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Chemistry I

001

28/07/2023 08:30 AM – 11:30 AM



ORDINARY LEVEL NATIONAL EXAMINATIONS, 2022-2023

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS:

- 1) Write your names and index number on the answer booklet as written on your registration form and **DO NOT** write your names and index number on additional answer sheets if provided.
- 2) **DO NOT** open this question paper until you are told to do so.
- 3) 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 any **ONE** question. **(15 marks)**
- 4) **You do not need the periodic table.**
- 5) Silent-non programmable calculators may be used.
- 6) Use only a **blue** or **black** pen for answering and a **pencil** for drawing.

SECTION A: ATTEMPT ALL QUESTIONS IN THIS SECTION (55 marks)

- 1) Air is essentially a mixture of gases and it can be polluted. Read carefully the following statements and answer with True (**T**) or False (**F**).
- Carbon monoxide is an air pollutant which causes acidic rain. **(1 mark)**
 - Catalytic converters are control devices which are added to automobiles and they increase air pollution. **(1 mark)**
 - Chlorofluorocarbons, CFCs, are responsible for ozone layer depletion. **(1 mark)**
- 2) In daily life, we use many substances that scientists call acids and bases.
- What is an acid-base indicator? **(1 mark)**
 - Fill in the blanks with a missing correct term:
 - The vinegar used in salad dressing contains **(1 mark)**
 - When milk turns sour, it contains **(1 mark)**
- 3) In chemistry, salts can be soluble, slightly soluble or insoluble.
- Define the term “solubility” of a salt. **(1 mark)**
 - Ammonium carbonate, $(\text{NH}_4)_2\text{CO}_3(s)$ decomposes on heating and gives off three products. Write a balanced chemical equation. **(2 marks)**
 - The solubility of a salt **AX** in water, is 90 at 20°C and 105 at 40°C . Explain. **(1 mark)**
- 4) Alkanes are saturated hydrocarbons obtained from crude oil.
- What is meant by saturated hydrocarbon? **(1 mark)**
 - State the process by which components of alkanes are obtained from crude oil. **(1 mark)**
 - On which physical property the process in (b) above is based? **(1 mark)**
 - Give the IUPAC name for a non-branched saturated hydrocarbon with four (4) carbon atoms. **(1 mark)**

- 5) Ensuring the laboratory safety is the responsibility of everyone working in the laboratory. Choose a correct answer about the safety rules of a laboratory and provide a short explanation to support your choice.
- a) In a laboratory you are allowed to eat and drink only: **(2 marks)**
- (i) If you are very hungry.
 - (ii) If you have washed your hands well.
 - (iii) If the food is healthy and can be digested fast and easily.
 - (iv) If the food has been covered well to avoid contamination.
 - (v) None of the above.
- b) In case of acid splashes onto your skin while working in a laboratory, immediately apply: **(2 marks)**
- (i) Oil or lotion.
 - (ii) Soap to wash out acids.
 - (iii) A strong base to neutralize the acid.
 - (iv) Plenty of clean water.
- 6) The conversion of reactants into products in a chemical reaction is often accompanied by some features (characteristics) which can be observed easily.
- a) State any two characteristics of chemical reactions. **(2 marks)**
- b) What type of reaction is the reaction below and which of the characteristics of chemical reactions does it exhibit? **(2 marks)**
- $$\text{AgNO}_3\text{(aq)} + \text{NaCl(aq)} \longrightarrow \text{AgCl(s)} + \text{NaNO}_3\text{(aq)}$$

- 7) Under certain conditions, alkenes can be converted into alcohols and vice versa.
- a) Write the reaction equation, with all conditions, to show the product formed when propan-1-ol is heated with sulphuric acid at 170°C. **(2 marks)**
- b) Both ethanol and butane are organic compounds. The molecular weight of butane (58) is higher than the molecular weight of ethanol (46), but the boiling point of ethanol (351K) is higher than the boiling point of butane (272K). Explain such a difference. **(2 marks)**
- 8) Carbon dioxide is a colorless, odorless gas produced either by burning carbon or burning organic compounds and by respiration. It is naturally present in air.
- a) State one environmental problem caused by the increase of carbon dioxide in the atmosphere. **(1 mark)**
- b) Describe any one process or phenomenon that acts to remove carbon dioxide from the atmosphere. **(3 marks)**
- 9) Carboxylic acids can be obtained by oxidation of alcohols.
- a) Give the IUPAC name or chemical formula of an alcohol which can be used to prepare ethanoic acid. **(1 mark)**
- b) Write the equation of preparation of ethanoic acid by oxidation of the alcohol in (a) above. **(1 mark)**
- c) State any three uses of ethanoic acid. **(3 marks)**

- 10) In a laboratory, oxygen can be prepared by carrying out a thermal decomposition of potassium chlorate in the presence of manganese (IV) oxide as depicted in figure 1.

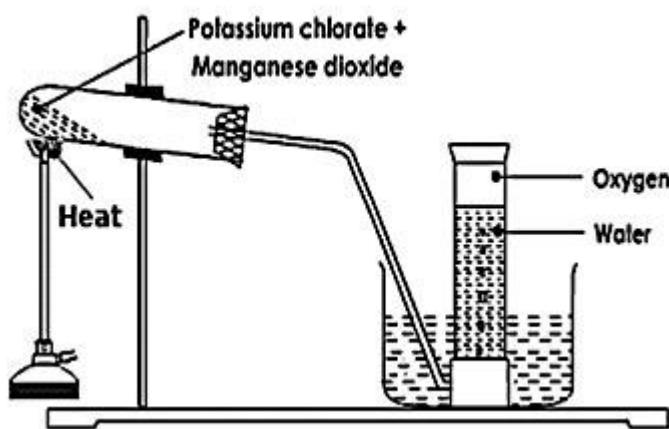


Figure 1

- a) Give the chemical formula of manganese (IV) oxide and explain its role in this reaction. **(2 marks)**
- b) Oxygen exists in two forms known as allotropes.
- (i) Define the term “allotropes”. **(1 mark)**
- (ii) One of the allotropes of oxygen plays a big role in protecting living things on earth. Give the name or chemical formula for this allotrope. **(1 mark)**
- 11) A few crystals of lead (II) nitrate were heated strongly. There was formation of a solid residue and two different gases.
- a) Write a well-balanced chemical equation for the reaction which occurs. **(1 mark)**
- b) The solid residue dissolves in dilute nitric acid to give a colourless solution **Y**, which in turn reacts with potassium iodide solution, **KI(aq)**, to form a yellow precipitate **Z**.
- (i) Write the reaction equation of solid residue and dilute nitric acid and identify **Y**. **(2 marks)**
- (ii) Give the ionic equation between **Y** and iodide ions to form **Z**. **(2 marks)**

12) A dilute solution of hydrochloric acid, HCl(aq) reacts with magnesium ribbons and magnesium powder in two different reactions as follows:

Reaction (1): HCl(aq) reacts with magnesium ribbons.

Reaction (2): HCl(aq) reacts with magnesium powder.

a) Write the reaction equation between HCl(aq) and magnesium metal with all state symbols for chemicals. **(2 marks)**

b) State the main factor which affects the rates of the two reactions above. **(1 mark)**

c) Compare the reaction (1) with the reaction (2) in terms of rate and amount of products formed. **(2 marks)**

13) When phosphorus burns in air, a bright yellow flame is observed and white fumes of phosphorus (V) oxide are produced.

a) Write a balanced chemical equation for this reaction. **(2 marks)**

b) Air is a mixture of gases in proportions: 78%, 21% and 1% of nitrogen, oxygen and other trace gases, respectively. Given that 133.5 dm³ of air was required to burn phosphorus completely.

(i) Find the volume, in dm³, of oxygen which reacted. **(1 mark)**

(ii) Deduce the amount, in grams, of oxygen which reacted. **(1 mark)**

(iii) Calculate the amount, in grams, of phosphorus (V) oxide produced. **(2 marks)**

(Atomic mass: P= 31, O= 16; molar gas volume = 22.4 dm³/mole)

SECTION B: ATTEMPT ANY THREE (3) QUESTIONS (30 marks)

- 14) During a laboratory investigation, a student was given a sample that was a mixture of 3.0 grams of NaCl (aq) and 4.0 grams of sand, which was mostly SiO₂(s). The purpose of the investigation was to separate and recover the compounds in the sample. In the first step, a student placed the sample in a 250-mL flask. Secondly, 50 grams of distilled water were added to the flask, and the content was thoroughly stirred. The mixture in the flask was then separated, using the equipment represented by the diagram in figure 2 below.

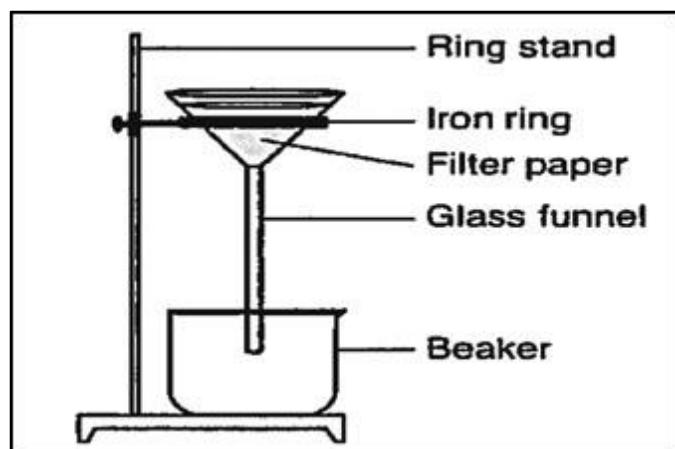


Figure 2

- a) Name the technique used to separate the above mixture. **(1 mark)**
- b) Explain, in terms of solubility, why the mixture in the flask remains heterogeneous even after thorough stirring. **(2 marks)**
- c) State and describe the process which can be used to remove water from the mixture that passes through the filter and collect it in the beaker. **(2 marks)**
- d) Differentiate between a mixture and a compound (at least two differences). **(2 marks)**
- e) Calculate the percentage of NaCl, sand and water in the mixture NaCl-SiO₂-water. **(3 marks)**

15) During electrolysis two points called electrodes are involved:

One which allows the current to enter the electrolyte and another which allows the current to leave the electrolyte.

- a) Name the electrode which allows the current to enter the electrolyte. Give its polarity. **(2 marks)**
- b) Name the electrode which allows the current to leave the electrolyte. Give its polarity. **(2 marks)**
- c) State any two applications of electrolysis. **(2 marks)**
- d) Consider electrolysis of dilute sodium chloride, NaCl(aq) using graphite electrodes.
 - (i) Show all the ions present in the solution. **(2 marks)**
 - (ii) Which product is obtained at the positive electrode and which one is obtained at the negative electrode? **(2 marks)**

16) Plastic carrier bags and single-use plastics have been identified to negatively impact the environment. This is one of the major reasons which pushed the Government of Rwanda to take a decision of banning such materials (plastic carry bags and single-use plastics).

- a) Define the term “waste material”. **(1 mark)**
- b) Differentiate between a biodegradable and a non-biodegradable waste, with one supporting example in each case. **(3 marks)**
- c) State and explain the impact of these plastic carry bags and single-use plastics on environment; soil, water (lakes, oceans), air and health. **(4 marks)**
- d) Formulate any two alternative solutions of materials which can be used in place of plastic carry bags and single-use plastics with less or no impact to the environment. **(2 marks)**

- 17) The most common laboratory method for preparation of chlorine is to heat manganese (IV) oxide with concentrated hydrochloric acid according to experimental set up shown by figure 3 below.

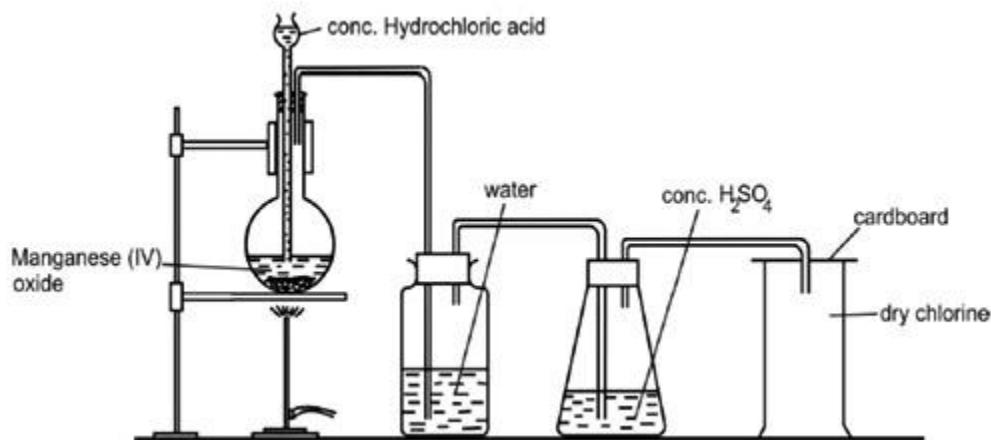


Figure 3

- a) Write a balanced chemical equation between manganese (IV) oxide and concentrated hydrochloric acid. **(2 marks)**
- b) Explain the role of water and sulphuric acid in this experiment. **(2 marks)**
- c) Name the method used to collect chlorine gas. **(1 mark)**
- d) Justify the choice of collecting chlorine gas by the method named in (c) above. **(2 marks)**
- e) Outline any three uses of chlorine and its compounds. **(3 marks)**
- 18) a) On analysis, a compound **P** gave the following percentage composition:
- $$\text{Na} = 43.4\%, \text{C} = 11.3\%, \text{O} = 45.3\%$$
- (i) Define the term empirical formula of a substance. **(1 mark)**
- (ii) Calculate the empirical formula of **P**.
(Atomic mass: Na = 23, C = 12, O = 16) **(4 marks)**
- (iii) If **P** has a molecular mass of 106, deduce the molecular formula. **(2 marks)**

- b) (i) State the Boyle's law. **(1 mark)**
- (ii) A certain mass of a gas occupies 48 mL at a pressure of 720 mm of Hg. What is the volume when the pressure is increased to 960 mm of Hg? (Temperature remains constant) **(2 marks)**

SECTION C: ATTEMPT ANY ONE (1) QUESTION (15 marks)

19) Crystals of zinc sulphate were prepared using the method described below. Excess zinc carbonate was mixed with aqueous sulphuric acid in a beaker. The mixture was warmed until the reaction stopped. The mixture was filtered to remove the unreacted zinc carbonate. The filtrate was evaporated until a small volume remained. The remaining solution was left to cool to form crystals.

- a) Write a balanced chemical equation for the reaction between zinc carbonate and sulphuric acid. **(2 marks)**
- b) Why was excess zinc carbonate used? **(1 mark)**
- c) Why will a similar method not be suitable for preparing lead (II) sulphate? **(1 mark)**
- d) A salt of zinc sulphate has the formula: $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$. How can you show with a chemical test that the compound contains water of crystallization? **(2 marks)**
- e) Calculate the percentage by mass of water in $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$.
(Zn = 65; S = 32; O = 16; H = 1) **(3 marks)**
- f) The solubility of a solute at 30°C is 40. What amount of water is required to make a saturated solution of 80 grams of the solute? **(2 marks)**

- g) A reaction scheme involving an unknown salt XY(aq) is shown in the figure 4 below.

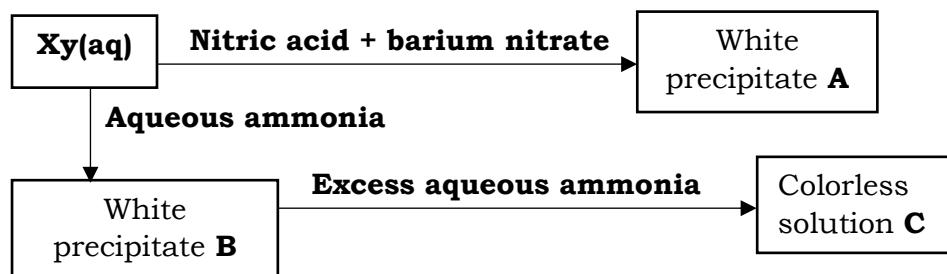


Figure 4

Give the names or chemical formulae for:

(4 marks)

- (i) Solutions **XY** and **C**.
- (ii) Precipitates **A** and **B**.

- 20) Students carried out a titration experiment in a laboratory.

During that titration, 20 cm^3 of sodium carbonate (Na_2CO_3) reacted completely with 0.15M hydrochloric acid (HCl) in excess, using phenolphthalein indicator. The table below has been used to record the volume of HCl used. ($\text{Na} = 23$, $\text{Cl} = 35.5$, $\text{C} = 12$, $\text{O} = 16$, $\text{H} = 1$, phenolphthalein indicator: colorless-pink)

Titration number	1 st	2 nd	3 rd
Final burette reading (cm^3)	25.0	49.5	73.9
Initial burette reading (cm^3)	0.00	25.0	49.5
Volume of hydrochloric acid used (cm^3)	V_1	V_2	V_3

- a) State the expected colour change observed. **(1 mark)**
- b) Find the average volume of HCl used. **(2 marks)**
- c) Write a balanced chemical equation for the reaction that took place. **(2 marks)**
- d) State any other observable change made as the reaction occurs. **(1 mark)**

e) Find:

(i) The mole ratio between Na_2CO_3 : HCl . **(1 mark)**

(ii) The number of moles of hydrochloric acid used and deduce the moles of Na_2CO_3 reacted. **(2 marks)**

(iii) The concentration of sodium carbonate, in mol/dm^3 . **(2 marks)**

(iv) The concentration of sodium carbonate, in g/dm^3 . **(2 marks)**

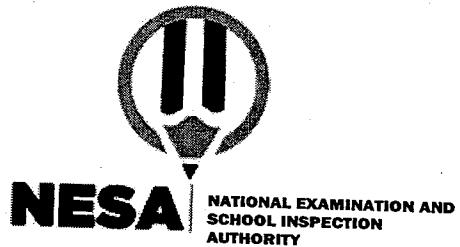
f) Draw a typical experimental set up expected to be used in this titration with all necessary equipment labeled. **(2 marks)**

-END-

Chemistry I

002

29/07/2022 08:30 AM – 11:30AM



ORDINARY LEVEL NATIONAL EXAMINATIONS, 2021-2022

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS:

- 1) Write your names and index number on the answer booklet as they appear on your registration form and **DO NOT** write your names and index number on additional answer sheets if provided.
- 2) Do not open this question paper until you are told to do so.
- 3) 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: This Section **is compulsory** **(15 marks)**
- 4) **You do not need the Periodic table.**
- 5) Silent non- programmable calculators may be used
- 6) Use only a **blue** or **black** pen.

SECTION A: ANSWER ALL QUESTIONS (55 marks)

1) a) A student entered a chemistry laboratory and found two solutions which were not labelled. One is known to be acidic and the other alkaline. He/she uses phenolphthalein indicator to test them. State the colour he/she observed:

(i) In acidic solution.

(1 mark)

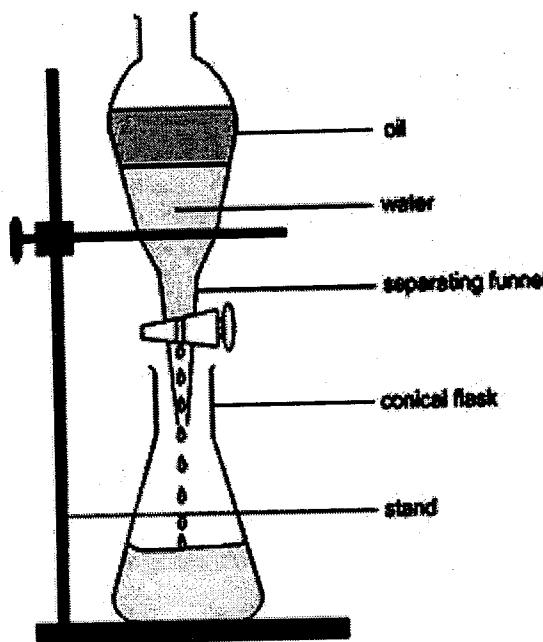
(ii) In basic solution.

(1 mark)

b) List any 2 rules and regulations that students must follow during an experiment in a chemistry laboratory.

(2 marks)

2) Study the experimental setup below and answer the questions that follow.



a) Which type of method for mixture separation does the diagram show?

(1 mark)

b) State to which type of mixture the method above in (2 a) can be applied.

(1 mark)

c) State why liquid oil forms the upper layer.

(1 mark)

d) Give an example of other mixture that can be separated by the same separation technique.

(1 mark)

3) Air can be liquefied by cooling it to about -200°C . The boiling point of oxygen is -183°C and the boiling point of nitrogen is -196°C .

a) When warming liquid air, which substance will boil off first and why?

(2 marks)

b) Give one use of nitrogen.

(1 mark)

c) Give one industrial use of oxygen.

(1 mark)

- 4) The number of protons, neutrons and electrons in particles W, X, Y and Z are shown in the table below.

