher that one of the factors that can affect the rate of a reaction is the level of reactivity of a metal. What do you think?

Plan and design an experiment to investigate what effect (if any) the reactivity of metals has on the rate of reaction.

LAB 25: CATALYSTS & RATES OF REACTION

SUGGESTED SKILLS: ORR/MM/AI

Another possible P and D

The decomposition of hydrogen peroxide occurs more rapidly when a catalyst is used. The decomposition reaction is shown in the equation below:

$$2\,H_2O_2\,(l) \xrightarrow{\text{catalyst}} 2\,H_2O\,(l) + O_2\,(g)$$

One common catalyst used for this decomposition is MnO_2 (manganese (IV) oxide) powder. It has been suggested that yeast will do a better job at catalysing this reaction. What do you think?

Plan and design an experiment to determine which of the two would be the better catalyst.

Energetics

Contributed by G. Bowman

LAB 26: ENERGY CHANGES

SUGGESTED SKILLS: ORR/MM/AI

Title: Energy Changes

Aim: To determine the type of reaction (endothermic/exothermic) involved in dissolving sodium hydroxide in water.

Material apparatus: Styrofoam cup, measuring cylinder, thermometer, watch glass, spatula, sodium hydroxide, triple beam balance.

Procedure:

1. Measure 50cm^3 of water and pour it into the Styrofoam cup. (Leave this to stand for a few minutes while you go on to the next step.)

2. Measure 2g of sodium hydroxide.

3. Measure and record the temperature (T_1) of the water in the Styrofoam cup.

4. Transfer the 2g of sodium hydroxide (all at once) to the water in the Styrofoam cup; stir the mixture while observing the temperature changes. Record the highest or lowest temperature (T_2) reached.

5. Wash up and put away all apparatus carefully.

Results:

Volume of water used: ________________ cm^3

Mass of sodium hydroxide used: ________ g

Initial temperature of water (T_1): ________ ^{0}C

Highest/lowest temperature (T_2) ________^{0}C

Exercise for AI:

1. Was there an increase or a decrease in temperature?
2. State whether the reaction was an endothermic or an exothermic reaction and give a reason?
3. State whether the ΔH value for this reaction is positive or negative and give a reason?
4. Calculate (a) the heat change for the reaction and (b) the heat change for dissolving 1 mole of sodium hydroxide in water.
5. State at least one assumption and one limitation.
6. Draw a fully labeled energy profile diagram for the reaction.

LAB 26: SAMPLE MARK SCHEMES

SKILL: MM (10 marks) /AI (10 marks)

MM Criteria

Correct use and reading of thermometer	3
(eye level, submerged, accuracy)	
Correct use and reading of measuring cylinder	3
(eye level, cylinder flat, accuracy)	
Careful transferring of chemical/water	1
Correct use and reading of balance	3
(zeroing, eye level, accuracy)	
Total	**10**

AI criteria

- Energy profile diagram 2
- Calculation of heat change 2
- Type of change explained 2
- Assumptions/limitations described 2
- Appropriate conclusion 2

Total 10

This exercise may be repeated using ammonium chloride instead of sodium hydroxide for the opposite kind of reaction

Organic Chemistry

Contributed by C. Harry

LAB 27: DISTINGUISHING HYDROCARBONS

SUGGESTED SKILL: PD

Planning and designing

Lab title: Distinguishing between hydrocarbons

Problem Statement: A patient is rushed into your ER having ingested an organic liquid. You need to know the nature of the compound in order to treat your patient effectively. You find a bottle amongst their personal effects but most of the label on the bottle is gone. You can make out the first three letters of the functional group which are 'ALK'. Preliminary analysis of the unknown liquid determined that it is a hydrocarbon. Plan and design an experiment to accurately determine the functional group of the organic liquid.

