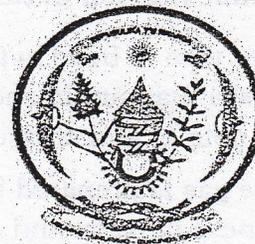


Chemistry I

002

5th Nov 2013 8.30am-11.30am

REPUBLIC OF RWANDA



RWANDA EDUCATION BOARD

ORDINARY LEVEL NATIONAL EXAMINATIONS 2013

SUBJECT : CHEMISTRY I

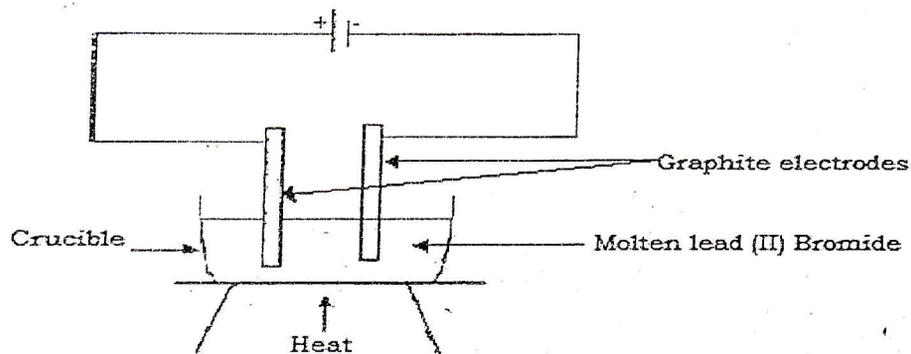
TIME : 3 HOURS

INSTRUCTIONS:

- 6) Don't open this question paper until you are told to do so.
- 7) This paper consists of **three** sections: **A, B** and **C**.
 - **Section A:** Attempt **all** questions. (55 marks)
 - **Section B:** Attempt any **three** questions. (30 marks)
 - **Section C:** Attempt **only one** question. (15 marks)
- 8) You do not need the Periodic Table.
- 9) Silent non-programmable calculators may be used

SECTION A: ATTEMPT ALL QUESTIONS. (55 MARKS)

- The atomic number of carbon (C) is 6 and that of chlorine (Cl) is 17.
 - What type of bond is formed between carbon and chlorine? (1 mark)
 - Draw a diagram to show bonding in the compound between carbon and chlorine. Use dots (.) and crosses (x) to represent electrons in the outer shells. (3 marks)
- Chlorine gas is prepared by heating a mixture of manganese (IV) oxide (manganese dioxide) and concentrated hydrochloric acid.
 - Write a balance equation for the reaction. (2 marks)
 - Describe a chemical test to show that the gas is chlorine. State the reagent and the expected observation for a positive result. (2 marks)
- Iron is extracted from haematite (Fe_2O_3) by heating it with coke (carbon). Carbon reacts with oxygen to form carbon monoxide which then reacts with Fe_2O_3 .
 - Write a balanced equation between haematite and carbon monoxide. (2 marks)
 - Identify the oxidizing agent in your equation in (a) above. (1 mark)
 - What harm might the extraction of iron have on the environment? Explain your answer. (2 marks)
- Ethene belongs to a family of organic compounds known as alkenes.
 - State the general formula of alkenes. (1 mark)
 - Give the name and formula of alkene with five carbon atoms. (2 marks)
 - Ethene reacts with hydrogen bromide to form another organic compound. Give the formula and name of the organic compound formed. (2 marks)
- Ethanol can be prepared from a mixture of a solution of sugar and yeast kept warm conditions.
 - What is the role of yeast? (2 marks)
 - What is the name given to the process of preparing ethanol from sugar? (1 mark)
 - What name is given to the organic compounds formed by reacting alcohols with carboxylic acids? (1 mark)
 - State one use of compound identified in (c) above. (1 mark)
- Sulphur and potassium were separately burned inside gas jars. The products were separately shaken with water in gas jars.
 - Write a balanced chemical equation to show the reaction that occurs when the product from potassium reacts with water. State the approximate pH of the solution. (3 marks)
 - The product from sulphur reacted with water and the solution formed was reacted with sodium hydroxide. Write a balanced equation for the reaction with sodium hydroxide. (2 marks)
- The set-up below was used to electrolyse molten lead (II) bromide.