Particles	Number of protons	Number of neutrons	Number of electrons
W	9	9	10
X	11	11	11
Y	12	12	10
Z	16	17	16

a) Which one(s) of the particles is/are: **(4 marks)**

- (i) A cation.
- (ii) An anion.
- (iii) Neutral.

b) Write the electronic configuration of X. **(1 mark)**

c) (i) State the valency of X. **(1 mark)**
 (ii) Give a reason for your answer in c)(i). **(1 mark)**

- 5) Sodium, Aluminum, Carbon and Sulphur can combine with Oxygen to form oxides. Copy and complete the following table to show the formula and class (amphoteric, acidic, basic, neutral) of the oxide formed by each of these elements.

(Na: Z= 11, Al: Z= 13, S: Z= 16, C: Z=12, O: Z= 8)

Element	Formula of oxide	Class of oxide
Sodium		
Aluminium		
Sulphur		
Carbon		

(4 marks)

- 6) Aluminium is a metal of group IIIa of the periodic table.

a) Using Bohr model of representation of electrons on shells, draw the structure of Aluminium atom. **(1 mark)**

b) Write a balanced chemical equation of a reaction that takes place when aluminium reacts with Chlorine. **(2 marks)**

Atomic numbers: Al (Z=13), Cl (Z=17).

c) How many grams of Aluminium chloride could be produced from 34g of Aluminium and 39g of Chlorine? **(4 marks)**

Relative Mass: Al=27, Cl=35.5

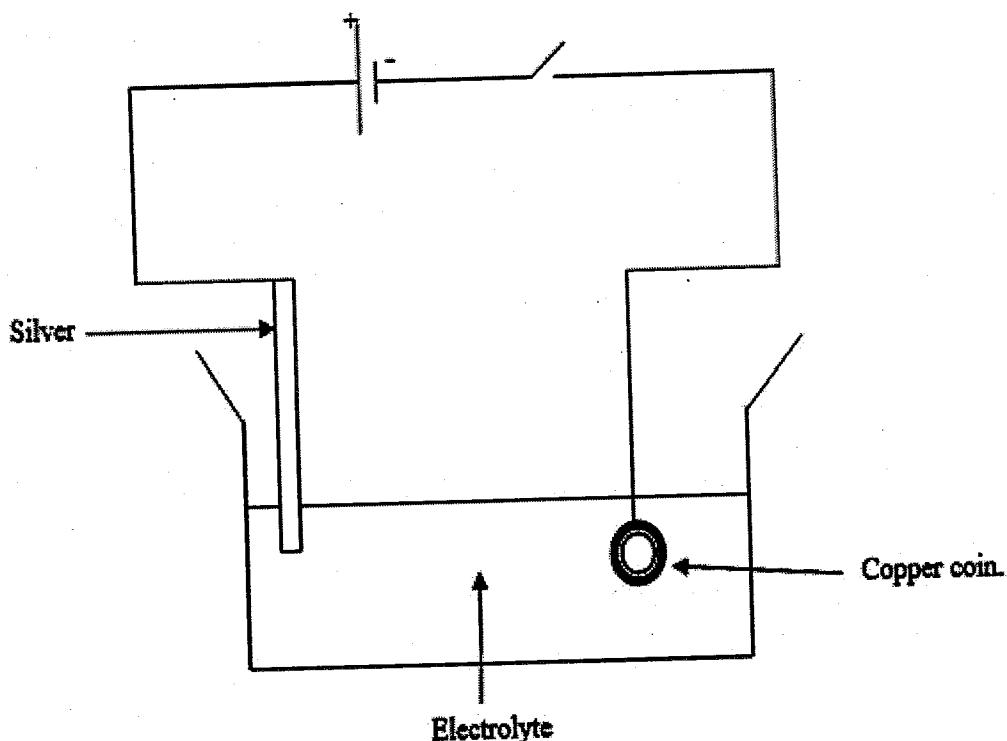
- 7) Aluminium metal conducts electricity in both solid and molten states but aluminium chloride conducts electricity in molten state and not in solid state. **(2 marks)**
- a) Explain this statement.
- b) Which particles are responsible for the conduction of electricity in: **(1 mark)**
(i) Aluminium? **(1 mark)**
(ii) Aluminium chloride?
- 8) Compare the reactivity of the following atoms: **(3 marks)**
a) Magnesium, Mg (Z=12) and Calcium, Ca (Z=20)
- b) Sulphur, S (Z=16) and Chlorine, Cl (Z=17) **(3 marks)**
- 9) Magnesium reacts with chlorine to form magnesium chloride.
(Atomic number: Mg=12, Cl=17) **(2 marks)**
Using this reaction, explain how ionic compounds are formed.
- 10) The molecular formula of an organic substance X is C_4H_{10} .
a) Write down the structural formulae of 2 isomers of substance X and give their chemical names. **(2 marks)**
- b) Write a balanced chemical equation for the reaction of X with chlorine. **(2 marks)**
- 11) Five steps in an acid-base titration are shown below.
- Step 1 - Slowly add the acid from a burette into a conical flask until the indicator becomes colourless.
- Step 2 - Add thymolphthalein.
- Step 3 - Use a volumetric pipette to add a fixed volume of alkali to a conical flask.
- Step 4 - Read and record the initial volume of acid in the burette.
- Step 5 - Read and record the final volume of acid in the burette.
- a) Choose the letter that illustrates the correct sequencing of acid-base titration. **(1 mark)**
- A) $2 \rightarrow 4 \rightarrow 1 \rightarrow 5 \rightarrow 3$
B) $3 \rightarrow 2 \rightarrow 4 \rightarrow 1 \rightarrow 5$
C) $3 \rightarrow 4 \rightarrow 1 \rightarrow 5 \rightarrow 2$
D) $4 \rightarrow 3 \rightarrow 1 \rightarrow 2 \rightarrow 5$
- b) State the role of thymolphthalein in the titration process. **(1 mark)**
- c) Why do we add the acid from a burette into a conical flask dropwise while approaching the end of the titration? **(1 mark)**

- 12) A senior three student passed 140 cm^3 of air over heated copper metal until there was no further change. The remaining volume of air was 115 cm^3 .
- a) State the main gas in the 115 cm^3 of the remaining air. **(1 mark)**
- b) Why did the volume of air decrease? **(1 mark)**
- c) Calculate the percentage by volume of oxygen in the 140 cm^3 of air. **(2 marks)**
- d) Is the air used polluted or not? Give a reason. **(2 marks)**

SECTION B: ATTEMPT ANY THREE (3) QUESTIONS (30 marks)

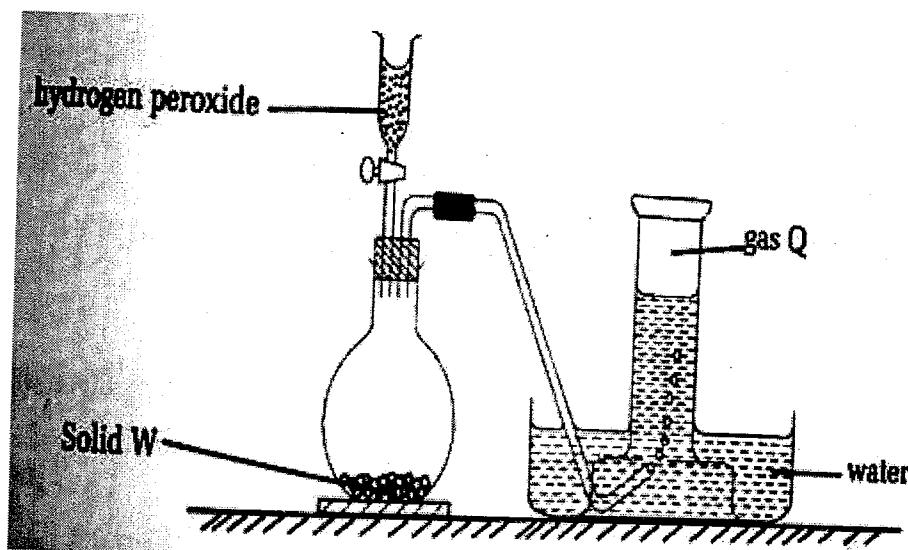
- 13) In an experiment, ammonia gas was prepared by heating ammonium Chloride (NH_4Cl) with Calcium hydroxide [$\text{Ca}(\text{OH})_2$]. After drying, 120 cm^3 of ammonia gas were collected at room temperature and pressure.
- a) Is Calcium hydroxide a base or an acid? Justify your answer. **(2 marks)**
- b) Ammonia gas is dried using calcium oxide and not concentrated sulphuric acid. Explain. **(2 marks)**
- c) Write a chemical equation of the reaction between Calcium hydroxide and ammonium chloride. **(2 marks)**
- d) Calculate the mass of ammonium chloride required to produce 120 cm^3 of ammonia. (RAM: N=14; H=1, Cl= 35.5, molar gas volume = 22.4 dm^3 per mole). **(2 marks)**
- e) The solubility of calcium chloride salt at 30°C is 40, what amount of water is required to make a saturated solution of 80g of solute? **(2marks)**
- 14) a) Burning is one way of managing wastes. Discuss 3 negative impacts of this practice on the environment. **(3marks)**
- b) Outline 3 dangers of materials that do not rot when dumped. **(3marks)**
- c) **Reuse, Recycling, Disposal** and **Minimization** are the steps of effective waste management. Discuss these 4 steps. **(4marks)**

15) Study the diagram below and answer the questions that follow.



- a) Name a suitable electrolyte that could have been used. (1 mark)
- b) What name is given to the negative electrode? (1 mark)
- c) Give an ionic equation for the reaction which occurred on the surface of the copper coin. (2 marks)
- d) What happened to the mass of the silver electrode? Explain your answer. (2 marks)
- e) State the name of particles responsible for conduction of electricity in:
- The electrolyte (1 mark)
 - The external wire connecting the electrodes. (1 mark)
- f) The original mass of the copper coin used was **12.8 g**. Calculate the number of moles of copper in the coin. ($\text{Cu} = 64$). (2 marks)

- 16) Study the diagram representing the preparation and collection of gas Q by decomposing hydrogen peroxide.



- a) Identify W and Q. **(2marks)**
- b) Give the chemical equations of decomposition of hydrogen peroxide, including states of the reactants in the flask. **(2marks)**
- c) Write the chemical equation when:
- Burning Sulphur in gas Q. **(1 mark)**
 - Burning magnesium in gas Q. **(1 mark)**
- (iii) The products in (c)(i) and (c)(ii) were dissolved separately in water and the resulting solution tested with litmus solution. Determine the colour change of litmus solution in each solution. **(2marks)**
- (iv) Explain the reasons of that change in colour in (c)(iii) with a chemical equation. **(2marks)**

SECTION C: THIS QUESTION IS COMPULSORY (15 marks)

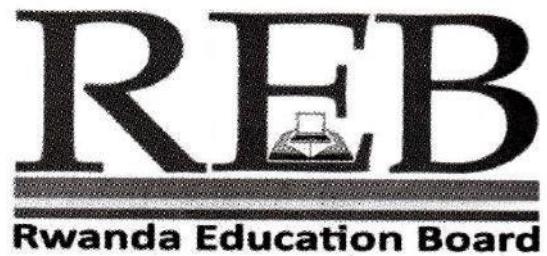
- 17) A sample of air was bubbled into two wash bottles containing soda lime and concentrated sulphuric acid respectively, and finely collected in a gas syringe.
- a) (i) State the role of soda lime in this experimental set up. **(1 mark)**
(ii) Suggest a reason for passing the air sample through concentrated sulphuric acid. **(1 mark)**
- b) 80cm³ of the gas was collected in the syringe and it was passed over heated copper filings in a combustion tube very many times until no further change occurred. On cooling to initial temperature, the volume of the gas did reduce to 63.2cm³.
- State what is observed in the combustion tube. **(1 mark)**
 - What is the purpose of copper fillings? **(1 mark)**
 - Calculate the volume change of the gas in the syringe. **(1 mark)**

- (iv) Determine the percentage change in the volume of the gas. **(2 marks)**
- c) What is the composition of residual gas in the syringe? **(1 mark)**
- d) 20 grams of Sulfur burn completely in air to form Sulfur Dioxide.
- (i) Write the chemical equation of combustion reaction of Sulfur. **(1 mark)**
 - (ii) State the limiting reactant. Support your answer. **(2 marks)**
 - (iii) Calculate the mass of SO_2 produced. **(2 marks)**
 - (iv) Explain how dioxide produced by burning Sulfur, can pollute atmospheric air. (Equation not required). **(2 marks)**

Chemistry I

002

15/11/2019 08.30 AM – 11.30 AM



ORDINARY LEVEL NATIONAL EXAMINATIONS, 2019

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS:

1. Write your names and index number on the answer booklet as they appear on your registration form, and **DO NOT** write your names and index number on additional answer sheets of paper if provided.
2. Do not open this paper until you are told to do so.
3. This paper consists of **three** sections **A**, **B** and **C**
 - Answer **ALL** questions in section A. **(55 marks)**
 - Answer **THREE** questions in section B. **(30 marks)**
 - Answer only **one** question in section C **(15 marks)**
4. Silent non-programmable calculators may be used.
5. You do not need the periodic Table.
6. Use only a **blue** or **black pen** for answering and a **pencil** for drawing.

SECTION A: Attempt all questions from this section.**(55 marks)**

1. a) The atomic number of aluminium is 13. Draw the structure of aluminium atom (Bohr model) showing electrons on shells. **(1 mark)**
b) Explain why aluminium is used to make electric wires. **(2 marks)**

2. a) Give one example of a mixture having 2 substances that can be separated by decantation. **(1 mark)**
b) In hospitals, blood constituents are separated using centrifuge machines in order to know illnesses of patients. **(2 marks)**
(i) Explain how the different constituents separate during centrifugation.
(ii) State two other mixtures that can be separated by centrifugation in hospitals. **(2 marks)**

3. A sports medal has a total surface area of 150 cm^2 . It was evenly coated with silver by electrolysis. Its mass increased by 0.216g. How many atoms of silver were deposited per cm^2 on the medal surface? **(3 marks)**
(Atomic mass: Ag = 107)
(1 mole = 6.02×10^{23} atoms)

4. You want to prepare ZnSO_4 using H_2SO_4 and Zn metal:
 - a) Write the equation of the reaction between Zn and H_2SO_4 solution indicating state symbols. **(2 marks)**
 - b) Explain the method you would use to obtain ZnSO_4 crystals from its aqueous solution. **(2 marks)**

5. An organic compound contains 4.07% hydrogen, 24.27% carbon and 71.65% chlorine by mass. Its molar mass is 99 g/mol.
 - a) Determine the empirical formula of the compound.
 - b) Determine the molecular formula of the compound.
(Atomic mass: C = 12, H = 1, Cl = 35.5)

6. a) Suggest two ways you can use to avoid pollution of water. **(2 marks)**
b) Describe two effects of polluted water to humans. **(2 marks)**

7. Silicon and germanium are metalloids.
 - a) Give two physical or chemical properties of metalloids. **(2 marks)**
 - b) State two important uses of silicon on a large scale. **(2 marks)**

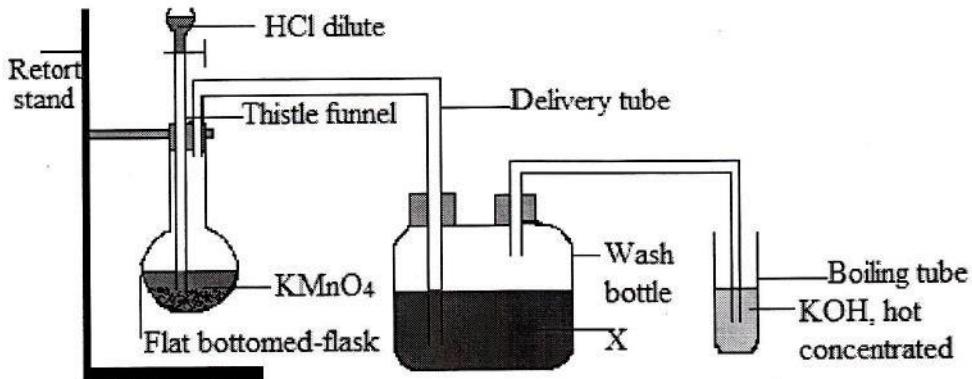
8. a) Ethanol is a compound in the homologous series of alcohols.
 - (i) Write the molecular formula of ethanol. **(1 mark)**
 - (ii) State one use of ethanol on a large scale. **(1 mark)**
b) Evaluate the social-economic importance of biogas which is produced by the decomposition of cow dung in domestic composts in Rwanda. **(2 marks)**

9. Aluminium is extracted from its ores by means of electrolysis of a solution of Al^{3+} .

- a) Write the equation of the reaction which takes place at the cathode during this electrolysis. **(1 mark)**
- b) Discuss the economic importance of aluminium to the Rwandan society. **(2 marks)**
10. (a) Give two conditions necessary for rusting of iron to take place and hence write the chemical formula of iron rust. **(2 marks)**
- (b) State two means that can be used to prevent rusting of iron objects. **(2 marks)**
11. Carbon atoms are linked by three (3) covalent bonds in graphite and the fourth electron of every carbon is free and mobile.
- a) State one physical property that results due to the mobility of electrons in graphite. **(1 mark)**
- b) Diamond is a carbon allotrope. State the type of bonding and one of the physical properties of diamond. **(2 marks)**
12. (a) Calcium carbonate reacts with hydrochloric acid according to the equation:
- $$\text{CaCO}_3 \text{ (s)} + 2 \text{ HCl (aq)} \rightarrow \text{CaCl}_2 \text{ (aq)} + \text{H}_2\text{O (l)} + \text{CO}_2 \text{ (g)}$$
- State two conditions that can be used to obtain the highest rate of production of carbon dioxide at room temperature. **(2 marks)**
- b) State one important use of:
- (i) Calcium carbonate **(2 marks)**
- (ii) Calcium oxide. **(2 marks)**
13. In your school laboratory, suppose that some iron debris (pieces) and about 5 ml of water have been accidentally put in a cup half-filled with table salt. Describe the method you can use to remove the iron and water so that you obtain again the salt in pure form. **(3 marks)**
14. (a) Explain why it is dangerous to keep the charcoal stove burning in a house while the doors and windows are closed. **(2 marks)**
- b) Explain how biodegradable solid wastes such as remains of plants and animals can be disposed of (dumped) to produce useful products in our homes. **(2 marks)**
15. Burning magnesium continues to burn when put in pure carbon dioxide.
- a) Write the equation of the reaction between Mg and CO₂. **(2 marks)**
- b) State two observable changes during the combustion process. **(1 mark)**

SECTION B: Attempt only three questions (30 marks)

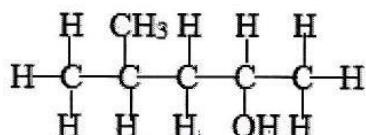
16. Study the diagram given below for the production of chlorine gas and answer the questions that follow:



- (a) Give the name or chemical formula of the substance X present in the bottle. **(1 mark)**
- (b) Write the equation for the reaction between hydrochloric acid, HCl and cold KMnO₄ (potassium permanganate) solution to form chlorine. **(2 marks)**
- (c) State the colour change in the flat-bottomed flask as the reaction between HCl and KMnO₄ proceeds to completion. **(1 mark)**
- (d) Give a test reagent (substance) for chlorine and describe the observable change for a positive test. **(2 marks)**
- (e) Suggest one important use of chlorine on a large scale. **(1 mark)**
- (f) Write the chemical equation for the reaction between Cl₂ and hot, concentrated KOH in the boiling tube. **(2 marks)**
- (g) State one important use of KClO₃. **(1 mark)**
17. During titration, 25 ml of a 0.1 mole/litre Na₂CO₃ solution was poured in a beaker. An appropriate indicator (3 drops of phenolphthalein) was added to the Na₂CO₃ alkaline solution. Titration of HCl (aq) from a burette was done. Neutralisation of the base was reached on addition of 27.50ml of HCl (aq).
Equation:
- $$2\text{HCl (aq)} + \text{Na}_2\text{CO}_3 \text{ (aq)} \rightarrow 2\text{NaCl (aq)} + \text{CO}_2 \text{ (aq)} + \text{H}_2\text{O (l)}$$
- a) State the name of another acid-base indicator that can be used to detect Na₂CO₃ solution and the colour of this indicator in the base. **(2 marks)**
- b) Calculate the number of moles of Na₂CO₃ present in 25ml of solution. **(2 marks)**
- c) Calculate the number of moles of HCl (aq) in 27.50ml of the solution. **(2 marks)**
- d) Calculate the molarity of HCl (aq) **(2 marks)**
- e) Calculate the mass of anhydrous Na₂CO₃ that was used to prepare 25 ml of the solution. **(2 marks)**
- (Atomic mass: Na = 23, C = 12, O = 16)*

- 18.a) An organic compound X is constituted of 40% carbon, 6.72% hydrogen and 53.28% oxygen by mass. *(Atomic mass: C = 12, H = 1, O = 16)*
- (i) Determine the empirical formula of compound X. **(3 marks)**
- (ii) Determine the molecular formula of compound X if its molar mass is 180g/mol. **(2 marks)**

- b) Draw the structural formula of the following organic compound:
3,3-dimethyl but-1-ene (1 mark)
- c) Give the IUPAC name of the following organic compound: (1 mark)

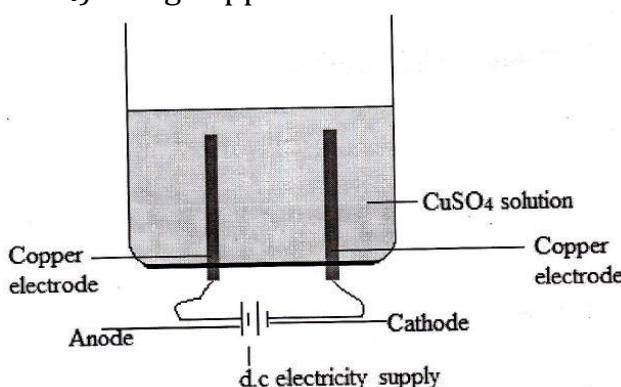


- d) Write the structural formula of the organic compound Y obtained in the following reaction: (1 mark)



- e) State two sources of alcohols. (2 marks)

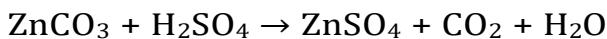
19. Study the diagram for the laboratory electrolysis of copper sulphate solution (CuSO_4) using copper electrodes and answer the questions that follow.