LAB 27: SAMPLE MARK SCHEME

SKILL: PD (10 marks)

P/D criteria

- Hypothesis clearly stated (1)
- Hypothesis is testable (1)
- Aim related to hypothesis (1)
- Appropriate apparatus (1)
- Appropriate method (1)
- Controlled variable stated (1)
- Manipulated and Responding variable stated (1)
- Expected results are reasonable and linked with method (1)
- Interpretation of expected data (1)
- Assumption/ Precautions/ Sources of error stated (1); Any one can be stated

Total: 10 marks

LAB 28: DISTINGUISHING HYDROCARBONS

SUGGESTED SKILLS: ORR/MM/AI

Lab title: Distinguishing between an alkane and an alkene

Aim: To distinguish between an alkane and an alkene

Apparatus : Cyclohexane, cyclohexene, acidified potassium manganate (VII) solution, bromine solution, test tubes, measuring cylinder

Method:

1. Measure and place 2 cm^3 of cyclohexane into two test tube each and label it A and B.
2. Measure and place 2 cm3 of cyclohexene into two test tube each and label it C and D.

3. Add a few drops of acidified potassium manganate (VII) solution to tubes A and C.
4. Shake and observe any colour changes which occur.
5. Add a few drops of bromine solution to test tubes B and D.
6. Shake and observe any color change.
7. Tabulate results

LAB 28: SAMPLE MARK SCHEME

SKILL: ORR (10 marks)

- Format of report correct and complete (1)
- Aim accurately stated (1)
- All apparatus listed (1)
- Results accurately recorded;Correct observation recorded for test tube A (1), Correct observation recorded for test tube B(1), Correct observation recorded for test tube C(1), Correct observation recorded for test tube D (1)
- Table drawn correctly and neatly (1)
- Table appropriate labeled (1)
- Table appropriate titled (1)

Total: 10 marks

LAB 29: MARGARINE VS BUTTER

SUGGESTED SKILLS: ORR/MM/AI

Skill: Planning and designing

Margarine vs Butter

Problem

Margarine vs butter? Which is healthier?

Both can be used as spreads on breads or biscuits or even in cooking to improve flavour. In this modern age where obesity and terms such as "good" cholesterol and "bad" cholesterol are "hot" topics, the question **margarine or butter, which is better for your health?** was given as an assignment to CSEC chemistry students. Through research, the students determined that the degree of unsaturation in these products plays a role in the health consequences of using these products. **Plan and design an experiment to determine the degree of unsaturation in samples of margarine and butter.**

LAB 29: SAMPLE MARK SCHEME

SKILL: PD (10 marks)

SAMPLE MARK SCHEME

P/D criteria

- Hypothesis clearly stated (1)
- Hypothesis is testable (1)
- Aim related to hypothesis (1)
- Appropriate apparatus (1)
- Appropriate method (1)
- Controlled variable stated (1)
- Manipulated and Responding variable stated (1)

- Expected results are reasonable and linked with method (1)
- Interpretation of expected data (1)
- Assumption/ Precautions/ Sources of error stated (1); Any one can be stated

Total: 10 marks

LAB 30: ESTERIFICATION

SUGGESTED SKILLS: ORR/MM/AI

Title: Esterfication

Aim: To prepare a sample of Ethyl Ethanoate

Apparatus: Ethanoic acid, ethanol, concentrated sulfuric acid, Bunsen Burner, beaker with water (water bath),boiling tube

Method:

1. Add 3 cm^3 of ethanol to 3 cm^3 of ethanoic acid in a boiling tube.
2. Add 2 drops of concentrated sulfuric acid.
3. Warm the mixture gently in a water bath for 5 minutes.
4. Pour the mixture into a beaker of very cold water.
5. Make observations.