- a) Why was it necessary to melt lead (II) bromide before electrolysis? (1 mark)
 b) Give an ionic equation to show the reaction at the anode. (2 marks)
 c) Is the reaction at the anode oxidation or reduction? Give a reason for your answer. (2 marks)

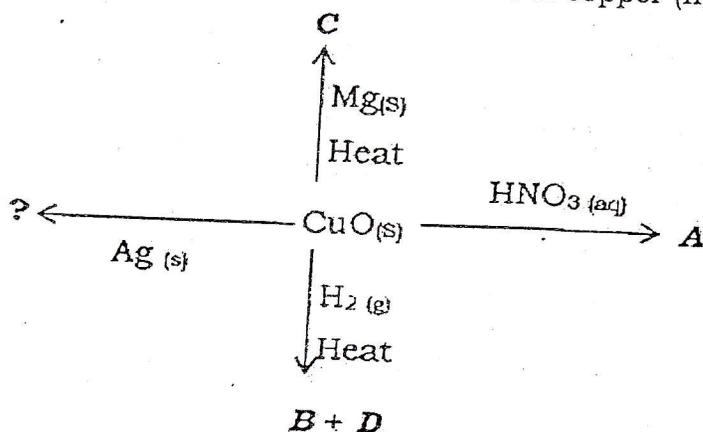
8. Draw structural formulae of the following organic compounds.

- a) Propene (1 mark)
 b) Butanoic acid (1 mark)
 c) Ethylethanoate (1 mark)
 d) Butane (1 mark)

9. A sample of lead (II) iodide (an insoluble salt) was prepared by reacting 20 cm³ of 0.2 mol dm⁻³ lead (II) nitrate with 40 cm³ of 0.2 mol dm⁻³ potassium iodide.

- a) What type of reaction occurs between lead (II) nitrate and potassium iodide solutions? (1 mark)
 b) Calculate the number of moles of lead (II) nitrate in 20 cm³ of the solution. (1 mark)
 c) Write a balanced equation for the reaction between lead (II) nitrate and potassium iodide solutions. (2 marks)
 d) Calculate the mass in grams of lead (II) iodide formed. (Pb = 207, I = 127). (2 marks)

10. The scheme below shows some reactions of copper (II) oxide to form different products.



- a) Give the name of compound A which contains copper. (1 mark)
 b) What name is given to the reaction between CuO and HNO₃? (1 mark)
 c) Give the names of products B and D. (2 marks)
 d) Give a reason whether you would expect a reaction between CuO and Ag. (1 mark)
11. a) Using specific examples, distinguish between a strong acid and a weak acid. (2 marks)
 b) Describe a simple laboratory test you could use to distinguish between a strong acid and a weak acid. State the reagent and the expected observation. (2 marks)
12. Compounds of P, N and K are often used as inorganic fertilizers.
- a) Explain what is meant by a fertilizer. (1 mark)
 b) Why is it necessary to apply fertilizers to soil? (1 mark)
 c) Give two compounds that could be used to prepare potassium nitrate fertilizer. (1 mark)

SECTION B: ATTEMPT ANY THREE QUESTIONS. (30 marks)

13. The grid below shows part of the Periodic Table for the first 20 elements. The letters are not the actual symbols of the elements. The atomic number of A is 1.

A							B
W			D		M	E	
X			G		Q	H	
Y	J						

Use the grid above to answer the questions below. Use the given letters to represent elements in your answers.

- Give the formula of the compound formed between J and E. What type of bond is present in the compound? Give a reason for your answer. (3 marks)
 - How many shells of electrons are present in G? (1 mark)
 - Element H exists as two isotopes. What is meant by the term isotopes? (1 mark)
 - Give two letters of elements which have high melting points. (2 marks)
 - Which element forms a divalent anion? (1 mark)
 - State two observations you would make when a small piece of element X is added to cold water. (2 marks)
14. A student tried to obtain a sample of hydrated crystals of copper (II) sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) from a rock containing copper (II) carbonate. He used the method described below:
- The rock was crushed into a fine powder. Excess of the powder was reacted with dilute sulphuric acid until no more bubbles were observed. The mixture was filtered. The filtrate was evaporated to dryness.
- Why was the rock crushed into a powder? (2 marks)
 - Why was excess of the powder used? (1 mark)
 - Why was the mixture filtered? (1 mark)
 - Write a balanced equation for the reaction between copper (II) carbonate and sulphuric acid. (2 marks)
 - The method used did not yield hydrated crystals of copper (II) sulphate. Explain why. (1 mark)
 - What change would you make in the method in order to obtain hydrated crystals? (2 marks)
 - State one use of copper metal. (1 mark)
15. Sulphur is a raw material for the manufacture of sulphuric acid in the "contact" process.
- Describe the steps involved in the manufacture of sulphuric acid by the "contact" process. In each step, write a balanced chemical equation for the reaction that occurs. (6 marks)
 - State two large scale uses of sulphuric acid. (2 marks)
 - How is the manufacture of sulphuric acid likely to harm the environment? (2 marks)
16. a) Explain the difference between hard water and soft water. (2 marks)
- Temporary hardness of water is caused by the presence of calcium hydrogen carbonate. Briefly explain how calcium hydrogen carbonate gets into water and how this type of hardness can be removed from water. (4 marks)
 - What causes permanent hardness? How is permanent hardness removed? (2 marks)
 - When carbon dioxide is bubbled through lime water, the litmus turns "milky". Briefly explain why lime water turns milky. (2 marks)