- a) Write the chemical symbols of all ions present in CuSO_4 solution. (2 marks)
- b) Write the chemical equation of the reaction that takes place at the:
- Anode
 - Cathode (2 marks)
- (c) What will be the product of the reaction at the anode if copper electrodes are replaced with carbon electrodes? (1 mark)
- (d) State two useful applications of electrolysis of copper sulphate on a large scale. (2 marks)
- (e) Two iron nails are put in 20 ml of a 0.05 mole/litre solution of copper sulphate in a boiling tube and are kept there for one week;
- State two observable changes in the boiling tube after one week. (1 mark)
 - Write the chemical equation for the reaction between iron, Fe and copper ions in the solution (include state symbols). (2 marks)

20. Study the table shown below and answer the questions that follow:

- Arrange the metals Fe, Pb, Mg, and Zn in order of increasing reactivity (start from the least reactive). (3 marks)
- Construct a balanced equation for the reaction of iron oxide, Fe_2O_3 with Zinc, Zn. (2 marks)
- A student prepared zinc sulphate by adding powdered, zinc carbonate to a beaker half-filled with dilute sulphuric acid.
Equation:



Describe the method that can be used to show that all the zinc carbonate has reacted. **(2 marks)**

- d) Give a reagent or set of reagents that can be used to test for the presence of Zn^{2+} ions in a solution and the observation made. **(2 marks)**
- e) Give one reason to explain why aluminium is used in the manufacture of aircrafts. **(1 mark)**

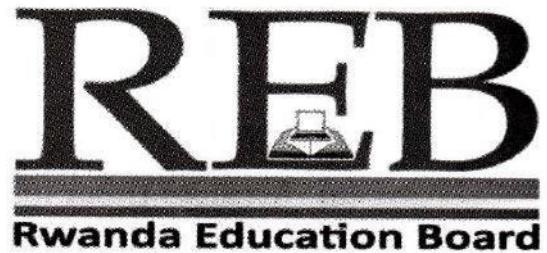
SECTION C: Attempt only one question (15 marks)

21. (a) Describe the term "polymerization". **(1 mark)**
(b) State two different uses of polymers. **(2 marks)**
(c) Describe the technique used during the separation of various fractions of crude oil in the refining process. **(2 marks)**
(d) Write the chemical equation between methanoic acid and potassium hydroxide and give the product of the reaction. **(2 marks)**
(e) Discuss the economic importance and environmental effects of the deposition of cow dung in domestic composts in Rwanda for the production of methane (biogas). **(3 marks)**
(f) Give two reasons to explain why alkanes are preferred for use as fuels instead of alkenes. **(2 marks)**
(g) Calculate the volume which is occupied by 4.2 g of CH_4 gas at 45°C and at 1520 mmHg of pressure. **(3 marks)**
(Atomic mass: C = 12, H = 1)
(1 mole of a gas occupies 24 dm^3 at 25°C and 760 mmHg pressure)
22. The relative densities of oxygen O_2 and carbon dioxide CO_2 are 16 and 22 respectively. It is found that 25 cm^3 of carbon dioxide CO_2 diffuses out in 75 seconds.
- (a) State Graham's law of diffusion of gases. **(2 marks)**
(b) Calculate the volume of oxygen that will diffuse in 100 seconds. **(4 marks)**
(c) State Charles' law of ideal gases that relates the variation of gas volumes with temperature change. **(1.5 marks)**
(d) State Boyle's law of ideal gases that relates the variation of gas volumes with pressure change. **(1.5 marks)**
(e) The volume of an ideal gas is 1500 cm^3 at 17°C and 700 mmHg of pressure.
i) Calculate the volume of this gas at 0°C and 760 mmHg. **(2 marks)**
ii) Calculate the number of moles of this gas present in the above volume. Discuss the important effects of gases in either inflated vehicle tyres, or during the process of rotation of engines when combustion of fuel takes place in engine cylinders. **(2 marks)**
(0°C = 273 Kelvins, 1 mole of a gas occupies 22400 cm^3 at 0°C and 760 mmHg pressure)

CHEMISTRY I

002

23/11/2018 08.30 AM – 11.30 AM



ORDINARY LEVEL NATIONAL EXAMINATIONS, 2018

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

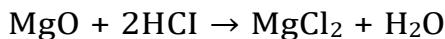
INSTRUCTIONS:

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2. Do not open this paper until you are told to do so.
3. This paper consists of **three** sections **A, B and C**
 - Answer **ALL** questions in section A. **(55 marks)**
 - Answer **THREE** questions in section B. **(30 marks)**
 - Answer only **one** question in section C **(15 marks)**
4. Silent non-programmable calculators may be used.
5. You do not need the periodic Table.
6. Use only a **blue** or **black pen** for answering and a **pencil** for drawing.

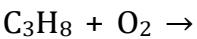
SECTION A: Attempt all questions from this section. (55 marks)

1. The atomic number of helium, neon and argon are 2, 10 and 18 respectively. The three elements are in group VIIa.
(a) Write the electronic configuration of argon, Ar. **(1 mark)**
(b) Explain briefly why these elements are not reactive. **(2 marks)**
2. Briefly explain how the following mixtures can be separated:
(a) Water and ethanol. **(2 marks)**
(b) Sand and iron nails. **(2 marks)**
3. (a) Describe what is observed when a solution containing magnesium ions, Mg^{2+} is added to a solution of sodium hydroxide, NaOH. **(2 marks)**
(b) Write the chemical equation for the reaction between magnesium metal, Mg and dilute hydrochloric acid, HCl. **(2 marks)**
4. The atomic mass of magnesium, oxygen and chlorine are 24, 16 and 35.5 respectively.
(a) Calculate the number of moles in 18g of MgO. **(2 marks)**
(b) Calculate the mass of $MgCl_2$ produced when 18g of MgO react completely with excess HCl. **(2 marks)**

Equation:



5. State a reagent that can be used to distinguish between the following pairs of ions and state the observable change in each case.
(a) CO_3^{2-} and Cl^- **(2 marks)**
(b) Cu^{2+} and Ca^{2+} **(2 marks)**
6. Consider the following oxides: CaO, NO_2 and Al_2O_3 .
(a) Indicate the oxide among the 3 above that is:
(i) Acidic **(1 mark)**
(ii) Amphoteric. **(1 mark)**
(b) Write a balanced chemical equation of the reaction between CaO and H_2O . **(2 marks)**
7. (a) Write the structural formula of ethanol, C_2H_5OH . **(1 mark)**
(b) State 2 uses of ethanol on a large scale. **(2 marks)**
8. $CuSO_4 \cdot 5H_2O$ of 16.5g by mass is heated to drive off water of crystallisation.
Equation: $CuSO_4 \cdot 5H_2O (s) \xrightarrow{\Delta} CuSO_4 (s) + 5H_2O (g)$
(a) Calculate the mass of anhydrous $CuSO_4 (s)$ formed. **(2 marks)**
(b) State the colour change that takes place when all H_2O is removed from $CuSO_4 \cdot 5H_2O$. (Atomic mass: Cu = 63.5, S = 32, O = 16, H = 1) **(2 marks)**
9. (a) Complete the following equation of combustion reaction and balance it:

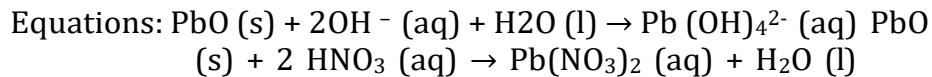


(2 marks)

(b) State 2 uses of alkanes on a large scale.

(2 marks)

10. Lead oxide, PbO reacts with aqueous sodium hydroxide as well as dilute nitric acid, HNO₃.



(a) State a reagent and condition that can be used to test for the presence of Pb²⁺ ions in Pb(NO₃)₂ (aq) solution and mention the observable colour change. **(2 marks)**

(b) Write the chemical equation of the reaction between ZnO and the following reactant to show its amphoteric properties:

(i) ZnO and aqueous dilute HCl solution.

(1 mark)

(ii) ZnO and aqueous NaOH solution.

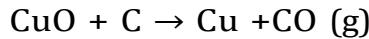
(1 mark)

11. Sulphur reacts with some metals:

(a) Write a balanced equation of the reaction between sulphur and iron. **(1 mark)**

(b) State the names of 2 allotropes of sulphur. **(2 marks)**

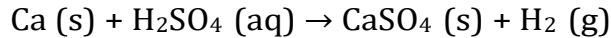
12. (a) Consider the equation of the reaction that is given below and answer the question that follows:



State the type of reaction that takes place to convert CuO to Cu. **(1 mark)**

(b) Indicate the observable changes that take place when CO₂ is bubbled in lime water slowly until in excess of CO₂ gas in the solution. **(2 marks)**

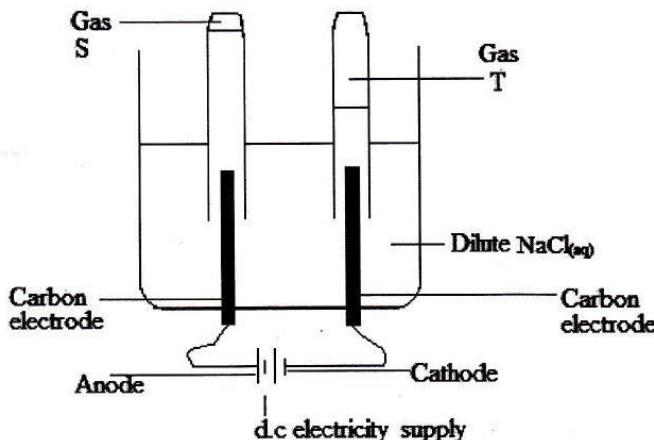
13. Calcium reacts with dilute following equation:



(a) Give one reason to explain why the above reaction occurs for a short period of time and stops. **(1 mark)**

(b) State 2 uses of compounds of group IIa elements. **(2 marks)**

14. The diagram below represents electrolysis of aqueous sodium chloride; NaCl solution prepared using distilled water.



(a) Write the symbols of all ions present in the solution of aqueous sodium chloride, NaCl. **(2 marks)**

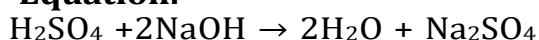
- (b) Write the chemical equation of the reaction that takes place at the:
 (i) Anode (1 mark)
 (ii) Cathode. (1 mark)

15. Chlorine gas is prepared in the laboratory using HCl acid and MnO₂ powder.
 (a) Write a balanced equation of the reaction between HCl acid and MnO₂ powder when hot.
 (b) State 2 uses of chlorine by man.

SECTION B: ATTEMPT ANY THREE QUESTIONS (30 Marks)

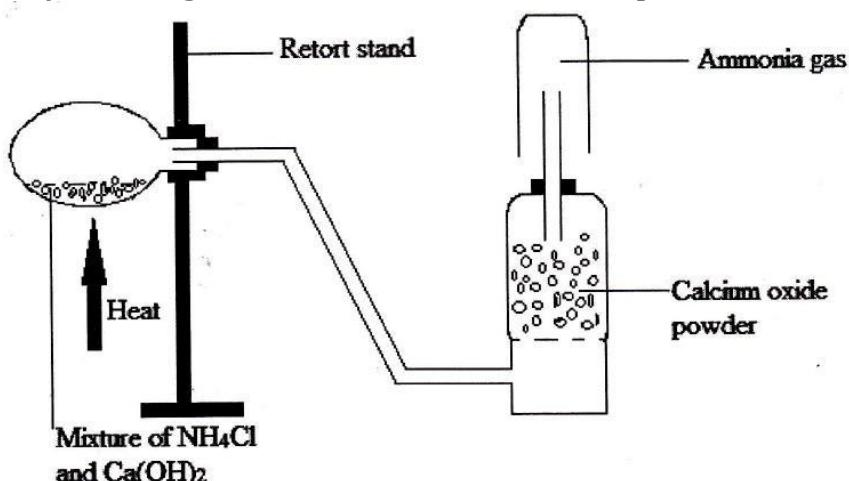
16. During titration, 25 ml of a 0.2 mole/litre NaOH solution was poured in a beaker. An appropriate indicator (phenolphthalein) was added to the NaOH base. Titration of H₂SO₄ (aq) from a burette was done. Neutralisation of the base was reached on addition of 23.50m1 of H₂SO₄ (aq).

Equation:



- (a) State the name of another acid-base indicator that can be used to detect NaOH solution and the colour of this indicator in the base. (2 marks)
 (b) Calculate the number of moles of NaOH present in 25ml of solution. (2 marks)
 (c) Determine the number of moles of H⁺ ions (aq) in 23.50ml of H₂SO₄ solution. (2 marks)
 (d) Calculate the number of moles of H₂SO₄ (aq) in 23.50m1 of its solution. (2 marks)
 (e) Calculate the molarity (moles /litre) of H₂SO₄ (aq). (2 marks)

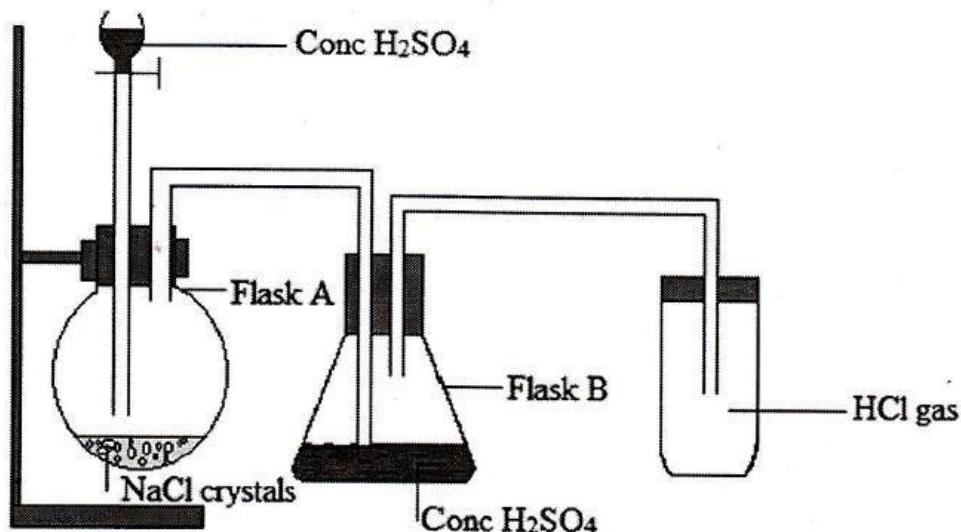
17. Study the diagram below and answer the questions that follow:



- (a) Explain the reason why calcium oxide, CaO is used instead of H₂SO₄ to dry ammonia gas in the apparatus set-up. (1 mark)
 (b) Write a chemical equation of reaction between NH₄Cl and Ca(OH)₂. (2 marks)

- (c) State the name of the method of collection of ammonia gas used in the apparatus set-up above. **(1 mark)**
- (d) Indicate the observable colour changes that take place when ammonia solution is dissolved in a solution of Cu^{2+} ions until in excess. **(2 marks)**
- (e) Write the equation of reaction that takes place when NH_3 gas reacts with HCl gas and state the observable change. **(2 marks)**
- (f) State 2 physical properties of ammonia, NH_3 . **(2 marks)**
18. Organic compound X is constituted of 85.71% carbon and 14.28% hydrogen by mass. The mass of 4.2g of hydrocarbon X occupies a volume of 2400 cm^3 when it is vaporised at room temperature and pressure.
- (a) Calculate the molar mass of compound X. **(3 marks)**
- (b) Determine the empirical formula of compound X. **(2 marks)**
- (c) Determine the molecular formula of compound X. **(2 marks)**
- (d) Write a balanced equation for the reaction of combustion of organic compound X in oxygen. **(2 marks)**
- (e) State 1 use of compound X on a large scale.
(Atomic mass: C = 12, H = 1) (Molar volume of a gas at room temperature and pressure = 24000 cm^3) **(1 mark)**

19. Study the diagram below and answer the questions that follow:



- (a) Write the equation of reaction between concentrated sodium chloride NaCl solution and concentrated sulphuric acid, H_2SO_4 to liberate HCl gas. **(2 marks)**
- (b) State the role of concentrated H_2SO_4 in conical flask B. **(1 mark)**
- (c) State 2 physical properties of hydrogen chloride gas, HCl . **(2 marks)**
- (d) Write a balanced equation of the reaction between magnesium metal, Mg and HCl acid. **(2 marks)**
- (e) (i) write the equation of the reaction between concentrated KMnO_4 solution and concentrated HCl acid to liberate chlorine gas, Cl_2 . **(1 mark)**
- (ii) State a reagent that can be used to detect Cl_2 gas and describe the observable colour change for a positive test. **(2 marks)**

20. The table below shows a part of the periodic table. The letters are not the correct symbols of elements.

Periods	Groups							
	I	II	III	IV	V	VI	VII	VIII
1								F
2	A		C		E			
3		B		D				
4								
5								

- (a) Which letters shown on the diagram are:
- (i) Two elements that are metals? (2 marks)
 - (ii) Two elements that are in one period? (1 mark)
 - (iii) An unreactive inert gas? (1 mark)
- (b) Write the formula of a compound formed between A and E. (2 marks)
- (c) State 2 physical properties of element B. (2 marks)
- (d) State the type of bond that exists between element D and E. (1 mark)
- (e) Element C is in group IV and in period 2. Write the electronic configuration of C. (1 mark)

SECTION C: THIS SECTION IS COMPULSORY (15 Marks)

21. Oxides are formed by reaction of oxygen with different elements.

- (a) State the name of a compound resulting from combination of oxygen with another element. (1 mark)
- (b) Write a chemical formula of such a compound mentioned in 21 (a) above. (1 mark)
- (c) Write the name of 1 rare gas found in its important use by man. (2 marks)
- (d) Describe the properties of oxygen that allows it to be collected upwards in a water tank. (1 mark)
- (e) State 1 example of:
 - (i) Slow oxidation. (1 mark)
 - (ii) Rapid oxidation. (1 mark)
- (f) Draw a labelled diagram of the laboratory preparation of ethene from ethanol. (3 marks)
- (g) State 2 main chemical reactants used for the preparation of soap. (2 marks)
- (h) 1g of sucrose sugar is put in a pyrex test tube, 2 ml of concentrated H_2SO_4 is added to it:
 - (i) State what is observed after 1 hour of reaction. (1 mark)
 - (ii) Give a brief description of the term "hygroscopic substance" and give an example of such a substance. (2 marks)

22. You are provided with substance Y. Study the observations in the table below and deduce the type of cation S and anion T present in substance Y.