LAB 30: SAMPLE MARK SCHEME

SKILL: ORR (10 marks)

AI Criteria

-Background information; Define esterification (1), Idenitfy the conditions necessary for esterification to take place(1)

-Explanation of results; explain why the the purpose of the sulfuric acid (2), explain why the mixture must be placed into a beaker of very cold water(2), Explain why the mixture must be warmed (2)

- Valid limitation (1)

- Valid conclusion (1)

Total: 10 marks

LAB 31: SAPONIFICATION

SUGGESTED SKILLS: ORR/MM/AI

Title: Saponification

Aim: To prepare a sample of soap

Apparatus: Vegetable oil, 2M sodium hydroxide, methylated spirit, concentrated sodium chloride soultion, 250cm^3 beaker, filter funnel, filter paper

Method:

1. Warm 10cm3 of vegetable oil in a 250cm3 beaker.
2. To the warm oil add 20cm3 of 2M sodium hydroxide solution to which 4 to 5 drops of methylated spirits has been added.

3. Heat the mixture gently until most of the liquid has evaporated.
4. Add concentrated sodum chloride solution to the mixture.
5. Filter the mixture.
6. Record observation.
7. Compare the lathering properties of the sample soap with one obtained commercially.
8. Tabulate results comparing the lathering properties of your sample soap with one obtained commercially.

LAB 31: SAMPLE MARK SCHEME

SKILL: ORR (10 marks)

ORR criteria

- Format of report complete (1)
- Format of report correctly sequenced (1)
- Aim accurately stated (1)
- All apparatus listed (1)
- No grammatical errors (1)
- Results accurately recorded;residue is present (1), residue lathers (1)
- Table drawn correctly and neatly (1)
- Table appropriate labeled (1)
- Table appropriate titled (1)

Total: 10 marks

LAB 32: OXIDATION OF ETHANOL

SUGGESTED SKILLS: ORR/MM/AI

Title: Oxidation of ethanol

Aim: To determine the product formed from the oxidation of ethanol

Apparatus: Ethanol, acidified potassium dichromate (VI) solution, test tube, measuring cylinder

Method:

1. Measure and add 2 cm3 of ethanol into a test tube.
2. Add an equal volume of potassium dichromate (VI) and shake to mix.
3. Observe colour change and odour

LAB 32: SAMPLE MARK SCHEMES

SKILL: ORR (9 marks) /AI (10 marks)

ORR criteria

- Format of report complete (1)
- Format of report correctly sequenced (1)
- Aim accurately stated (1)
- All apparatus listed (1)
- No grammatical errors (1)
- Results accurately recorded;correc t color change noted
- Table drawn correctly and neatly (1)
- Table appropriate labeled (1)
- Table appropriate titled (1)

Total: 9 marks

AI Criteria

-Background information; Define alkanols (1), Define oxidation (1)

-Explanation of results; account for the color change (1), identify, with reason, the product of the reaction(2), write the balanced equation for the reaction, including state symbols (2)

- Valid limitation/Source of error (1)

-Precaution and assumptions stated(1)

- Valid conclusion (1)

Total: 10 marks

Planning and Designing Explained

The following section on planning and designing is taken from the CSEC 2012 Chemistry report. It contain information on planning and designing which you may find helpful.

"Generally, the standard of the laboratory exercises assessed for the Planning and Designing (PD) skill has declined this year as there was a 10 per cent increase in exercises with unsatisfactory PD skills.

This was due mainly to the noticeable increase in the number of standard practical exercises presented this year. Standard practical exercises are those which can be obtained from a chemistry text, and are therefore deemed inappropriate for PD activities, for example:

Plan and design an experiment to determine

The effect of concentration on the rate of a reaction

The products of electrolysis of H_2SO_4 using inert electrodes

The conditions for rusting.

Various formats have been used for the presentation of PD skills, some of which make it very difficult to moderate. Below is a suggested format which may be useful to both teachers and students:

Scenarios

Students should be encouraged to write the scenarios or problem statements at the beginning of each PD exercise. These should also be included in the teachers' mark scheme.