17. A compound contains 85.7% by mass of carbon and 14.3% by mass of hydrogen. Its molar mass is 56g/mol. (C = 12, H = 1)

- a) Calculate its empirical formula. (2 marks)
- b) Determine its molecular formula. (1 mark)
- c) Draw a possible structural formula of the compound. (1 mark)
- d) Write a balanced equation for its combustion in oxygen. (2 marks)
- e) 40cm³ of hydrogen gas were reacted with 70cm³ of chlorine gas to form hydrogen chloride gas.
 - i) Write a balanced equation for the reaction. (2 marks)
 - ii) Calculate the volume of hydrogen gas formed. (Assume that all volumes of gases are measured at the same temperature and pressure). (2 marks)

SECTION C: ATTEMPT ONLY ONE QUESTION. (15 marks)

18. A sample of dry hydrogen gas was prepared as follows:

Concentrated sulphuric acid was added to sodium chloride crystals in a flat-bottomed flask at room temperature. The gas was dried and collected by downward delivery in a gas jar.

- a) State a suitable reagent to dry hydrogen chloride gas. (1 mark)
 - b) Which one has a higher density: air or hydrogen chloride? Explain your answer. (2 marks)
 - c) What is observed when hydrogen chloride reacts with ammonia gas? Write an equation for the reaction. (2 marks)
 - d) A solution of hydrogen chloride in water was mixed with silver nitrate solution. State what is observed and write an equation for a reaction that occurs. (3 marks)
 - e) Hydrogen chloride gas was dissolved in pure water to form hydrochloric acid. The acid was titrated with sodium carbonate solution. 25cm³ of 0.2mol dm⁻³ sodium carbonate reacted with 24cm³ of the hydrochloric acid.
 - i. Write a balanced equation for the reaction of hydrochloric acid and sodium carbonate. (2 marks)
 - ii. Calculate the number of moles of sodium carbonate in 25cm³ of the solution. (1 mark)
 - iii. Calculate the number of moles of hydrochloric acid needed to react with sodium carbonate. (1 mark)
 - iv. Calculate the concentration of hydrochloric acid in mol dm⁻³. (3 marks)
19. Drinking water was suspected to be contaminated with the following ions: Cu²⁺, Fe³⁺, SO₄²⁻ and CO₃²⁻. A sample of the water was divided into several portions and tested for the presence of the above ions.
- a) The first portion was mixed with nitric acid and there was no observable change. What conclusion can be made from this observation? Explain your answer. (2 marks)
 - b) A second portion was tested using aqueous ammonia solution. A few drops of ammonia solution were added, followed by excess ammonia. Describe what would be observed if Cu²⁺ ions were present. (3 marks)
 - c) How would you test for the presence of SO₄²⁻? State the reagent and the expected observation for a positive result. (2 marks)
 - d) Another portion was mixed with a reagent which removed Cu²⁺. If the remaining solution contained Fe³⁺, what test would confirm the presence of Fe³⁺? State the reagent and observation. (2 marks)

e) Rust contains a compound of iron (III).

i. State the conditions necessary for rusting to take place. (2 marks)

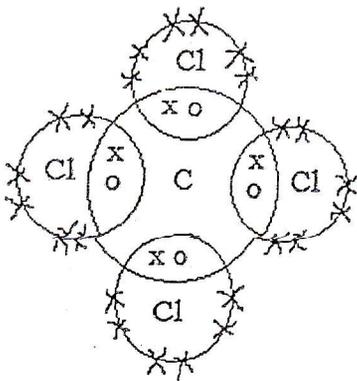
ii. Give two methods of prevention of rusting. (2 marks)

iii. Give one similarity and one difference between rusting and combustion. (2 marks)