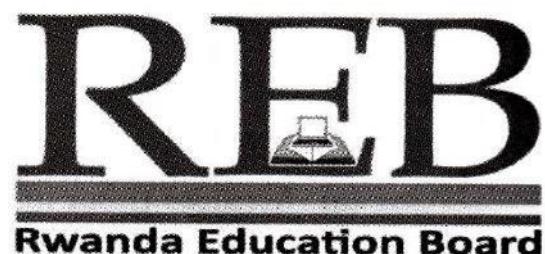
Test	Y (solution) + Reagent	Observation	Possible ions present (symbols of Ions)
1	Y (aq) + NaOH	Pale blue precipitate formed	
2	Y (aq) + KI (aq)	Brown precipitate formed	
3	Y (aq) + Na ₂ CO ₃ (aq)	Pale blue precipitate formed	
4	Y (aq) + NH ₃ (aq) then add in excess of NH ₃ (aq)	Pale blue precipitate formed that turns deep blue in excess of NH ₃ (aq)	
5	Y (aq) + BaNO ₃ (aq)	White precipitate formed	
6	Y (aq) + Mg (s)	Brown solid deposited on the bottom of the test tube	

- (a) Copy the table and write the possible ions present in tests 1, 2, 3, 4, 5 and 6 respectively. **(12 marks)**
- (b) Cation present in Y is: **(1mark)**
- (c) Anion present in Y is: **(1 mark)**
- (d) The chemical formula of substance Y is: **(1 mark)**

Chemistry I

002

24/11/2017 08.30 AM – 11.30 AM



ORDINARY LEVEL NATIONAL EXAMINATIONS, 2017

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS:

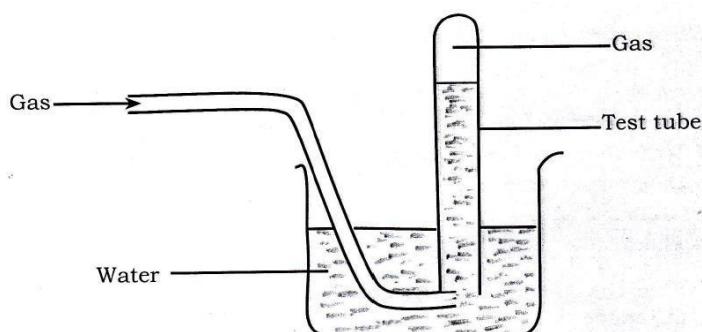
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 - Answer **ALL** questions in section A. **(55 marks)**
 - Answer **THREE** questions in section B. **(30 marks)**
 - Answer only **one** question in section C **(15 marks)**
4. Silent non-programmable calculators may be used.
5. You do not need the periodic Table.
6. Use only a **blue** or **black pen** for answering and a **pencil** for drawing.

SECTION A: Attempt all questions from this section. (55 marks)

1. The number of protons, neutrons and electrons in particles W, X, Y, and Z are shown in the table below.

Particles	Number of protons	Number of neutrons	Number of electrons
W	6	6	6
X	9	10	10
Y	12	12	10
Z	19	20	19

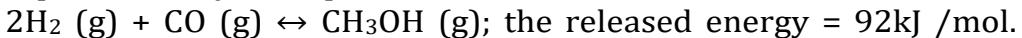
- (a) Which one of the particles is: (3 marks)
- (i) a cation?
 - (ii) an anion?
 - (iii) neutral?
- b) Write the electronic configuration of Z. (1 mark)
- c) (i) State the valency of Z. (1 mark)
- (ii) Give a reason for your answer in 1 c) (i) above. (1 mark)
2. Sodium, aluminium and sulphur can combine with oxygen to form oxides. Copy and complete the following table to show the formula and class (amphoteric, acidic or basic) of the oxide of each of these elements. (K: Z = 19; Al: Z = 13; S: Z = 16; O: Z = 8) (6 marks)
- | Element | Formula of oxide | Class of oxide |
|-----------|------------------|----------------|
| Potassium | | |
| Aluminium | | |
| Sulphur | | |
3. You are given a list of different gases: hydrogen chloride, hydrogen sulphide, sulphur dioxide and carbon dioxide. From the above list, identify the gas that has the following properties: (3 marks)
- a) turns blue litmus paper red,
 - b) forms white fumes with ammonia,
 - c) forms a white precipitate with aqueous silver nitrate.
4. State which of the following gases: NH_3 , O_2 , HCl and F_2 , can be collected by the method shown in the figure below and explain why the others cannot. (3 marks)



5. Calculate the mass percentage of water of crystallization in $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.
(Atomic mass: Cu = 64; S = 32; O = 16; H = 1) **(3 marks)**
6. An alkane X of formula mass 30 consists of 80% carbon by mass.
a) Determine the empirical formula of X. **(2 marks)**
b) Determine the molecular formula of X. **(1 mark)**
c) Write a chemical equation for the complete combustion of X in oxygen. **(1 mark)**
7. Ethene can react to form a solid whose molecular mass is more than 10,000.
a) Name the reaction that occurs. **(1 mark)**
b) Write the chemical equation of that reaction. **(1 mark)**
c) (i) State what is observed when ethene reacts with bromine. **(1 mark)**
(ii) Write the equation for the reaction in 7(c)(i) above. **(1 mark)**
8. Explain why:
a) Hard water requires a lot of soap to form a lather. **(1 mark)**
b) Isotopes of an element show similar chemical reactions. **(1 mark)**
c) When carbon dioxide is bubbled through lime water, the lime water turns milky and finally clears. **(1 mark)**
9. Calculate the mass of nitric acid (HNO_3) required for preparing 200cm^3 of 2M HNO_3 solution. (Atomic mass: H = 1, N = 14, O = 16) **(2 marks)**
10. Soap can be prepared by boiling vegetable oil with sodium hydroxide and adding a solution of sodium chloride to the reaction mixture.
a) What name is given to the reaction leading to the formation of soap? **(0.5 mark)**
b) Name one crop from which oil for making soap can be obtained. **(1 mark)**
c) Why is sodium chloride added to the reaction mixture? **(1 mark)**
d) State one advantage of using detergents instead of soap. **(1 mark)**
11. When hydrogen gas was passed over X g of strongly heated copper (II) oxide until there was no further change, 4 g of a solid was formed.
(Atomic mass: Cu = 64, O: 16)
a) State what was observed. **(1 mark)**
b) Write the equation for the reaction. **(1 mark)**
c) Determine the value of X. **(2 marks)**
12. Acidified water was electrolyzed using platinum electrodes.
a) Write the chemical equation of reaction that took place at the:
(i) Anode
(ii) Cathode **(2marks)**
b) Name any other substance that can be used as electrodes in the electrolysis of acidified water. **(0.5 mark)**

13. Describe the industrial preparation of nitric acid from ammonia (the diagram is not required). Your description should include equations for reactions that occur. **(6 marks)**

14. The formation of methanol from hydrogen and carbon monoxide is represented by the equation:



the released energy = 92kJ /mol.
Calculate the energy that is released, in kJ/mole, when 96g of methanol is formed. (Relative mass: C= 12, H= 1 and O = 16)

15. Magnesium reacts with steam to give solid X and gas y.

a) Identify:

(i) Solid X. **(0.5 mark)**

(ii) Gas Y. **(0.5 mark)**

b) Describe how Y could be tested. **(1 mark)**

c) Write the chemical equation for the reaction between X and hydrochloric acid. **(1 mark)**

SECTION B: ATTEMPT ANY THREE QUESTIONS (30 MARKS)

16.a) Substance X reacts with a solid chloride to produce hydrogen chloride.

(i) Identify X. **(1 mark)**

(ii) State the conditions for the reaction. **(1.5 mark)**

(iii) Write the equation for the reaction. **(1 mark)**

b) (i) Name the substance that is formed when hydrogen chloride is dissolved in water. **(1 mark)**

(ii) Explain why an aqueous solution of hydrogen chloride is an electrolyte whereas the solution of the gas in organic compounds is a non- electrolyte (no equation is required). **(2 marks)**

c) An aqueous solution of hydrogen chloride was added drop-wise to 4.2 g of solid sodium hydrogen carbonate until there was no further change. A colourless gas was evolved.

(i) Write the chemical equation(s) for the reaction between sodium hydrogen carbonate and hydrogen chloride. **(1 mark)**

(ii) Calculate the volume of the gas, measured at s.t.p that was evolved. (1 mole of gas occupies a volume of 22400 cm³ at s.t.p, Na = 23, H= 1, C = 12, O= 16) **(2.5 marks)**

17.a) Copper (II) carbonate was heated strongly until there was no further change.

(i) State what was observed. **(1 mark)**

(ii) Write the chemical equation for the reaction. **(1 mark)**

b) Excess dilute sulphuric acid was added to the residue in 17 (a) (ii) and the mixture warmed.

(i) State what was observed. **(1 mark)**

(ii) Write the chemical equation for the reaction. **(1 mark)**

c) To the product in 17 (b) above was added dilute sodium hydroxide solution drop wise until in excess.

(i) State what was observed. **(1 mark)**

- (ii) Write the chemical equation for the reaction. **(1 mark)**
 d) 25.0 cm³ of 0.1M hydrochloric acid required 10.0 cm³ of sodium carbonate for complete neutralization. **(1 mark)**
 (i) Write the chemical equation for the reaction which took place between sodium carbonate and hydrochloric acid. **(1 mark)**
 (ii) Calculate the concentration of sodium carbonate in mole/dm³. **(3 marks)**

18. 5.34g of a salt of formula M₂SO₄ (where M is a metal) were dissolved in water. The sulphate ion was precipitated by adding excess barium chloride solution and 4.66g of barium sulphate (BaSO₄) were obtained

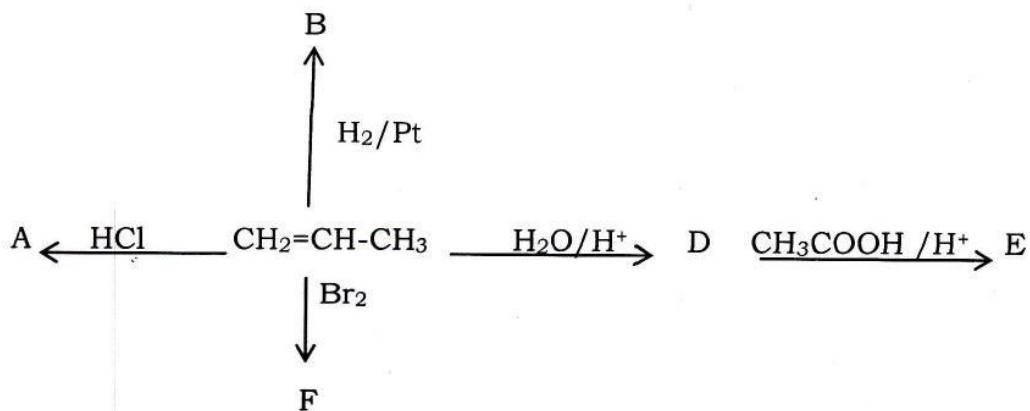
(Atomic mass: S = 32, O = 16, Ba = 137;

Avogadro constant = 6.023 x 10²³ mol⁻¹)

- a) Write the ionic equation of the reaction that leads to formation of the precipitate. **(1 mark)**
 b) How many moles of sulphate ions were precipitated as barium sulphate? **(1.5 marks)**
 c) How many moles of M₂SO₄ were in the solution? **(1.5 marks)**
 d) What is the formula mass of M₂SO₄? **(2.5 marks)**
 e) What is the relative atomic mass of M? **(2.5 marks)**
 f) What is the mass of 60²³ x 10²¹ atoms of M? **(1 mark)**

- 19.a) (i) State two properties which show that air is a mixture. **(1 mark)**
 (ii) Name two gases other than oxygen that are constituents of air and give their approximate percentages in air. **(2 marks)**
 b) Describe an experiment to determine the percentage of oxygen in air.
 (Show how the percentage can be calculated from the results). **(6marks)**
 c) Write the chemical equation of the reaction that takes place in the silica tube. **(1 mark)**

20. a) Write the molecular formula of A, B, D, E and F: **(5 marks)**



- b) Name the reactants CH₂ = CH-CH₃ and CH₃COOH and the products A, B and F. **(5 marks)**

SECTION C: THIS QUESTION IS COMPULSORY (15 marks)

- 21.a) What is meant by "rate of chemical reaction"? **(1 mark)**
b) Explain how the following factors affect the rate of a chemical reaction:
(i) Temperature. **(1 mark)**
(ii) Surface of the reactants. **(1 mark)**
c) The table below shows the volume of hydrogen gas collected at various time intervals when magnesium was reacted with 2 M hydrochloric acid.

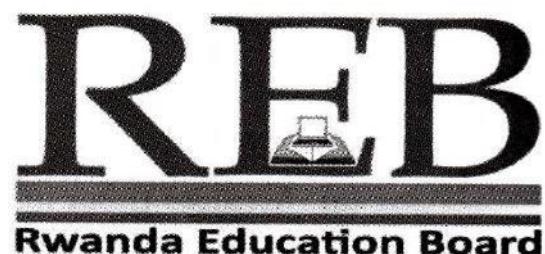
Time (seconds)	0	1	2	3	4	5	6	7
Volume of H ₂ collected (cm ³)	0	25	45	60	70	75	77	77

- (i) Write the chemical equation of the reaction. **(1 mark)**
(ii) Plot a graph of volume of hydrogen versus time. **(6 marks)**
(iii) Determine the rate of reaction at 3 seconds (take the tangent at 3 seconds and find the slope, $s = \frac{\Delta y}{\Delta x} = \text{rate}$) **(2 marks)**
(iv) Determine the volume of hydrogen evolved at 3.5 seconds. **(2 marks)**
(v) When did the reaction end? **(1 mark)**
22. a) (i) Draw a labelled diagram to show how a sample of oxygen gas can be prepared in the laboratory from hydrogen peroxide. **(5 marks)**
(ii) Write the chemical equation for the reaction that takes place in 22)a)(i) above. **(1 mark)**
b) State and explain what happens when each of the following substances are lowered in a gas jar of oxygen and water added to the products.
(i) Hot sodium. **(3 marks)**
(ii) Ignited magnesium. **(2 marks)**
(iii) Hot iron. **(2 marks)**
c) Name one natural process by which oxygen can be obtained. **(1 mark)**
d) State one use of oxygen. **(1 mark)**

Chemistry I

002

14 Nov. 2016 08.30 am – 11.30 am



ORDINARY LEVEL NATIONAL EXAMINATIONS, 2016

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS:

1. Write your names and index number on the answer booklet as they appear on your registration form, and **DO NOT** write your names and index number on additional answer sheets of paper if provided.
2. Do not open this paper until you are told to do so.
3. This paper consists of **three** sections **A, B and C**
 - Answer **ALL** questions in section A. **(55 marks)**
 - Answer **THREE** questions in section B. **(30 marks)**
 - Answer only **one** question in section C **(15 marks)**
4. Silent non-programmable calculators may be used.
5. You do not need the periodic Table.
6. Use only a **blue** or **black pen** for answering and a **pencil** for drawing.

SECTION A: Attempt all questions from this section. (55 marks)

1. Iron metal undergoes rusting when it is exposed to air for a long period of time.
 - (a) Indicate names of 2 chemical substances that are necessary for causing rusting of iron, Fe. **(2 marks)**
 - (b) Mention 2 means that are used, to prevent rusting of objects which are made of iron (Fe) metal. **(2 marks)**
2. Water is used for various domestic purposes
 - (a) State 2 natural sources of water. **(2 marks)**
 - (b) Briefly describe one method used, to treat unclean drinking water to be ready for cooking food. **(2 marks)**
3. A student uses 100 cm³ of a 0.5 mole.dm⁻³ sodium hydroxide solution to react with excess sulphuric acid.
 - (a) Calculate the number of moles of NaOH contained in 100 cm³ of solution. **(2 marks)**
 - (b) Calculate the mass of sodium sulphate crystals that are formed after evaporation of the resultant solution. **(2 marks)**

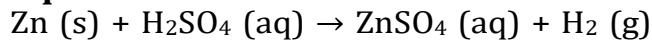
Equation: H₂SO₄ (aq) + 2NaOH (aq) → Na₂SO₄ (aq) + 2H₂O (aq)
(Atomic mass: Na = 23, S = 32, O = 16, H = 1)
4. (a) When hydrated sodium sulphate crystals are heated gently, water is given off.
State the name of the reagent used to test the presence of water and the expected observation for a positive test. **(2 marks)**
(b) Pure oxygen for industrial use can be obtained from atmospheric air.
State the percentage composition of oxygen gas by volume in air. **(1 mark)**
5. In the upper atmosphere, there is a layer of ozone surrounding the earth.
 - (a) Explain the importance of this layer in terms of human health. **(2 marks)**
 - (b) State the type of chemical substances that destroy the ozone layer. **(1 mark)**
6. Calcium is a metal of group IIa of the periodic table.
 - (a) Using Bohr model of the representation of electrons on shells, draw the structure of calcium atom. **(2 marks)**
 - (b) Write a balanced equation of the reaction that takes place when calcium reacts with oxygen (O₂). (Atomic number of Ca = 20). **(2 marks)**
7. Sodium atom loses 1 electron and sulphur accepts 2 electrons to form ions.
 - (a) Deduce the chemical formula of the compound formed between sodium and sulphur. **(2 marks)**
 - (b) State one physical and one chemical property of the compound formed when sodium reacts with sulphur. (Atomic number: Na = 11, S = 16) **(2 marks)**

8. When calcium reacts with water, hydrogen gas is evolved and an alkaline solution is formed.
- (a) State two observable changes that take place when calcium reacts with water. **(2 marks)**
- (b) Write the equation of reaction between calcium and water; include state symbols. **(2 marks)**
9. Magnesium is an alkaline earth metal; copper is a transition element. State one difference between these two metals in terms of
- (a) Melting point. **(1 mark)**
- (b) Density. **(1 mark)**
- (c) Colour. **(1 mark)**
10. In an experiment, SO_2 gas was dissolved in a test tube of cold water; blue and red litmus papers were put in the resultant mixture.
- (a) Indicate the litmus paper that changed colour.
- (b) Write down the chemical equation for the reaction which took place between SO_2 and H_2O .
11. State the reagent that you would use to differentiate between each of the pair of compounds and give the observable change for a positive test:
- (a) Sulphur dioxide, SO_2 and hydrogen sulphide H_2S .
- (b) Copper II nitrate $\text{Cu}(\text{NO}_3)_2$ and Iron II nitrate $\text{Fe}(\text{NO}_3)_2$.
12. Alkanes are members of a homologous series of saturated hydrocarbons with the general formula $\text{C}_n\text{H}_{2n+2}$.
- (a) Write the chemical equation of reaction for the combustion of an alkane with 4 carbon atoms. **(2 marks)**
- (b) State 2 uses of hydrocarbon compounds. **(2 marks)**
13. Silicon dioxide has a similar structure to that of diamond. Suggest the reason why silicon dioxide:
- (a) Does not conduct electricity. **(2 marks)**
- (b) Is solid at 25°C . **(2 marks)**
14. A student added 3.0 g of magnesium to an excess sulphuric acid solution of $0.5 \text{ mole} \cdot \text{dm}^{-3}$ by concentration to react in a container.
- (a) Calculate the number of moles contained in 3.0 g of magnesium. **(2 marks)**
- (b) Calculate the maximum volume of sulphuric acid that reacted with all the 3.0 g of magnesium. (Atomic mass, Mg= 24). **(2 marks)**
- Equation of reaction:
- $\text{Mg} \text{ (s)} + \text{H}_2\text{SO}_4 \text{ (aq)} \rightarrow \text{MgSO}_4 \text{ (aq)} + \text{H}_2 \text{ (g)}$
15. (a) Write the chemical formula of 1 weak base. **(1 mark)**
- (b) Describe the difference between a strong acid and a weak acid. **(1 mark)**

SECTION B: ATTEMPT ANY THREE QUESTIONS**(30 MARKS)**

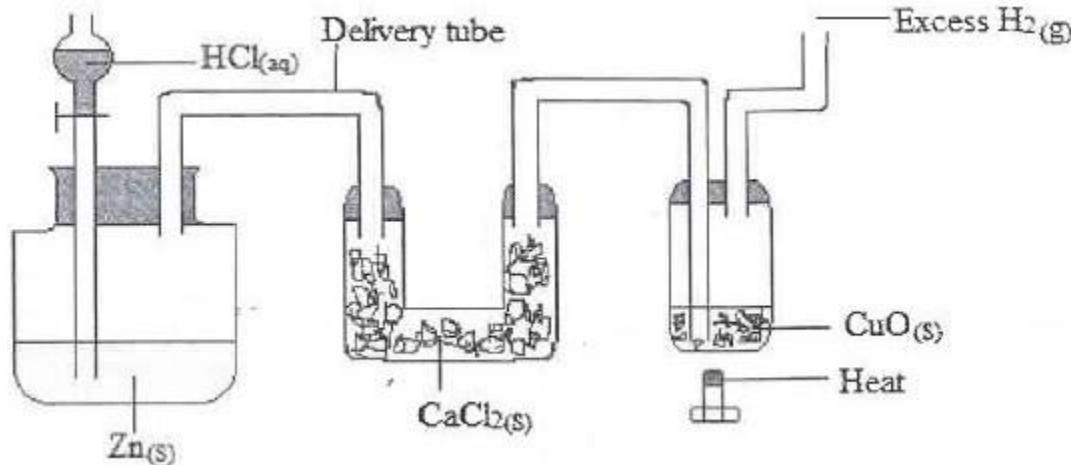
16. A mixture of Zinc and Zinc oxide were reacted with excess sulphuric acid. 400 cm³ of hydrogen gas were produced (measured at room temperature and pressure). If the mixture had a mass of 2 g and only Zinc reacted with the acid to produce H₂ gas, determine:

- (a) The number of moles of H₂ gas produced. **(2 marks)**
(b) The number of moles of Zn that reacted with the acid. **(2 marks)**
(c) The mass of zinc in the mixture. **(2 marks)**
(d) The mass of zinc oxide in the mixture. **(2 marks)**
(e) The percentage composition of Zinc oxide by mass in the mixture. **(2 marks)**

Equation:

(Atomic mass: Zn = 65, O = 16; 1 mole of a gas occupies 24000 cm³ at room temperature and pressure)

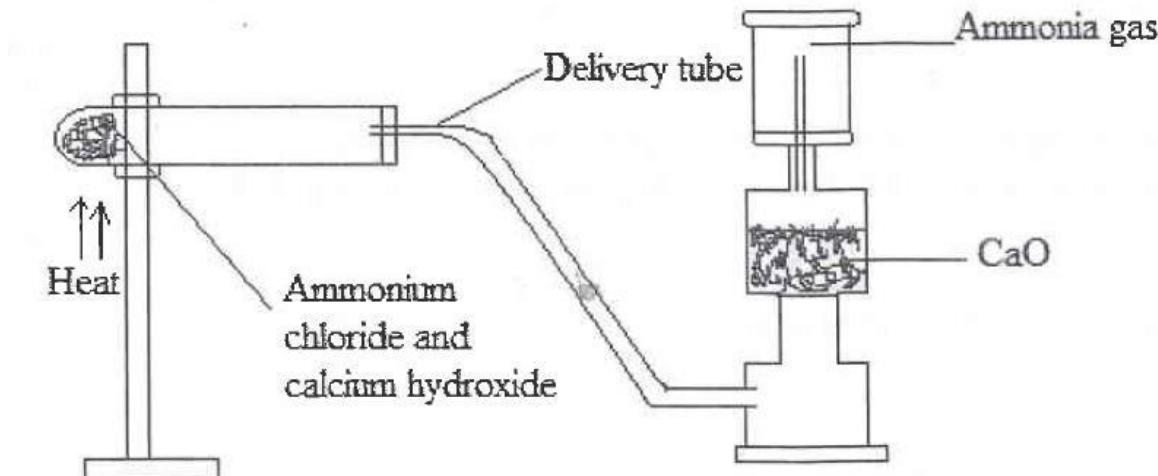
17. Copper II oxide, CuO can be reduced by hydrogen gas H₂. Study the set-up of the diagram below and answer the questions that follow:



- (a) Write the equation of the reaction that takes place when copper II oxide reacts with hydrogen gas. **(2 marks)**
(b) State the observable colour change when copper II oxide has completely been reduced by hydrogen. **(2 marks)**
(c) State the role of CaCl₂ in the tube. **(1 mark)**
(d) Zn reacts with dilute HCl to produce H₂:
(i) Indicate 1 physical property of H₂ gas. **(1 mark)**
(ii) Mention 1 test for H₂ gas and give the observation of the test. **(2 marks)**
(e) Copper II oxide can also be reduced by carbon on heating.
Write the equation of reaction between CuO and C. **(2 marks)**

18. The set-up apparatus below is for the preparation of ammonia gas in the laboratory.

Equation for the reaction:



- (a) (i) State the role of calcium oxide (CaO) in the apparatus. **(1 mark)**
(ii) State the type of method used for the collection of the gas NH₃ in the set up. **(1 mark)**
(iii) Write a balanced equation of reaction between NH₃ and H₂SO₄. **(2 marks)**
(iv) State 2 uses of ammonia on a large scale. **(2 marks)**
- (b) Nitric acid is used to prepare fertilizers.
(i) Write a balanced equation of the reaction between HNO₃ and Ca(OH)₂. **(2 marks)**
(ii) State 1 danger of using chemical fertilizers. **(1 mark)**
- (c) Nitrogen gas from the atmosphere is absorbed by plants via root nodules to form nitrate fertilizers. State the percentage composition of nitrogen gas in the atmosphere. **(1 mark)**

19. The table below shows some symbols of elements of the periodic table. Study the table and answer the questions that follow:

Element symbol	Group of element	Period of element	Atomic number
Li	I	2	3
O	VI	2	8
Ca	II	4	20
Cl	VII	3	17
Al	III	3	13
N	V	2	7

- (a) Write the electronic configuration of the oxygen atom (O). **(1 mark)**
(b) Write a chemical equation that represents the ionization (ion formation) of Li. **(2 marks)**
(c) Deduce the formula of the compound formed by reaction of Al and Cl. **(2 marks)**

- (d) State 2 physical properties of a compound formed between N and O. (2 marks)
- (e) Indicate 1 important use of compounds of N element. (1 mark)
- (f) Give 2 reasons to suggest why Al is the best of the above elements at being used as electric cables. (2 marks)
20. (a) Draw a well labelled diagram for the preparation of chlorine gas in the laboratory. (3 marks)
- (b) A red litmus paper is placed in chlorine gas for 5 minutes, state 2 observable changes on the red litmus paper during the exposure in chlorine gas. (2 marks)
- (c) Chlorine gas dissolves in cold water:
- (i) Write a chemical equation of the reaction that takes place between Cl_2 and H_2O . (2 marks)
- (ii) Describe the observation seen when AgNO_3 solution is added to the solution of Cl_2 . (2 marks)
- (d) State 1 use of chlorine. (1 mark)

SECTION C: THIS QUESTION IS COMPULSORY (15 MARKS)

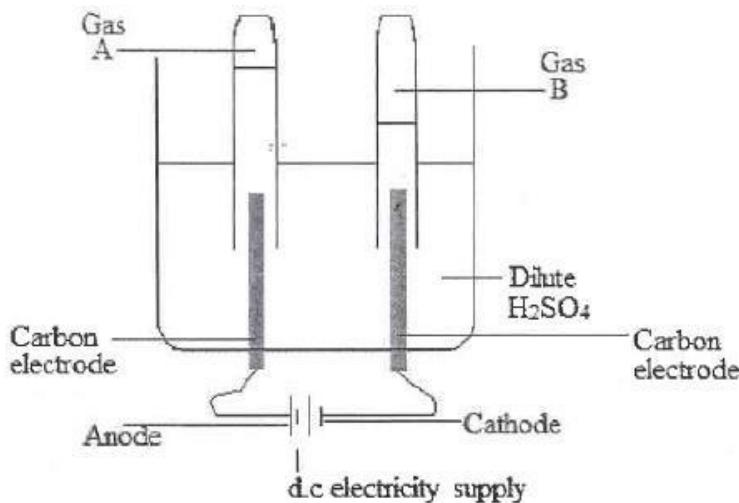
21. Graphite and diamond are allotropes of carbon with different physical properties.
- (a) Write 1 physical property of:
- (i) Graphite. (1 mark)
- (ii) Diamond. (1 mark)
- (b) Write a chemical equation of the reaction between carbon (C) and iron oxide (Fe_2O_3). (2 marks)
- (c) State 1 use of:
- (i) Graphite. (1 mark)
- (ii) Diamond. (1 mark)
- (d) Carbon reacts with oxygen during combustion according to the equation:
- $$\text{C (s)} + \text{O}_2 \text{ (g)} \rightarrow \text{CO}_2 \text{ (g)}$$

In insufficient oxygen, the reaction shown below takes place:

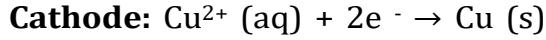
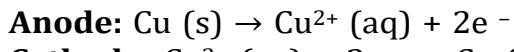


- (i) Mention 2 important uses of CO_2 in nature. (2 marks)
- (ii) State 1 important use and 1 danger of CO gas. (2 marks)
- (e) Carbon dioxide (CO_2) causes global warming. Describe 2 means of reducing CO_2 from the atmosphere. (2 marks)
- (f) Marble rock that is formed of carbonates can be degraded by acid rain.
- (i) Write the equation of the reaction between calcium carbonate, CaCO_3 , and hydrochloric acid, HCl. (2 marks)
- ii) Temporary hard water contains hydrogen carbonates, HCO_3^- . Indicate 1 means that is used to soften (eliminate) HCO_3^- from hard water.

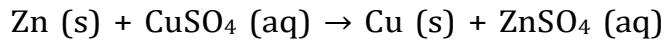
- (1 mark)
22. (a) Describe the term "electrolyte" substance. (2 marks)
 (b) Write the chemical formula of 1 electrolyte substance. (1 mark)
 (c) Study the diagram below and answer the questions that follow:



- (i) Write the chemical equation of the reaction that takes place at the "anode" and at the "cathode". (4 marks)
- (ii) Describe a simple test for gas B and the observation for this test. (2 marks)
- (d) When carbon electrodes are replaced with copper electrodes using copper sulphate solution (CuSO_4) instead of H_2SO_4 ; the following reactions take place:



- (i) Indicate 1 observable change in the mixture when the reaction is almost complete. (1 mark)
- (ii) State 2 important applications of electrolysis on a large scale. (2 marks)
- (d) Zinc metal is put in a solution of copper sulphate. The following reaction takes place:



- (i) If Zn and Cu metals are connected in an electrochemical cell; which of the two metals can act as "anode"? (1 mark)
- (ii) Indicate a reagent substance that can be used to distinguish ZnSO_4 solution and CuSO_4 solution and the observable change when the reagent reacts in each case. (2 marks)

Chemistry I

002

17/11/ 2015 08.30AM - 11.30AM



ORDINARY LEVEL NATIONAL EXAMINATIONS, 2015

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS:

- 1) Write your names and index number on the answer booklet as they appear on your registration form, and **DO NOT** write your names and index number on additional answer sheets of paper if provided.
- 2) Do not open this question paper until you are told to do so.
- 3) This paper consists of three sections: **A**, **B** and **C**.
 - **Section A:** Attempt all questions. **(55marks)**
 - **Section B:** Attempt any **THREE** questions. **(30marks)**
 - **Section C:** Attempt **ONLY ONE** question. **(15marks)**
- 4) You do not need the Periodic Table.
- 5) Silent non-programmable calculator may be used.

SECTION A: ATTEMPT ALL THE QUESTIONS. (55MARKS)

- 1) An atom of an element has the structure ${}^A_Z X$. This atom belongs to group VI and period III of the periodic table.
- (a) Give the electronic configuration of atom X. (1mark)
- (b) Find Z. (1mark)
- (c) How many protons does this atom have? (0.5marks)
- (d) How many electrons does the ion X^{2-} have? (1mark)
- 2) Some elements of the periodic table are called noble or inert gases.
- (a) In which group are these gases in the periodic table? (1mark)
- (b) What is meant by the term "inert"? (1mark)
- (c) Explain in terms of electronic structure why these gases are inert. (1mark)
- 3) Name the process by which the components of the following mixtures can be separated:
- (a) Water and methanol. (0.5marks)
- (b) Pigments of leaves. (0.5marks)
- (c) Sand in water. (0.5marks)
- (d) Ammonium chloride and sodium chloride. (0.5marks)
- 4) (a) A solution containing calcium ions was added to a solution of potassium carbonate.
- (i) State what was observed. (0.5marks)
- (ii) Write the equation for the reaction that took place. (1mark)
- (b) To the mixture prepared in (a) above, dilute hydrochloric acid was added.
- (i) State what was observed. (0.5marks)
- (ii) Write the equation for the reaction. (1mark)
- 5) Hydrochloric acid reacts with magnesium according to the equation:
 $Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$
- (a) Calculate the number of moles of magnesium that will react with excess hydrochloric acid to produce 720 cm^3 of hydrogen at room temperature and pressure. (1 mole of a gas occupies 24 dm^3 at room temperature and pressure, Mg (Ar = 24)). (3marks)
- (b) Why is it necessary to use excess of hydrochloric acid? (1mark)
- 6) (a) Calculate the molar mass of Fe_2O_3 . (Atomic mass of: Fe= 56, O= 16) (1mark)
- (b) How many atoms of oxygen are contained in 4.8 g Fe_2O_3 ? (1 mole contains 6.02×10^{23} atoms.) (2marks)
- 7) State one reagent that can be used to distinguish between each of the following pairs of ions and in each case state what would be observed if each ion is treated with the reagent.
- (a) $SO_4^{2-}(aq)$ and $CO_3^{2-}(aq)$ (2.5marks)
- (b) $Fe^{2+}(aq)$ and $Fe^{3+}(aq)$ (2.5marks)

- 8) The boiling and the melting points of substances W, X, Y and Z are given in the table below:

Substance	Melting point (°C)	Boiling point (°C)
W	+29	+40
X	-5	+20
Y	0	100
Z	15	85

- (a) Give the physical state (gas, solid or liquid) of the substances W, X, Y and Z at room temperature (25°C). (2marks)

- (b) Which of these substances is water? (1mark)

- 9) (a) The oxides of some elements are listed below:

Sulfur dioxide, Aluminium oxide, Sodium oxide.

State the oxide which reacts with:

- (i) Acids only
- (ii) Alkalies only
- (iii) Both acids and alkalies.

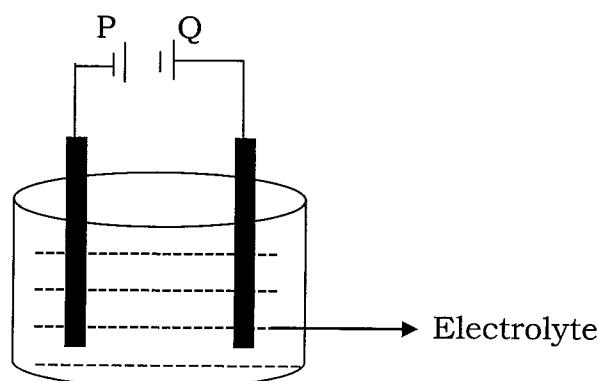
(0.5marks)

(0.5marks)

(0.5marks)

- (b) When excess oxygen was passed over 6.20g of a strongly heated metal W, 14.20g of oxide was formed. Find the empirical formula of the oxide W. (Atomic mass: W = 31, O = 16) (4marks)

- 10) The diagram below shows the arrangement of apparatuses used for the purification of copper.



- (a) Indicate which part is the anode and which part is the cathode on the diagram above. (1mark)
- (b) Name the substance used as:
- (i) Anode
 - (ii) Cathode
- (c) Name the electrolyte (0.5marks)
- (d) Write the equation of the reaction that takes place at:
- (i) Anode
 - (ii) Cathode

(0.5marks)

(0.5marks)

(0.5marks)

(0.5marks)

(0.5marks)

11) The molecular formula of an organic compound is $C_4H_{10}O$.
 This compound is an alcohol. Give the structural formula and names of all possible isomers (alcohols) of $C_4H_{10}O$. **(4marks)**

12) Using the table below that shows the pH of different aqueous solutions, answer the questions that follow:

Solution	A	B	C	D	E
pH	12	5.5	3	7	9

Which of the solutions is :

- (a) Most acidic? **(0.5marks)**
- (b) Most alkaline? **(0.5marks)**
- (c) Distilled water? **(0.5marks)**
- (d) Likely to be rain water? **(0.5marks)**
- (e) Which two of the solutions above would give a neutral solution when mixed? **(0.5marks)**
 - (i) A + E; (ii) C + D; (iii) B + C; (iv) B + E

13) When 14.2g of hydrated sodium carbonate, $Na_2CO_3 \cdot nH_2O$ was heated, the mass of the residue was 10.6g.

- (a) Complete this equation: $Na_2CO_3 \cdot nH_2O \xrightarrow{\text{heat}} \dots + \dots$ **(1 mark)**
- (b) Calculate the number of moles of water of crystallization (n). **(4.5marks)**
- (c) Write the molecular formula of hydrated sodium carbonate. **(0.5marks)**

14) Complete and balance the equations below: **(3marks)**

- (a) $CH_3COOH + CH_3CH_2OH \rightarrow$
- (b) $CH_3CH=CH_2 + Br_2 \rightarrow$
- (c) $CH_2=CH_2 + HCl \rightarrow$

15) (a) Describe how you would prepare pure crystals of lead (II) nitrate in the laboratory starting from lead (II) oxide. **(3marks)**
 (b) Write the equation for the reaction that takes place. **(1mark)**

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

16) (a) Copper (II) carbonate was heated strongly until there was no further observable change. During the reaction, a colourless gas was given off and a black solid was observed.

- (i) Give the name of the black solid. **(1mark)**
- (ii) Write the equation for the reaction. **(2marks)**
- (iii) State the name of one reagent which can be used to identify the gaseous product and write an equation for the reaction. **(2marks)**

(b) Excess dilute sulphuric acid was added to the residue in 16) (a) (ii) and the mixture warmed.

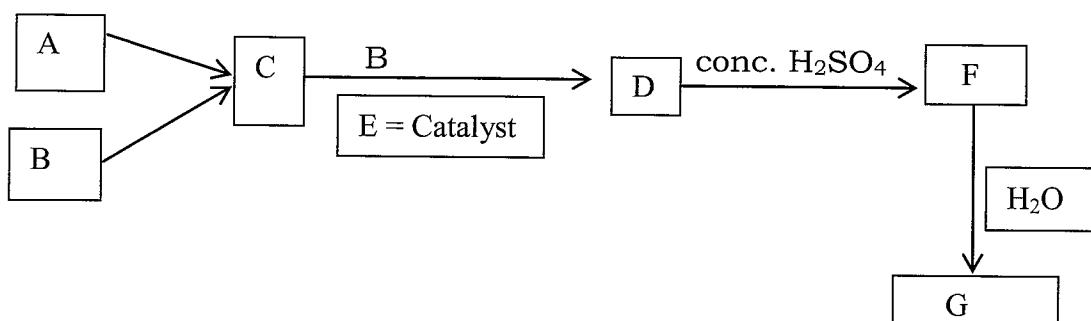
- (i) State what was observed. **(1mark)**
- (ii) Write the equation for the reaction. **(1mark)**

(c) To the product in (b) dilute sodium hydroxide solution was added drop wise until in excess.

(i) State what was observed. (1mark)

(ii) Write an ionic equation for the reaction. (2marks)

17) The diagram below represents the flow chart for the manufacture of sulphuric acid by the contact process.



(a) Write the molecular formula of the substance: A, B, C, D, E and F. (3marks)

(b) Write the equation of the reaction that gives substance: (3marks)

(i) C; (ii) D; (iii) F; (iv) G. (4marks)

(c) The purity of sulphuric acid prepared in the contact process is 98% by mass; which means 98g of pure sulphuric acid in 100g of the solution.

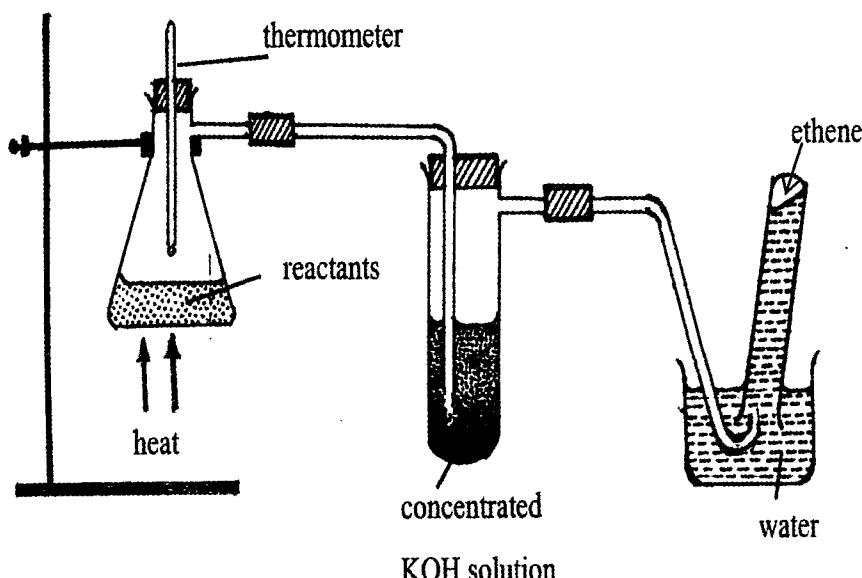
(i) What mass of the acid is present in 1 litre of prepared sulphuric acid? (2marks)

(1 millilitre of prepared sulphuric acid weighs 1.84g.)