It is recommended that the same scenario/problem be given to all students in the group and that other means of encouraging independent work (other than assigning individual PD's) be found.

It is not recommended that students be left to generate the problems/scenarios of their own; however, in circumstances where this is done these problems/scenarios should be vetted by the teacher to make sure that they are testable and chemistry based.

Hypothesis

The hypothesis should be testable.

As much as possible the manipulated variable should be included in the hypothesis.

The hypothesis should be restricted to one sentence only. Neither the rationale for the position that has been taken nor the method to be used on the experiment should be outlined in the hypothesis.

The language of the hypothesis is also important. It should be stated like an aim.

Aim

Students should be encouraged to specify the method or technique to be employed in the experiment.

The aim must relate to the hypothesis as well as the problem statement.

Apparatus/Materials

Traditionally, most teachers require that the apparatus and materials be placed before the procedure in keeping with the format used for the laboratory exercises. Please note that PD skills in this section may also be written and accepted after the procedure as it is a good practice to identify from the procedure the list of apparatus and materials required.

This is better done while planning the experiment rather than writing a procedure to fit the apparatus and materials.Students should also be encouraged to pay special attention to this section since a mark is deducted for every piece of essential apparatus omitted as determined by the suggested procedure.

Procedure

Special attention must be given to the tense used in the procedure. Students should be taught to write the procedure in the present or future tense; any other tense is unacceptable.

As mentioned before, this section may also be placed before the apparatus and materials section.

Variables

It is recommended that the variables; manipulated, control and responding, be placed immediately after the procedure. Students should be encouraged to list these variables separately as this is an exercise in critical analysis.

Data to be collected

Some students refer to this section as 'Expected Results'. It is recommended that the term Data to be Collected be used rather than 'Expected Results'.

In this section, the observations, measurements or qualitative data to be collected that will prove or disprove the hypothesis should be recorded. Please note that actual values should not be recorded in the tables.

The data to be collected may be presented in tabular form or as a description of specific data including units, where appropriate.

Some examples

When doing a titration, the data to be collected will be volumes used rather than concentration. Concentration is actually calculated from the data and hence it will be inappropriate to be used as data collected.

If chromatography is used, then the data collected should include the number of spots or components, their colours and the distance travelled by the components as well as the solvent from the origin. Rf values should never be used as data to be collected since this is also calculated.

Treatment/Interpretation of Data

Again, it is recommended that the term data be used rather than 'results' in the heading in an attempt to make it clear that this section looks at how the data collected will be used to prove or disprove the hypothesis.

This is the link that shows how the data to be collected answers the aim and validates the hypothesis.

Some examples:

In a scenario where students are trying to find out which brand of vinegar is more concentrated, the Interpretation of Data could be: If Brand Y vinegar uses the least volume (Data to be collected) to neutralize X cm3 of base then Brand Y is the most concentrated vinegar (stated in aim), and therefore the hypothesis is supported.

 In a scenario where students are trying to find out whether two brands of ink contain the same dyes, the Interpretation of Data could be: If both brands of ink contain the same number of components with the same colour and are the same distance from the origin (Data to be Collected), then both brands of ink contain the same dye (stated in the aim) and therefore the hypothesis is supported.

Limitations/Precautions/Assumptions

It is recommended that teachers assist students in distinguishing between these terms.

While they can be related, the way that they are stated can make a significant difference. Please note that Sources of Error should not be presented in a PD lab since it refers to a lab that has been carried out.

In addition, teachers should also be aware of the following:

All PD activities should be based on chemical concepts. Although scenarios may involve Biology, Physics, Food & Nutrition, the focus of the activity must involve chemical concepts related to the Chemistry syllabus.

Students should undertake at least four PD activities over the two-year period. When this is not done, students are at a disadvantage.

Some PD exercises submitted for SBA were assessed for other skills as well. This suggests that the exercise was carried out and so cannot be moderated for PD skills. This places the students at a serious disadvantage.