END

CHEMISTRY III 2013

SECTION A

<p>1. a) Covalent bond b)</p> 	<p>2. a) $MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + Cl_2(g) + 2H_2O(l)$ b) Reagent: Pass the gas over a wet red/blue litmus paper, the litmus paper is bleached/loses color.</p> <p>3. a) $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$ b) Oxidizing agent = Fe_2O_3/haematite.Iron (III) oxide c) - It increases th level of carbon dioxide which causes global warming.</p> <p>4. a) C_nH_{2n} b) Pentane (C_5H_{10})</p> <p>c) Bromoethane C_2H_5Br</p>
<p>5. a) Yeast contains an enzyme which speeds up the breakdown of ethanol/ speeds up the reaction. b) Fermentation c) Esters d) Manufacture of perfumes, soap or solvents.</p>	<p>6. a) $K_2O(s) + H_2O(l) \rightarrow 2KOH(aq)$ PH = 13 - 14 b) $H_2SO_3(aq) + 2NaOH(aq) \rightarrow Na_2SO_3(aq) + 2H_2O(l)$</p>
<p>7. a) To make irons free to move or because in solid, irons are not free to move. b) $2Br^- \rightarrow Br_2 + 2e^-$ c) Oxidation: There is loss of electrons</p>	<p>8. a)</p> $\begin{array}{c} H & H & & H \\ & & & \\ H-C & -C & = & C-H \\ & & & \\ H & & & \end{array}$ <p>b)</p> $\begin{array}{c} H & H & & H & & O \\ & & & & & \\ H-C & -C & - & C & - & C \\ & & & & & \backslash \\ H & & & H & & O-H \end{array}$ <p>c)</p> $\begin{array}{c} H & O & & H & H \\ & & & & \\ H-C & -C & - & O-C & -C-H \\ & & & & \\ H & & & H & H \end{array}$ <p>d)</p> $\begin{array}{c} H & H & H & H \\ & & & \\ H-C & -C & -C & -C-H \\ & & & \\ H & H & H & H \end{array}$
<p>9. a) Precipitation b) moles of $Pb(NO_3)_2 = 0.2 \times \frac{20}{1000} = 0.004$ mol c) $Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$ d) Molar mass of $PbI_2 = 461$ ($207 + (2 \times 127) = 461$) No. of molcs of $PbI_2 = 0.004$mol Mass of $PbI_2 = 0.004 \times 461 = 1.84$g (3 s.f)</p>	

<p>10.</p> <p>a) Copper (II) nitrate</p> <p>b) Neutralization</p>	<p>c) B = Copper, D = Water</p> <p>d) No reaction because Ag is less reactive than water, hence cannot reduce CuO to Cu.</p>
<p>11. a) A strong acid is fully ionized/completely immersed in aqueous solution e.g HCl or HNO₃ or H₂SO₄.</p> <p>A weak acid is partially ionized/not completely ionized in aqueous solution</p> <p>e.g</p> <p>CH₃COOH(ethanoic acid) or any other suitable example.</p>	<p>b) Test both solutions with universal indicator solution PH paper/PH meter.</p> <p>Weak acid = higher PH = 4 - 6</p> <p>Strong acid = lower PH = 1 - 3</p>
<p>12.</p> <p>a) An organic fertilizer is a substance added to soil to help grow better crops or it's a substance added to soil to improve growth of crops/plants.</p> <p>b) Because plant nutrients get used up in the soil.</p>	<p>c) - Potassium hydroxide (oxide) and nitric acid</p> <p>- Potassium carbonate + Nitric acid</p> <p>- Potassium chloride + Nitric acid</p> <p>- Lead Nitrate + Potassium Iodide</p> <p>- Potassium + Nitric acid</p>

SECTION B

<p>13. a) JE₂, ionic/Electrovalent bond</p> <p>A metal combining with a non-metal</p> <p>b) 3 shells of Es</p> <p>c) Isotopes are atoms of the same proton number but different number of neutrons</p>	<p>d) D and G</p> <p>e) M or G</p> <p>f) - Moves quickly of the surface</p> <p>- Gives out a gas</p> <p>- melts as it reacts with water</p>
<p>14. a) To increase surface area so that it can react faster.</p> <p>b) To ensure that all the acid reacts.</p> <p>c) To separate the un reacted solid from the mixture.</p> <p>d) $CuCO_3(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq)$</p>	<p>e) Heating caused all the water to evaporate</p> <p>f) - Heat the solution until a small amount remains/to saturation point</p> <p>- Leave the solution to cool after some heating.</p> <p>g) Used in electric wires, money coins, ornaments, as brass for musical instruments.</p>
<p>15. a) Step 1: Burning sulphur</p> $S_{(s)} + O_{2(g)} \rightarrow SO_{2(g)}$ <p>Step 2: Oxidation of SO₂</p> $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ <p>Catalyst = vanadium (v) oxide)(V₂O₅)</p> <p>Step 3: Absorption of SO₃ into Conc H₂SO₄</p> $SO_{3(l)} + H_2SO_{4(g)} \rightarrow H_2S_2O_7(l)$ <p>(Oleum)</p> <p>Step 4: Dilution of oleum</p> $H_2S_2O_7(l) + H_2O(l) \rightarrow 2H_2SO_4$	<p>b) Manufacture of fertilizers, manufacture of detergents, used in car batteries, dehydrating agent, drying agent etc.</p> <p>c) SO₂ may escape to the atmosphere and cause acid rain which is harmful to buildings, vegetation and fish</p>
	<p>16. b) Rain water containing dissolved CO₂ (or carbonic acid) dissolves limestone rock</p> <p>(CaCO₃) to form soluble calcium hydrogen</p>