(ii) What is the molar concentration of this solution? (1mark)

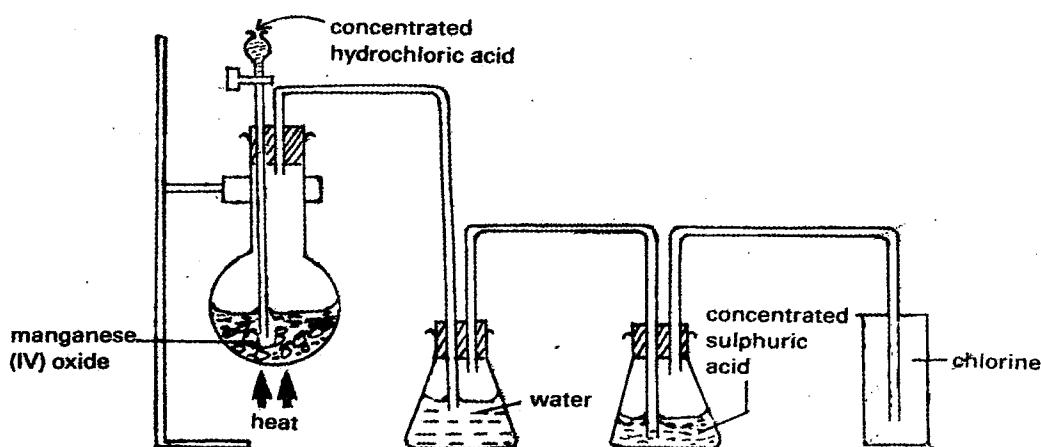
(S= 32, H= 1, O= 16)

18) Study the diagram below that shows the preparation of ethene in the laboratory and answer questions that follow:



(a) Name the reactants. (1mark)

- (b) Write the equation of the reaction between the reactants. **(1mark)**
 (c) At which maximum temperature are the reactants heated? **(1mark)**
 (d) Why is it possible to collect ethene over water? **(1mark)**
 (e) In this experiment, what is the use of:
 (i) Concentrated potassium hydroxide? **(1mark)**
 (ii) the thermometer? **(1mark)**
- (f) Write the equation of the reaction in the tube containing KOH. **(1mark)**
 (g) If the empirical formula of compound W is C_2H_3O and its molecular mass is 258. Find the molecular formula of W.
 (Atomic mass: H=1, C=12, O=16) **(3marks)**
- 19) In an experiment to titrate the solution of hydrochloric acid, 15.9 g of pure anhydrous sodium carbonate (Na_2CO_3) was dissolved in distilled water to make 500 cm^3 of the solution. 20 cm^3 of this solution neutralized 15 cm^3 of HCl acid using methyl orange. (Atomic masses: H=1, Cl=35.5, Na=23, C=12, O=16)
- (a) What was observed during the titration? **(1mark)**
 (b) Write the equation of the reaction during the titration. **(1mark)**
 (c) What was the role of methylorange in this experiment? **(1mark)**
 (d) Calculate the concentration of Na_2CO_3 in g/dm^3 . **(1mark)**
 (e) Find the molarity of Na_2CO_3 solution. **(1.5marks)**
 (f) Calculate the moles of Na_2CO_3 that reacted with HCl. **(1mark)**
 (g) Find the moles of HCl that reacted with Na_2CO_3 . **(1mark)**
 (h) Calculate the molarity of the solution of HCl. **(1mark)**
 (i) Find the concentration of hydrochloric acid in g/dm^3 . **(1.5marks)**
- 20) Dry chlorine can be prepared by the reaction between manganese (IV) oxide with concentrated sulphuric acid. Below is a diagram of this preparation:



- (a) Write the chemical equation of the reaction between manganese (IV) oxide

and concentrated hydrochloric acid.

(1mark)

(b) What are the roles of water and concentrated sulphuric acid in this experiment?

(2marks)

(c) When chlorine reacts with iron:

(i) Why is iron (II) chloride not formed?

(1mark)

(ii) State the compound that is formed instead of iron (II) chloride?

(1mark)

(d) With the aid of ionic equation, state what would be observed if chlorine was bubbled through the solution of:

(i) iron (II) sulphate

(2marks)

(ii) potassium iodide

(2marks)

(e) Chlorine is a bleaching agent when in the presence of cold water.

Write an equation for the reaction between chlorine and cold water.

(1mark)

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

21) The figure below shows a part of the periodic table. The letter is not a correct symbol of the elements.

I	II	III	IV	V	VI	VII	VIII
J				G		E	
A						R	D
X							

(a) Which of the elements are metals?

(2marks)

(b) Write the formula of the compounds formed between :

(i) X and R.

(1mark)

(ii) J and G.

(1mark)

(c) Which element is least reactive? Explain your answer.

(2marks)

(d) Which of the compounds (aqueous solution) formed between A and R, or between G and J would conduct electricity. Explain your answer. (2marks)

(e) State which formula of the following : R₂, E₂, D₂, A₂ is written correctly.

(2marks)

(f) X is in period IV and group II of the periodic table. Give its electronic structure.

(1mark)

(g) State the type of bond that exists in the chloride of X and write the formula of the ion formed by X.

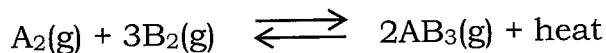
(2marks)

(h) The nitrate of X was strongly heated.

(i) State what was observed. (1mark)

(ii) Write the equation of the reaction. (1mark)

22) Substance A₂ reacts with B₂ to produce AB₃ according to the following equation (the letters A and B are not correct symbols of elements):



(a) Is this reaction exothermic or endothermic? Explain. (2marks)

The table below shows percentage yield of AB₃ at various temperatures and pressure

Temperature	Pressure (atmosphere)		
	10	200	1000
250	30%	75%	96%
500	1%	18%	60%
1000	0%	0.1%	60%

(b) Draw a graph showing the percentage yield of AB₃ at different pressures

and 250 °C. (%: x-axis, Pressure: y-axis) (6.5marks)

(c) Using the graph, find the percentage yield of AB₃ at 700 atm. and 250°C. (2.5marks)

(d) State :

(i) How the percentage yield of AB₃ varies with the temperature at constant pressure. (1mark)

(ii) How the percentage yield of AB₃ varies with pressure at constant temperature. (1mark)

(e) At which temperature and pressure is the production of AB₃ maximum? (2marks)

Chemistry I

002

04/11/ 2014

8.30AM- 11.30AM



ORDINARY LEVEL NATIONAL EXAMINATIONS, 2014

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS:

- 1) Do not open this question paper until you are told to do so.
- 2) 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)**
- 3) **You do not need the Periodic Table.**
- 4) Silent non-programmable calculators may be used.

SECTION A: ATTEMPT ALL QUESTIONS. (55 marks)

1. One of the types of bonding is "metallic".
 - a) Draw a labeled diagram to illustrate "metallic bonding". **(2 marks)**
 - b) By using ideas about the structure of metals, state 2 physical properties of metals. **(2 marks)**
2. Give a brief description of the following terms :
 - a) Melting point
 - b) Fluid. **(4 marks)**
3. The equation for the reaction between aqueous lead II nitrate and aqueous potassium iodide is shown below :
$$\text{Pb}(\text{NO}_3)_2 \text{ (aq)} + 2\text{KI} \text{ (aq)} \longrightarrow \text{PbI}_{2(s)} + 2\text{KNO}_3 \text{ (aq)}$$
Lead II iodide is a yellow precipitate.
Briefly describe a method that could be used to separate the precipitate from the mixture. **(2 marks)**
4. Bromine is an element of group VII. It has two naturally occurring isotopes.
 - a) Describe the term "isotopes". **(2 marks)**
 - b) One isotope of bromine has the symbol below:

$$\begin{array}{c} 81 \\ \text{Br} \\ 35 \end{array}$$

State the number of protons and neutrons in this isotope of bromine. **(2 marks)**
5. When sodium (Na) reacts with cold water (H_2O), hydrogen gas H_2 is given off and an alkaline solution is formed.
 - a) Mention one observation that can be made when sodium reacts with cold water. **(1 mark)**
 - b) Write a balanced equation for the reaction of sodium with water. **(2 marks)**
 - c) State the colour of phenolphthalein indicator in the alkaline solution mentioned above. **(1 mark)**
6. Nitrogen gas makes up 78% of atmospheric air.
 - a) State one importance of nitrogen gas in air. **(1 mark)**
 - b) Most substances burn in air by reaction with oxygen and not with nitrogen. Give a brief explanation of these occurrences. **(2 marks)**

7. When 8g of a metal oxide were reduced using hydrogen gas; 6.4g of metal M were obtained.
- Given that the relative atomic mass of the metal is 64, and that of oxygen is 16, determine the empirical formula of the metal oxide. **(3 marks)**
 - Write an equation for the reaction which occurred between the metal oxide and hydrogen gas. **(2 marks)**
8. Limestone consists mainly of calcium carbonate compound.
- Write the names or chemical formula of the compounds obtained when calcium carbonate decomposes on heating. **(2 marks)**
 - Write a balanced equation of reaction between sodium oxide (Na_2O) and water (H_2O). **(2 marks)**
9. Draw the conventional representation according to Bohr (show circumferences which represent the shells with electrons on them) of the following elements: **(2 marks)**
- Sodium.
 - Oxygen. (Atomic number: Na=11, O=8).
10. a) Solid sulphur in crystalline state consists of rings of Sulphur molecules of formula S_8 .
State names of 2 allotropes of sulphur that exist in crystalline form. **(2 marks)**
- Sulphur is a non-metal; indicate 2 properties of non-metals. **(2 marks)**
11. a) Write the chemical equation that represents the reaction between iron sulphide (FeS) and dilute hydrochloric acid (HCl). **(2 marks)**
- Write a chemical equation or give names of 2 substances that can react in a displacement reaction. **(1 mark)**
12. Write chemical symbols of ions or formulae of radicals which migrate to each of the following electrodes during the electrolysis of dilute sulphuric acid (H_2SO_4).
- Anode. **(2 marks)**
 - Cathode. **(1 mark)**
13. Ammonia is manufactured by the Haber-Bosch process.
- Write a balanced equation of reaction for the formation of ammonia from nitrogen and hydrogen gases in the Haber-Bosch process. **(2 marks)**

- b) State the name of the catalyst used to speed up the reaction between nitrogen and hydrogen gases in this process. **(1 mark)**
14. a) A salt solution contains 12g of NaCl per 100 cm³ of solution. Calculate the molarity (molar concentration) of the solution. **(3 marks)**
(Atomic mass: Na = 23, Cl = 35.5)
- b) Calculate the number of moles of HCl in 20 cm³ of a 2M HCl (2 moles per litre) solution. **(3 marks)**
15. Calculate the volume of nitrogen dioxide gas (NO₂) produced when 42g of copper nitrate completely decomposes at room temperature and pressure. **(4 marks)**
- $$2 \text{ Cu}(\text{NO}_3)_{2(\text{s})} \longrightarrow 2\text{CuO}_{(\text{s})} + 4\text{NO}_{2(\text{g})} + \text{O}_{2(\text{g})}$$
- (1 mole of a gas occupies 24 dm³ at room temperature and pressure; Atomic mass: Cu = 63.5, N = 14, O = 16).
- SECTION B: ATTEMPT ANY THREE QUESTIONS. (30 marks)**
16. A student pours (titrates) 30ml of a 0.1M aqueous sodium hydroxide from a burette into a beaker containing 25cm³ of a 0.1M sulphuric acid solution. The student measures the pH of the mixture in the beaker using a pH meter during the addition of sodium hydroxide.
- a) Describe how pH values change in the mixture of the beaker during addition of the base. **(2 marks)**
- b) Establish an ionic equation to represent the neutralisation reaction between sodium hydroxide (NaOH) and sulphuric acid H₂SO₄. **(2 marks)**
- c) Sulphuric acid is a strong acid.
- (i) What is meant by the term "acid"? **(2 marks)**
- (ii) Explain the difference between a "strong" acid and a "weak" acid. **(2 marks)**
- d) Dilute sulphuric acid reacts with magnesium (Mg) to give off hydrogen gas.
- Write an equation for the reaction between Mg and H₂SO₄. **(2 marks)**
17. a) Draw a labeled diagram for the preparation of ammonia gas in the laboratory. **(4 marks)**

- b) Write a balanced equation of reaction between ammonium chloride and calcium hydroxide. **(2 marks)**
- c) By giving an appropriate equation of reaction, explain how temporary hardness of water is treated to get soft water. **(2 marks)**
- d) Briefly explain how permanent hard water containing $MgSO_4$ is treated to get soft water. **(2 marks)**

18.a) Methane is a member of the homologous series of hydrocarbons called alkanes. Describe the meaning of the term :

- (i) Homologous series. **(2 marks)**
- (ii) Alkane. **(2 marks)**

b) Write a balanced equation of reaction that takes place when butane burns in oxygen gas. **(2 marks)**

- c) Ethene reacts with hydrogen chloride.
- (i) Write the equation of reaction that takes place between ethene and hydrogen chloride. **(2 marks)**
- (ii) State the type of reaction taking place in c) (i) above and draw the structural formula of the organic product obtained. **(2 marks)**

19.a) A compound constituted of carbon, hydrogen and oxygen contains 40% carbon, 6.67% hydrogen and 53.33% oxygen by mass. The molar mass of the compound is 60 g mol^{-1} .

Determine:

- (i) The empirical formula of the compound. **(2 marks)**
- (ii) The molecular formula of the compound. **(2 marks)**
- c) When very hot carbon reacts with steam and they form carbon monoxide and hydrogen gas according to the equation below:



- (i) Calculate the mass of steam required to react completely with 40g of carbon. **(2 marks)**
- (ii) What volume of carbon monoxide, measured at room temperature and pressure will be produced? **(2 marks)**

(Atomic mass: C=12, H=1, O=16; 1 mole of a gas occupies 24 dm^3 at

room temperature and pressure.)

- d) Hydrogen gas is used as a fuel; write an equation of reaction between hydrogen gas and oxygen. **(2 marks)**

20. a) Samples of iron were placed in aqueous solutions having different pH values. The table below shows how the speed of corrosion of iron varies with the pH of the solution.

Speed of corrosion/cm per year	0.043	0.029	0.012	0.010	0.010	0.010	0.009	0.006
pH	2	3	4	5	6	8	10	12

Describe how pH affects the speed of corrosion of iron.

(2 marks)

- b) Mention a material that can be coated on iron metal or mixed with it so that you avoid it being degraded by corrosion. **(1 mark)**

- c) Two gases are unlabeled. It is known that one is chlorine and the other is hydrogen chloride.

Mention a reagent that can be used to test one gas so as to distinguish it from another. State the observable change for each gas.

(i) Chlorine gas. **(2 marks)**

(ii) Hydrogen chloride gas. **(2 marks)**

- e) (i) Write an equation of the reaction observed when chlorine gas (Cl_2) is passed in a solution of potassium iodide (KI). **(2 marks)**

- (ii) State the type of reaction that has taken place when chlorine gas (Cl_2) is passed in a solution of potassium iodide (KI). **(1 mark)**

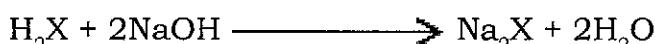
SECTION C : ATTEMPT ONLY ONE QUESTION. (15 marks)

21. a) 25 cm³ of a 0.12 M sodium hydroxide solution was neutralized by 30 cm³ of a solution of a dibasic acid H₂X, containing 6.3 g of acid per litre.

Calculate :

- (i) The number of moles of NaOH that was used in the reaction. (2 marks)
- (ii) The molarity of the acid. (2 marks)
- (iii) The relative molecular mass of the acid. (2 marks)

Equation :



- b) Mention 2 uses of Sulphur. (2 marks)
- c) Write an equation of reaction between chlorine gas and phosphorous. (2 marks)
- d) Briefly explain the reason why a mixture of chlorine and hydrogen gas explodes once it is exposed to bright light. (1 mark)
- e) Chlorine is a powerful bleaching agent in the presence of water.

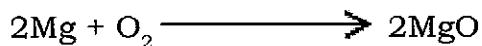
Briefly, describe how chlorine bleaches materials. (2 marks)

- f) Chlorine gas (Cl₂) was passed over heated iron powder (Fe) in a combustion tube. Write down the observable changes and the equation of reaction that took place. (2 marks)

22. a) Petroleum is a complex mixture of hydrocarbons and is also a source of many useful fuels.

- (i) Describe the meaning of the term "functional group" and give two examples of substances with different functional groups. (3 marks)
- (ii) Name 3 fractions (products) obtained from petroleum. (3 marks)
- (iii) Write the structural formula of an unsaturated hydrocarbon that contains 4 carbon atoms. (1 mark)

(b) Magnesium reacts with oxygen in air to form magnesium oxide.



If the yield (MgO produced) of the reaction is 100%, calculate the mass of magnesium oxide formed when 6 g of magnesium burns in excess oxygen. (3 marks)

(Atomic mass: Mg=24, O=16)

c) Using pentane as an example,

(i) Write the molecular formula and structural formula of pentane.

(2 marks)

(ii) Mention two uses of pentane on a large scale.

(2 marks)

d) Write the name of a hydrocarbon derivative that can cause

environmental hazard in the atmospheric ozone layer.

(1 mark)

Chemistry I

002

05 Nov. 2013 08.30am - 11.30am

REPUBLIC OF RWANDA



RWANDA EDUCATION BOARD

ORDINARY LEVEL NATIONAL EXAMINATIONS 2013

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS:

- 1) Don't open this question paper until you are told to do so.
- 2) 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)**
- 3) **You do not need the Periodic Table.**
- 4) Silent non-programmable calculators may be used.

SECTION A: ATTEMPT ALL QUESTIONS. (55 marks)

1. The atomic number of carbon (C) is 6 and that of chlorine (Cl) is 17.
 - a) What type of bond is formed between carbon and chlorine? (1 mark)
 - b) Draw a diagram to show bonding in the compound between carbon and chlorine. Use dots (·) and crosses (×) to represent electrons in the outer shells. (3 marks)
2. Chlorine gas is prepared by heating a mixture manganese (IV) oxide (manganese dioxide) and concentrated hydrochloric acid.
 - a) Write a balanced equation for the reaction. (2 marks)
 - b) Describe a chemical test to show that the gas is chlorine. State the reagent and the expected observation for a positive result. (2 marks)
3. 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 .
 - a) Write a balanced equation between haematite and carbon monoxide. (2 marks)
 - b) Identify the oxidizing agent in your equation in (a) above. (1 mark)
 - c) What harm might the extraction of iron have on the environment? Explain your answer. (2 marks)
4. Ethene belongs to a family of organic compounds known as alkenes.
 - a) State the general formula of alkenes. (1 mark)
 - b) Give the name and formula of an alkene with five carbon atoms. (2 marks)
 - c) Ethene reacts with hydrogen bromide to form another organic compound. Give the formula and the name of the organic compound formed. (2 marks)
5. Ethanol can be prepared from a mixture of a solution of sugar and yeast kept warm conditions.
 - a) What is the role of yeast? (2 marks)
 - b) What name is given to the process of preparing ethanol from sugar? (1 mark)
 - c) What name is given to organic compounds formed by reacting alcohols

with carboxylic acids? **(1 mark)**

d) State one use of such compounds identified in (c) above. **(1 mark)**

6. Sulphur and potassium were separately burned inside gas jars.

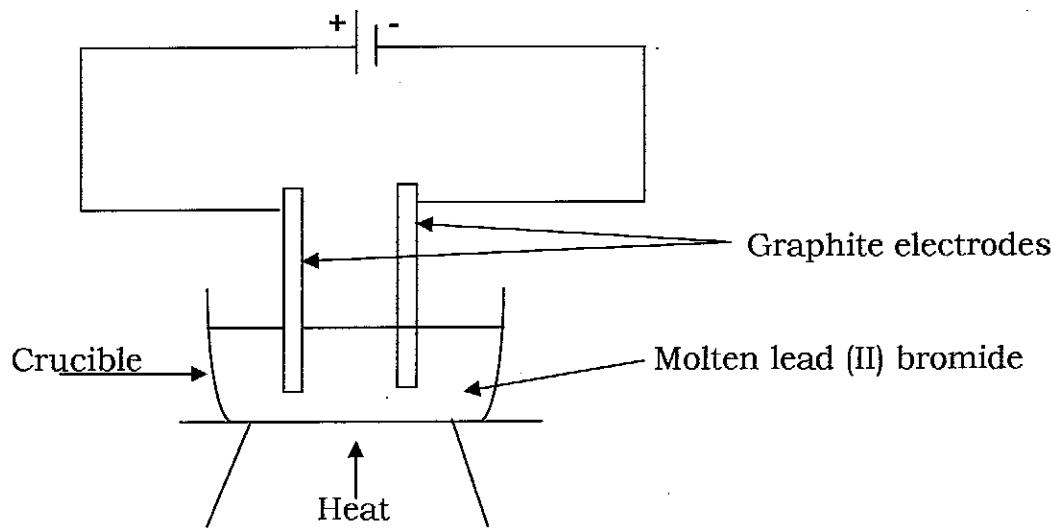
The products were separately shaken with water in gas jars.

a) 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)**

b) 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)**

7. 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)**

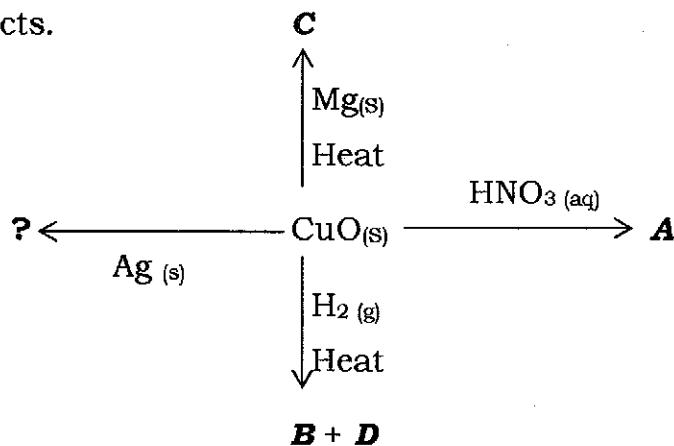
b) Calculate the number of moles of lead (II) nitrate in 20 cm³ of the solution. **(1 mark)**

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 HNO_3 ? **(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.
- Explain what is meant by a fertilizer. **(1 mark)**
 - Why is it necessary to apply fertilizers to soil? **(1 mark)**
 - 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 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.