While a general mark scheme can be written to assess all PD activities, teachers should ensure that it does indeed suit all the PD activities submitted. If not, each PD activity should have a separate mark scheme.

To assist in improving the standard of PD exercises, some ideas for possible PD activities adapted from Jacques (2006) are suggested below.

1. Comparison of homemade vinegar against store-bought vinegar.

2. Best solvent to remove ink stain from a shirt.

3. Comparison of the heat content of alcohols (how the number of carbon atoms in the alcohol affect the heat of combustion)

4. Which water source is best for rusting

5. Vitamin C content in different brands of Vitamin C tablets or fruit juices

6. Electroplating a coin: which would deposit greater amount of metal for a given quantity of electricity — univalent or divalent metal ion. Please note that items like leather belts or sandals should not be used here.

7. Acidity in green-skinned fruits compared to ripened fruits

8. Comparison of different brands of baking powder

9. Comparison to determine if different brands of black marker contain the same ink

10. Comparison of a recently discovered fuel with gasoline (existing fuels)

11. Comparison of hardness of water using soap

12. Comparison of melting point of pure and impure substances, for example, pure stearic acid and stearic acid with a small amount of glucose added

13. Eating peanuts from Brand A makes one thirstier than eating peanuts from Brand B

Please find below more detailed information as examples for number 4 and number11.

4. – Scenario:

Mrs. Jones and Mrs. Thompson both bought steel burglar bars for their homes. Mrs. Jones lives near the beach while Mrs. Thompson lives inland. Three years later Mrs. Jones's bars have more rust than Mrs. Thompson's. Mrs. Jones believes that the rust is due to the exposure of the burglar bars to water from the sea. Plan and design an experiment to determine whether sea water accelerates rusting in steel.

Hypothesis: Iron rusts faster when exposed to salt water than fresh water.

Aim: To investigate the effect of salt water as opposed to fresh water on iron by measuring the mass of iron produced.

Variables:

Manipulated – types of water

Controlled – volumes of water used and the time exposed to air

Responding – mass of rust

11. – Scenario

Debbie went in Dominica and while washing clothes she realized that she used less soap than when washing in Barbados. Plan and design an experiment to explain this observation.

Possible hypotheses:

1. The water in Dominica is softer than the water in Barbados

2. The water in Barbados contains more calcium and magnesium ions than the water in Dominica.

Possible Aim:

To determine which water contains more calcium and magnesium by ionic precipitation

Variables:

Manipulated – types of water

Controlled – type of detergent, volume of water

Responding – the mass of precipitate formed"

MODERATION OF SCHOOL-BASED ASSESSMENT – CHEMISTRY

FRM/EDPD/054

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MODERATION OF SCHOOL-BASED ASSESSMENT

CHEMISTRY

NAME OF CENTRE: ____________________ CENTRE CODE: ____________________

NAME OF TEACHER: ____________________ NUMBER OF CANDIDATES IN CENTRE: : ____________

TERRITORY: ____________________ YEAR OF EXAMINATION: ____________________

For CXC use only
Teacher I.D. No.: ____________

	Registration Number	Candidate's Name	ASSESSOR	PRACTICAL SKILLS				PROFILE TOTAL		OVERALL TOTAL
				Obs./Rec./ Rep.	Manip./ Meas.	Plan./ Design.	Analysis & Interpr.			
				P3 (30)	P3 (30)	P3 (30)	P2 (40)	P2 (40)	P3 (90)	130
1.			Teacher							
			Moderator							
2			Teacher							
			Moderator							
3.			Teacher							
			Moderator							
4.			Teacher							
			Moderator							
5.			Teacher							
			Moderator							

MODERATOR'S INITIALS: ____________ CHIEF/ASSISTANT EXAMINER'S INITIALS: ____________ EXAMINER'S INITIALS: ____________ DATE: ____________

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To be sent to the Local Registrar for submission to CXC