- a) Why was the rock crushed into a powder? **(2 marks)**
- b) Why was excess of the powder used? **(1 mark)**
- c) Why was the mixture filtered? **(1 mark)**
- d) Write a balanced equation for the reaction between copper (II) carbonate and sulphuric acid. **(2 marks)**
- e) The method used did not yield hydrated crystals of copper (II) sulphate. Explain why. **(1 mark)**
- f) What change would you make in the method in order to obtain hydrated crystals. **(2 marks)**
- g) State one use of copper metal. **(1 mark)**

15. Sulphur is a raw material for the manufacture of sulphuric acid in the “Contact” process.

- a) 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)**
- b) State two large scale uses of sulphuric acid. **(2 marks)**
- c) 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)**

- b) 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)**
- c) What causes permanent hardness? How is permanent hardness removed? **(2 marks)**
- d) When carbon dioxide is bubbled through lime water, the lime 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)
- Calculate its empirical formula. **(2 marks)**
 - Determine its molecular formula. **(1 mark)**
 - Draw a possible structural formula of the compound. **(1 mark)**
 - Write a balanced chemical equation for its combustion in oxygen. **(2 marks)**
 - 40cm³ of hydrogen gas were reacted with 70cm³ of chlorine gas to form hydrogen chloride gas.
 - Write a balanced equation for the reaction. **(2 marks)**
 - Calculate the volume of hydrogen chloride 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 chloride 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.
- State a suitable reagent to dry hydrogen chloride gas. **(1 mark)**
 - Which one has a higher density: air or hydrogen chloride? Explain your answer. **(2 marks)**
 - What is observed when hydrogen chloride reacts with ammonia gas? Write an equation for the reaction. **(2 marks)**
 - 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)**
 - Hydrogen chloride gas was dissolved in pure water to form hydrochloric acid. The acid was titrated with sodium carbonate solution. 25cm³ of 0.2moldm⁻³ sodium carbonate reacted with 24cm³ of the hydrochloric acid.
 - Write a balanced chemical equation for the reaction of hydrochloric acid and sodium carbonate. **(2 marks)**

- ii. Calculate the number of moles of sodium carbonate in 25cm^3 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:

Cu^{2+} , Fe^{3+} , SO_4^{2-} and CO_3^{2-} . 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 Cu^{2+} ions were present. **(3 marks)**
- c) How would you test for the presence of SO_4^{2-} ? State the reagent and the expected observation for a positive result. **(2 marks)**
- d) Another portion was mixed with a reagent which removed Cu^{2+} . If the remaining solution contained Fe^{3+} , what test would confirm the presence of Fe^{3+} ? State the reagent and observation. **(2 marks)**
- e) Rust contains a compound of iron (III).
- State the conditions necessary for rusting to take place. **(2 marks)**
 - Give two methods of prevention of rusting. **(2 marks)**
 - Give one similarity and one difference between rusting and combustion. **(2 marks)**

Chemistry I

002

20 Nov. 2012 08.30am - 11.30am

REPUBLIC OF RWANDA



RWANDA EDUCATION BOARD (REB)

ORDINARY LEVEL NATIONAL EXAMINATIONS 2012

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS:

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)**

You do not need the Periodic Table.

Silent non-programmable calculators may be used.

SECTION A : Attempt all questions. (55 marks)

01. The atomic number of potassium is 19 and that of oxygen is 8.
- (a) Write the electronic configuration (arrangement) of an atom of potassium. **(1 mark)**
- (b) Write the electronic configuration of an atom of oxygen. **(1 mark)**
- (c) Write a balanced chemical equation for the reaction between potassium and oxygen. **(2 marks)**
02. Carbon monoxide was passed over a hot oxide of iron to reduce it to iron. 1.60g of the oxide produced 1.12g of iron. (Fe = 56, O = 16)
- (a) Calculate the number of moles of Fe. **(1 mark)**
- (b) Calculate the mass of oxygen and the number of moles of oxygen atoms. **(2 marks)**
- (c) Determine the empirical formula of the oxide of iron. **(1 mark)**
03. An organic compound has a molecular formula $C_2H_4O_2$. Its aqueous solution produces carbon dioxide when mixed with sodium carbonate.
- (a) Give the empirical formula of the compound. **(1 mark)**
- (b) State the name of the functional group present in the compound. **(1 mark)**
- (c) Give the full structural formula of the compound, showing all the covalent bonds. **(1 mark)**
04. Write one term or word to describe each of the following reactions or processes.
- (a) A reaction between an acid and a base. **(1 mark)**
- (b) A reaction between an alcohol and a carboxylic acid. **(1 mark)**
- (c) A method used to separate different dyes present in ink. **(1 mark)**
- (d) A method used to obtain pure water from sea water. **(1 mark)**
05. Calcium metal can be extracted by electrolysis of molten calcium chloride.
- (a) Give the formula of calcium chloride. **(1 mark)**
- (b) Give a balanced ionic equation to show the reaction which occurs at the anode. **(2 marks)**
- (c) Why is it necessary to have the calcium chloride molten before electrolysis? **(1 mark)**

06. Propane is a compound of carbon and hydrogen. It can be used as a fuel.
- (a) Write the chemical formula of propane. **(1 mark)**
- (b) To which homologous series does propane belong? **(1 mark)**
- (c) Briefly explain how the combustion of propane might affect the environment. **(2 marks)**
07. A student prepared ammonia gas by heating an aqueous mixture of two compounds.
- (a) State any two compounds that can be heated together to produce ammonia gas. **(1 mark)**
- (b) What type of bonding is present in ammonia gas? **(1 mark)**
- (c) Ammonia gas dissolves easily in water. What is the approximate pH of the resulting solution? **(1 mark)**
08. A student prepared zinc sulphate crystals by reacting excess zinc with sulphuric acid. The mixture was filtered to remove excess zinc.
- (a) Why was excess zinc used? **(1 mark)**
- (b) Briefly explain how the student obtained crystals of zinc sulphate from the mixture. **(2 marks)**
09. Ethene is one of the major chemicals used to prepare plastics.
- (a) How is ethene obtained from ethanol? State the reagent and condition used. **(2 marks)**
- (b) State the name of a plastic obtained from ethene. **(1 mark)**
- (c) State the name of the chemical process for changing ethene into the plastic named in (b) above. **(1 mark)**
10. Carbon dioxide gas was prepared by reacting excess hydrochloric acid with zinc carbonate. 0.125g of zinc carbonate was used. ($Zn = 65$, $C = 12$, $H = 1$)
- (a) Write a balanced equation for the reaction. **(2 marks)**
- (b) Calculate the number of moles of zinc carbonate used. **(1 mark)**
- (c) State one use of carbon dioxide. **(1 mark)**
11. From the following list of chemical compounds:
 $MgSO_4$, $CaCl_2$, HNO_3 , C_2H_4 , C_2H_6 ;
Select the compound (write the formula) which:
- (a) Produces a white precipitate when mixed with acidified silver nitrate solution. **(1 mark)**

- (b) Decolourises bromine easily. **(1 mark)**
- (c) Is manufactured from ammonia gas. **(1 mark)**
- (d) Produces a white precipitate when mixed with acidified barium nitrate solution. **(1 mark)**
12. Iodine vapour was reacted with hydrogen gas in the presence of a suitable catalyst to form hydrogen iodide gas.
- (a) What is meant by the term 'catalyst'? **(1 mark)**
- (b) Write a balanced equation for the reaction. **(1 mark)**
- (c) What volume of hydrogen iodide is produced by reacting 60 cm³ of iodine vapour with 60 cm³ of hydrogen? (Assume that all volumes are measured at the same temperature and pressure). **(2 marks)**
13. Three metals X, Y and Z were investigated in order to place them in order of reactivity. Metal X did not react with a sulphate of Z but metal Y reacted with a sulphate of Z as well as a sulphate of X.
- (a) Place the three metals in order of their reactivity, starting with the most reactive and explain your reasoning. **(2 mark)**
- (b) Metal Z is heated with an oxide of X. State if there would be a reaction and give a reason for your answer. **(2 marks)**
14. Sodium (atomic number 11) combines with sulphur (atomic number 16).
- (a) State what type of bond is present in the compound formed. **(1 mark)**
- (b) Give the chemical formula of the compound formed. **(1 mark)**
- (c) Would the compound formed conduct electricity when it is in molten form? Give a reason for your answer. **(2 marks)**
15. Air is an important raw material for the manufacture of some important chemicals.
- (a) Name a process that is used to separate the major components of air. **(1 mark)**
- (b) Name an important chemical manufactured from the most abundant component of air. **(1 mark)**

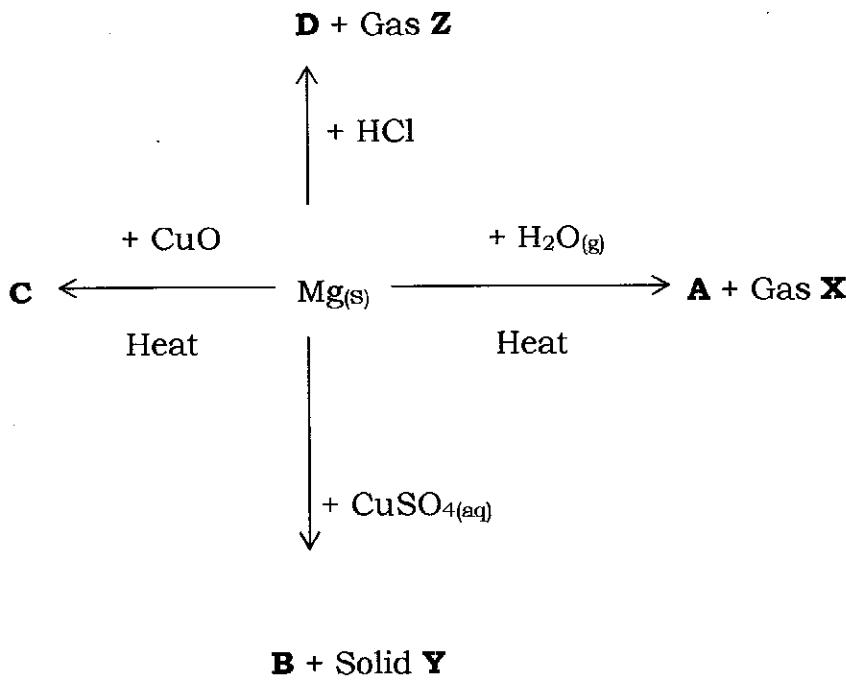
SECTION B: Attempt ONLY any THREE questions

(30 marks)

16. Hydrogen gas was prepared by reacting magnesium with dilute sulphuric acid. The gas was dried and then burnt in air in a controlled way. The gaseous product was cooled to obtain a colourless liquid.

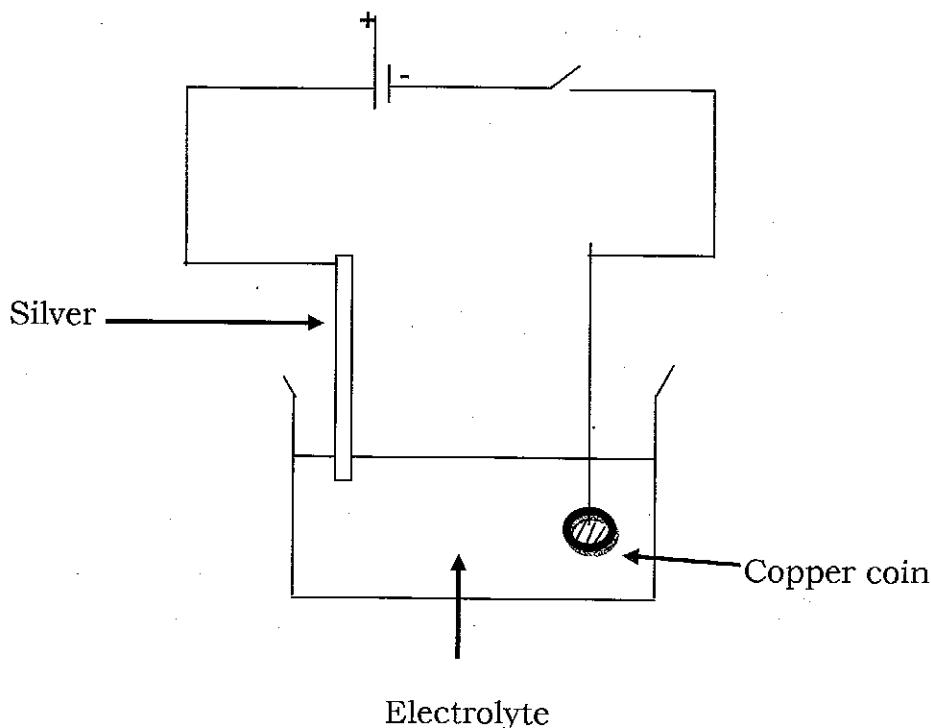
- (a) How would you show by a chemical test that the gas is **(2 marks)**
hydrogen?
- (b) How would you show that the colourless liquid is pure **(2 marks)**
water?
- (c) Hydrogen gas can be used as a fuel.
State:
(i) One advantage of using hydrogen as a fuel. **(1 mark)**
(ii) One disadvantage of using hydrogen as a fuel. **(1 mark)**
- (d) Give the name of the product formed when hydrogen is **(1 mark)**
reacted with propene.
- (e) Hydrogen gas was passed over hot copper (II) oxide. Write a **(2 marks)**
balanced equation for the reaction.
- (f) Identify the oxidising agent in the reaction (e) above. **(1 mark)**

17. The scheme below shows some reactions starting with magnesium.



- (a) State the name of compound **A** and the name of gas **X**. **(2 marks)**
- (b) Give the name of solution **B** and the name of solid **Y**. **(2 marks)**
- (c) **C** is a mixture of two solids. Identify the two solids. **(2 marks)**
- (d) State the name of solution **D** and the name of gas **Z**. **(2 marks)**
- (e) Give two different ways of increasing the rate of reaction **(2 marks)**
between magnesium and hydrochloric acid.

18. One of the uses of electrolysis is electroplating. A student used the set up below to electroplate a copper coin with silver.



- (a) Name a suitable electrolyte that could have been used. **(1 mark)**
- (b) What name is given to the negative electrode? **(1 mark)**
- (c) Give an ionic equation for the reaction which occurred on the surface of the copper coin. **(2 marks)**
- (d) What happened to the mass of the silver electrode? Explain your answer. **(2 marks)**
- (e) State the name of particles responsible for conduction of electricity in: **(2 marks)**
- (i) The electrolyte.
 - (ii) The external wire connecting the electrodes.
- (f) The original mass of the copper coin used was 12.8g. Calculate the number of moles of copper in the coin. **(2 marks)**
(Cu = 64)
19. Sulphur dioxide gas was prepared in the laboratory by heating sodium sulphite (Na_2SO_3) with hydrochloric acid. The gas was dried and collected by downward delivery.
- (a) Write a balanced chemical equation for the reaction between sodium sulphite and hydrochloric acid. **(2 marks)**

- (b) Name one reagent that is used to dry sulphur dioxide. Why is such a reagent unsuitable for drying ammonia gas? **(2 marks)**
- (c) State the name of the solution produced by dissolving sulphur dioxide in water and give the approximate pH of that solution. **(2 marks)**
- (d) Calculate the percentage by mass of sulphur in the compound sodium sulphite (Na_2SO_3). **(2 marks)**
[$\text{Na} = 23$, $\text{S} = 32$, $\text{O} = 16$]
- (e) Explain one undesirable effect of sulphur dioxide on the environment. **(2 marks)**
20. Calcium (atomic number 20) and fluorine (atomic number 9) combine to form a chemical compound called calcium fluoride.
- (a) Explain the type of bonding that is present in calcium fluoride. **(2 marks)**
- (b) Give the electronic configuration of the calcium and fluoride ions. **(2 marks)**
- (c) Would you expect the melting point of calcium fluoride to be high or low? Explain your answer. **(2 marks)**
- (d) Mg (atomic number 12) is in the same group of the Periodic Table as calcium.
- (i) In which group are the two metals found. Give a reason for your answer. **(2 marks)**
- (ii) Compare the reactivities of the two metals with water and give a reason for your answer. **(2 marks)**

SECTION C: Attempt ONLY ONE question. (15 marks)

21. A sample of rock was analysed to determine if it contained the following ions: Fe^{2+} , NH_4^+ , Cl^- and CO_3^{2-} . First it was crushed into a fine powder and then nitric acid was added. A vigorous reaction occurred. The mixture was filtered and the filtrate was analysed.
- (a) Why was the sample of rock crushed into a fine powder? **(2 marks)**
- (b) Define the term "filtrate". **(1 mark)**
- (c) Name the gas produced when nitric acid was added. How would you test the gas? Give the reagent you would use and the expected observation. **(3 marks)**
- (d) Describe a chemical test you would carry out to confirm the presence of the following ions. In each case state the reagent and the expected observation for a positive result.

- (i) Fe^{2+} (2 marks)
- (ii) NH_4^+ (2 marks)
- (iii) Cl^- (2 marks)

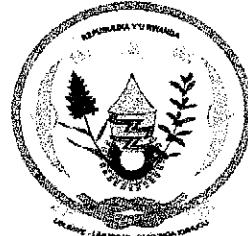
- (e) Suppose a piece of magnesium metal is added to the filtrate. Which of the ions stated above will react with magnesium? Write a balanced equation for the reaction. (3 marks)
22. Precipitation is one of the methods for preparing salts. Lead sulphate ($PbSO_4$) was prepared by mixing 25 cm^3 of 0.2 mol dm^{-3} lead nitrate $[Pb(NO_3)_2]$ solution with 25 cm^3 of 0.2 mol dm^{-3} magnesium sulphate ($MgSO_4$) solution. The mixture was filtered to separate the products.
- (a) State which salt was in the residue and which salt was in the filtrate. (2 marks)
 - (b) Write a balanced equation for the reaction. (2 marks)
 - (c) Calculate the number of moles of lead nitrate in 25 cm^3 of the solution. (2 marks)
 - (d) Calculate the number of moles of magnesium sulphate in 25 cm^3 of the solution. (2 marks)
 - (e) State the number of moles of lead sulphate formed. Calculate the molar mass of lead sulphate. Hence calculate the mass of lead sulphate produced. ($Pb = 207, S = 32, O = 16$) (4 marks)
 - (f) Write a balanced equation to represent the thermal decomposition of lead nitrate. (2 marks)
 - (g) State one observation you would make if sodium hydroxide solution is added to aqueous lead ions (Pb^{2+}). (1 mark)

Chemistry I

002

08 Nov. 2011 08.30am - 11.30am

REPUBLIC OF RWANDA



RWANDA EDUCATION BOARD (REB)
P.O.BOX 3817 KIGALI. TEL/FAX: 586871

ORDINARY LEVEL NATIONAL EXAMINATIONS 2011

SUBJECT: CHEMISTRY I

DURATION : 3 HOURS

INSTRUCTIONS :

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)**

You do not need the Periodic Table.

Calculators may be used.

SECTION A : Attempt all questions.

(55 marks)

01. Some oxides of period 3 of the periodic table are: Na_2O , Al_2O_3 and SO_3 .
- (a) From the list choose and write down the formula of an oxide which is:
- (i) Acidic **(1 mark)**
(ii) Basic **(1 mark)**
(iii) Amphoteric **(1 mark)**
- (b) Write a balanced equation to show the reaction between the basic oxide and water. **(2 marks)**
02. The following list shows the chemical formulae of some ions: Na^+ , Al^{3+} , Zn^{2+} , Br^- , PO_4^{3-} and O^{2-} .
- Use the list to write down the chemical formula of:
- (a) Sodium phosphate **(1 mark)**
(b) Aluminium oxide **(1 mark)**
(c) Zinc bromide. **(1 mark)**
03. Silicon (atomic number 14) combines with chlorine (atomic number 17) to form compound A.
- (a) Write the electronic arrangement of silicon. **(1 mark)**
(b) Using a 'dot and cross' diagram and the symbols Si (silicon) and Cl (chlorine), draw a diagram to show the bonding in the compound formed between Si and Cl.
- Use electrons in the outer shell only. **(2 marks)**
- (c) Would you expect the compound formed in (b) to conduct electricity when in molten state?
- Explain your answer. **(2 marks)**
04. C_5H_{12} is an organic compound which is a member of the homologous series of alkanes.
- (a) What is the name of C_5H_{12} ? **(1 mark)**

- (b) Give the formula of an alkane with 7 C atoms. **(1 mark)**
- (c) Alkanes are examples of fossil fuels. Explain one environmental problem caused by the burning of alkanes. **(2 marks)**
05. Magnesium sulphate crystals ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$) were prepared by reacting excess magnesium oxide and sulphuric acid.
- (a) Write an equation for the reaction of magnesium oxide with sulphuric acid to form a solution of magnesium sulphate. **(2 marks)**
- (b) Why was excess magnesium oxide used? **(1 mark)**
- (c) Calculate the percentage of oxygen by mass in the compound $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ ($\text{Mg}=24$, $\text{S}=32$, $\text{O}=16$, $\text{H}=1$) **(2 marks)**
06. 11.0g of manganese were reacted with oxygen to produce 17.4g of an oxide of manganese.
- (a) Calculate the mass of oxygen in the oxide of manganese. **(1 mark)**
- (b) Calculate the number of moles of:
- (i) Manganese (Mn) atoms **(1 mark)**
- (ii) Oxygen (O) atoms, and then **(1 mark)**
- (c) Determine the empirical formula of the oxide of manganese. **(1 mark)**
07. An alcohol has molecular formula $\text{C}_3\text{H}_8\text{O}$.
- (a) Write down the formula of the functional group in alcohols. **(1 mark)**
- (b) Write down the structural formulae of two possible isomers which are alcohols with molecular formula $\text{C}_3\text{H}_8\text{O}$. **(2 marks)**
- (c) Give the name of one of the isomers in (b). **(1 mark)**
08. A concentrated solution of sodium chloride was electrolyzed, using carbon (graphite) electrodes.
- (a) List all the ions present in aqueous sodium chloride by giving their formulae or names. **(2 marks)**
- (b) What is produced at the cathode? **(1 mark)**
- (c) After electrolysis, the remaining solution was tested with red and blue litmus papers. State and explain the expected observations. **(2 marks)**

09. Chlorine gas was prepared by heating concentrated hydrochloric acid and manganese (IV) oxide (MnO_2). After drying, it was collected by downward delivery.
- (a) Write a balanced equation for the reaction of hydrochloric acid with manganese (IV) oxide to produce chlorine, manganese (II) chloride and water. **(2 marks)**
- (b) How would you test for chlorine gas? Give the expected observation. **(2 marks)**
- (c) How is chlorine gas dried? **(1 mark)**
- (d) Suggest one precaution that would be taken while preparing chlorine gas in the laboratory? **(1 mark)**
10. The structures of some organic compounds are given below:
- A:** $CH_3-CH_2-CH=CH_2$ **B:** $CH_3-CH_2-CH_2-OH$
C: CH_3-CH_2-COOH **D:** $CH_3-CH_2-CH_3$.
- (a) Which of these compounds is:
- (i) an alkane? **(1 mark)**
(ii) A carboxylic acid? **(1 mark)**
(iii) An alcohol? **(1 mark)**
- (b) Which of the compounds would react with sodium carbonate? **(1 mark)**
- (c) **B** and **C** were reacted together.
- What class of organic compounds is produced by reacting **B** and **C**? **(1 mark)**
11. Separation of mixtures can be carried out using some methods below: Fractional distillation, simple distillation, filtration, chromatography.
- Select a method which would be used to separate:
- (a) Components of chlorophyl. **(1 mark)**
(b) Kerosine and petrol (gasoline). **(1 mark)**
(c) Copper (II) hydroxide from a precipitate of copper (II) hydroxide and water. **(1 mark)**
(d) Pure water from sea water. **(1 mark)**
12. Ammonia (NH_3) is an important chemical used to manufacture other products such as fertilizers and nitric acid.

- (a) Write a balanced equation to show the formation of ammonium nitrate from ammonia and nitric acid. **(2 marks)**
- (b) State one pollution problem associated with nitrate fertilizers. **(1 mark)**
- (c) Ammonium salts usually sublime when heated.
- (i) What is meant by sublimation? **(1 mark)**
- (ii) Write an equation to show the products of heating ammonium chloride. **(1 mark)**

SECTION B: Attempt any three questions. **(30 marks)**

13. Hydrogen peroxide was mixed with manganese (IV) oxide to produce oxygen gas. The gas was collected in several gas jars so that some experiments could be carried out with it.
- (a) What is the role of manganese (IV) oxide (MnO_2) in this experiment? **(1 mark)**
- (b) How is oxygen gas tested?
Describe the test and the expected observation. **(2 marks)**
- (c) The elements sodium and sulphur were burned separately in gas jars containing oxygen. The product in each gas jar was mixed with water and the mixture shaken. The resulting solution was tested with litmus paper.
Write a balanced equation to show:
- (i) How each element reacts with oxygen. **(2 marks)**
- (ii) How each product in (i) reacts with water. **(4 marks)**
- (d) State the observation made when the product of burning sulphur in oxygen was shaken with water and tested with blue litmus paper. **(1 mark)**
14. Drinking water was suspected to have been contaminated by some salts. It was tested to identify some ions which were suspected to be present. The following tests were carried out:
One sample was acidified with nitric acid and then barium nitrate was added. A white precipitate was observed.
Another sample was mixed with nitric acid and then silver nitrate was added. A white precipitate was observed.
A third sample was mixed with sodium hydroxide and there was no observable change.
- (a) Which ion was identified by the test with barium nitrate? Write an ionic equation to show the formation of the white precipitate. **(3 marks)**
- (b) Which ion was identified by the test with silver nitrate? Write an ionic equation to show the formation of the white precipitate. **(3 marks)**

- (c) Suggest two possible cations which could be have been present as shown by the test using sodium hydroxide. **(2 marks)**
- (d) Suppose the water contained some ammonium ions. What test would confirm the presence of NH_4^+ ions? **(2 marks)**
15. The chart below shows some reactions starting with ethene.
- A**
- $\text{H} \quad \text{H}$
 $\text{H} - \text{C} = \text{C} - \text{H} \quad \text{H}_2(\text{g})$
 $\text{HCl}(\text{g}) \quad \text{Ni} \quad \text{Heat}$
 $\text{Br}_2(\text{g}) \quad \text{C}$
- (a) Give the structure and name of each of the compounds **A**, **B** and **C**. **(6 marks)**
- (b) What name is given to the type of reaction that produces compound **D**? **(1 mark)**
- (c) Give the name and the structural formula of the compound C_3H_6 . **(2 marks)**
- (d) Bromine is used to test for organic compounds which contain $\text{C} = \text{C}$.
What is observed in this test? **(1 mark)**
16. Sulphuric acid is manufactured in the contact process according to the steps shown below.
- I: Sulphur is burned in air (oxygen).
- II: The product is reacted with more air (oxygen) in the presence of a catalyst to form sulphur trioxide.
- III: Sulphur trioxide is absorbed in concentrated sulphuric acid and then diluted with water.
- (a) Give a balanced equation for the reaction in step I. **(2 marks)**
- (b) Give a balanced equation for the reaction in step II. **(2 marks)**
- (c) Name the catalyst used in step II. **(1 mark)**
- (d) Briefly explain why sulphur trioxide is not directly reacted with water. **(2 marks)**
- (e) Some sulphur dioxide may escape into the atmosphere. Explain an environmental problem this may cause. **(2 marks)**
- (f) Give one large scale use of sulphuric acid. **(1 mark)**

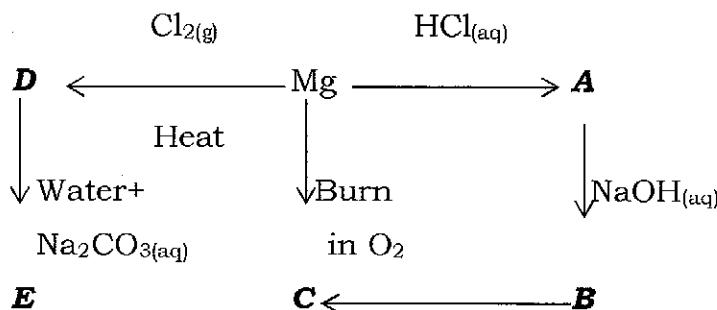
17. A sample of carbon dioxide was prepared and collected for further experiments. The gas was produced by mixing calcium carbonate with hydrochloric acid. It was collected over water.
- (a) Write a balanced equation to show the reaction of calcium carbonate with hydrochloric acid. **(2 marks)**
- (b) Describe a chemical test for carbon dioxide, by stating the reagent and the expected observation for a positive result. **(2 marks)**
- (c) Carbon dioxide can be prepared by burning charcoal in air (oxygen).
- (i) Write a balanced equation for the reaction. **(1 mark)**
- (ii) What might be formed if the charcoal burns in insufficient air (oxygen)? **(1 mark)**
- (d) State one environmental problems caused by too much carbon dioxide in the atmosphere. **(2 marks)**
- (e) Carbon dioxide is used in some fire extinguishers.
Give two properties of carbon dioxide which enable it to be used as a fire extinguisher. **(2 marks)**
18. **SECTION C: Attempt only one question.** **(15 marks)**
- A titration experiment was carried out to determine the concentration of potassium hydroxide (KOH) and prepare crystals of potassium sulphate. In this experiment, 25cm³ of KOH were neutralised by 24.50cm³ of 0.1 mol/dm³ sulphuric acid, using a suitable indicator.
- (a) Write a balanced equation for the reaction of KOH and H₂SO₄. **(2 marks)**
- (b) Calculate the number of moles of H₂SO₄. **(2 marks)**
- (c) Calculate the number of moles of KOH in 25cm³. **(2 marks)**
- (d) Calculate the concentration of KOH in mol/dm³. **(2 marks)**
- (e) Calculate the mass of KOH that was dissolved in 1dm³ of solution. [K=39, O=16, H=1] **(2 marks)**
- (f) In order to prepare a sample of crystals of potassium sulphate, 25cm³ of KOH were mixed with 24.50cm³ of 0.1 mol/dm³ sulphuric acid without the indicator.
Describe in details how a sample of crystals of the salt would be obtained from the solution. **(3 marks)**

(g) Rubidium (Rb) is below potassium (K) in Group I of the periodic table.

How would you compare the reactivity of Rb with K? Explain your reason.

(2 marks)

19. The chart below shows some reaction of magnesium and its compounds.



(a) Identify the compounds **A**, **B**, **C**, **D** and **E** either by names or by the chemical formula.

(10 marks)

(b) In the reaction which produces compound **A**, a gas is produced also.

(i) Name the gas produced.

(1 mark)

(ii) Describe a chemical test for the gas.

(2 marks)

(c) Write a balanced equation for the reaction of compound **A** with $\text{NaOH}_{(aq)}$.

(2 marks)

Chemistry I

003

08 Nov. 2010 08.30 - 11.30am



P. O. BOX 3817 KIGALI -TEL/FAX 586871

ORDINARY LEVEL NATIONAL EXAMINATIONS 2010

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS :

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)**

You do not need the Periodic Table.

SECTION A: Attempt all questions.**(55 marks)**

1. The stomach secretes gastric juice, which contains hydrochloric acid. The gastric juice helps with digestion. Sometimes there is an overproduction of acid, leading to indigestion. Antacids, such as milk of magnesia, can be taken to neutralise the excess acid. Milk of magnesia is only slightly soluble in water and has the chemical formula $Mg(OH)_2$.
 - a) Write a balanced chemical equation to show how the antacid reacts with the acid. **(1 mark)**
 - b) The directions on the bottle recommend that children under the age of 12 years take one teaspoon of milk of magnesia, whereas adults can take two teaspoons of the antacid. Briefly explain why the dosages are different. **(1 mark)**
 - c) Why is it not advisable to take an overdose of the antacid in the stomach? Refer to the hydrochloric acid concentration in the stomach in your answer. **(1 mark)**
2. An unknown substance has a molar mass of 162.2 g.mol^{-1} and consists of the following elements: 74.07 % carbon, 17.28 % nitrogen and 8.65 % hydrogen.
 - a) Determine the empirical formula of the substance. **(2.5 marks)**
 - b) What is the molecular formula of the substance? **(1.5 marks)**
(Atomic mass: H:1, C:12, N:14)
3. Two test tubes, A and B, both contain HCl at a concentration of 1M. One gram of calcium carbonate powder is added to test tube A. In test tube B, one gram of calcium carbonate chunks is added. The reaction that takes place in the two test tubes is:
$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2(g)$$
 - a) i) In which test tube (A or B) will the formation of $CO_2(g)$ take place at a higher rate? **(0.5 mark)**
ii) Give a reason for your answer. **(1 mark)**
 - b) Will the rate at which $CO_2(g)$ is formed in test tube A be influenced (yes or no) if more of the HCl solution of the same concentration is poured into the test tube? **(0.5 mark)**

- c) Name two ways in which the rate of CO_2 formation in both test tubes can be increased, excluding the option of adding more CaCO_3 . **(1 mark)**
4. 0.72 g of O_3 reacts with 0.66 g NO according to the following equation:
- $$\text{O}_3(\text{g}) + \text{NO}(\text{g}) \rightarrow \text{O}_2(\text{g}) + \text{NO}_2(\text{g})$$
- a) Calculate the number of moles of O_3 and of NO present at the start of the reaction. **(2 marks)**
- b) Identify the limiting reagent (reactant) in the reaction and justify your answer.
(Atomic mass: O:16; N:14) **(2 marks)**
5. Research has shown that the temperature on Earth is gradually rising.
- a) What term has been given to this phenomenon? **(1 mark)**
- b) What is the likely cause of this phenomenon? **(1 mark)**
- c) What are the consequences of this phenomenon? **(1 mark)**
- d) What can be done about it? **(1 mark)**
6. Study the formula of the compound: crystalline magnesium sulphate: $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$
- a) Determine the percentage of sulphur present in the compound. **(2 marks)**
- b) If we have 5 g of this substance available, what mass will comprise of water? **(2 marks)**
(Atomic mass: H:1, O:16, S:32, Mg:24)
7. Write only the word/term for each of the following descriptions:
- a) The distance between two atoms in a molecule. **(0.5 mark)**
- b) A chemical reaction during which electrons are transferred. **(0.5 mark)**
- c) A measure of how much solute is dissolved in a solvent. **(0.5 mark)**
- d) An ionic solution that conducts electricity. **(0.5 mark)**

8. a) Hydrogen is not a metal, but it classified in IA group (alkali metals), why? **(1 mark)**
- b) $15 \text{ cm}^3 \text{ N}_2$ react with $30 \text{ cm}^3 \text{ of H}_2$ to produce ammonia gas $[\text{NH}_3 \text{ (g)}]$. Determine the total volume of gas left in the container if the reaction runs to completion and if the volumes are measured at the same temperature and pressure before and after the reaction. **(3 marks)**
9. Read the following statements and then choose the best answer(s) from the column marked possible answers. There could be more than one correct answer and the possible answers may be used more than once. **(4 marks)**

Statement	Possible answers
1. The extent to which a salt dissolves in water is known as the of the salt.	A. Element
2. Sand and water is an example of a	B. Compound
3. In the case of a cup of a black coffee, the coffee is the	C. Solution
4. A homogenous mixture can also be called a	D. Homogenous mixture
5. Salt dissolved in water is an example of a	E. Heterogeneous mixture
6. When AgNO_3 and NaCl are mixed a is formed.	F. Solvent
	G. Precipitate
	H. Solubility
	I. Solute
	J. Mixture

10. a) Name the following compounds:
- i) NaHCO_3 **(1 mark)**
 ii) CS_2 **(1 mark)**
- b) Write down the chemical formulae for the following compounds:
- i) Ammonium sulphate **(1 mark)**
 ii) Aluminium hydroxide **(1 mark)**
11. a) What is an element? **(1 mark)**
- b) Write down the name of seven elements on the periodic table which always occur as diatomic molecules in nature. **(3 marks)**

12. a) Define dilution. **(1 mark)**
- b) What volume of 15M sulphuric acid must be used to prepare 1.5L of a 0.1 M H_2SO_4 solution? **(2 marks)**
13. a) Name the type of chemical bond that occurs between the atoms in water molecule. **(1 mark)**
- b) Comment on the following table: Boiling points of the hydrides of VIA group elements against molecular weights. **(3 marks)**

Compound	H_2O	H_2S	H_2Se	H_2Te
Molecular weight	18	34	81	130
Boiling point (K)	373	213	231	271

14. Sketch a diagram showing a water cycle. **(4 marks)**
15. a) The atomic number of phosphorus is 15. What does this mean? **(1 mark)**
- b) Phosphorus is also classified as a non-metal. Name four physical properties phosphorus should have because of its non-metallic status. **(2 marks)**
- c) Phosphorus has only one naturally occurring isotope. The isotope has 16 neutrons. The two radioactive isotopes of phosphorus have 17 and 18 neutrons respectively. Represent the two radioactive isotopes of phosphorus according to the notation ${}_Z^AX$. **(1 mark)**

SECTION B: Attempt any three questions from this section. (30 marks)

16. Study the following reaction: $\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \rightarrow 2\text{Fe}(\text{s}) + 3\text{CO}_2(\text{g})$

Carbon monoxide is added to 500 kg of iron (III) oxide at STD.

Determine:

- a) The mass of iron formed. (4 marks)
- b) The volume of carbon dioxide released. (2 marks)
- c) The number of iron atoms formed. (2 marks)
- d) The number of atoms present in 500 kg of Fe_2O_3 . (2 marks)
(Atomic mass: Fe : 56; O : 16; C : 12; Number of Avogadro, $N_A = 6.023 \times 10^{23}$; molar volume = 22.4 l. mol^{-1})

17. A student wants to test sea water for the presence of chloride ions.

a) Make a list of the chemicals and apparatus that he will need to conduct his test. (2 marks)

b) Suggest a method (procedure) to test sea water for the presence of chloride ions. (4 marks)

c) Write balanced ionic equations for all reactions that take place. (2 marks)

d) If chloride ions are present, a precipitate forms. What is the colour of the precipitate? (1 mark)

e) Do you think the precipitate will contain other ions as well? Give a reason for your answer. (1 mark)

18. Bauxite is the principal ore of aluminium.

a) Describe briefly how bauxite is purified. (2 marks)

b) Explain why cryolite is added to the purified ore before it is electrolysed. (1 mark)

c) Write equations to show the reactions that take place at the electrodes during the electrolysis of the purified ore (Al_2O_3). (2 marks)

d) Explain why the anode is replaced from time to time. (1 mark)

e) State two reasons why aluminium is not obtained from bauxite by heating the purified ore with carbon. (2 marks)

- f) What is the reason why certain metals (such as gold) are more expensive than others (such as aluminium, copper)? **(2 marks)**
19. Because the world population is increasing so rapidly, the demand for food is incredibly high. The largest percentage of the world's soil is used for the cultivation of the crops, but large shortages of nutrients and minerals to allow good crop growth exist. The solution is the use of fertilisers.
- a) Where do plants get the elements carbon, hydrogen and oxygen from? **(1 mark)**
- b) The fertiliser: NPK is sold as NPK 14-26-16. What does this mean? **(2 marks)**
- c) Why are liquid fertilisers used more and more in agriculture? **(3 marks)**
- d) Write two paragraphs in which you address the impact of fertilisers on the environment. **(4 marks)**
20. a) Hydrocarbons are obtained from crude oil through fractional distillation.
- i) Which physical property is used to separate the various hydrocarbons from crude oil? **(1 mark)**
- ii) Which of the hydrocarbons, ethane or butane, will be removed first during distillation? Give a reason for your answer. **(1.5 marks)**
- b) Consider the following organic compound: $\text{CH}_3\text{-CO-O-CH}_3$.
- i) Write down the name of this compound. **(1 mark)**
- ii) Write down the names of the two organic compounds that were used to prepare this compound. **(1 mark)**
- iii) Write down the structural formula and name of one isomer of this compound. **(2 marks)**
- c) Write the functional group of an amine, a ketone. **(2 marks)**
- d) Is butane saturated or unsaturated hydrocarbon? Give a reason for your answer. **(1.5 marks)**

SECTION C: Attempt only one question from this section.**(15 marks)**

21. A chemist conducts an investigation and makes use of the following:

- 0.1 mol.dm⁻³ NaOH
- unknown concentration HCl
- bromothymol blue indicator
- burette
- stand
- erlenmeyer flask

20 cm³ of the HCl and a few drops of the indicator are placed in the erlenmeyer flask. Die burette is filled with NaOH. The latter is added to an acid solution until a permanent colour change occurs.

The reactions mixture heats up slightly. The whole process is repeated three times.

Results:

Volume acid	20	20	20
Volume base	15.3	15.15	15.2

- a) Supply a possible hypothesis for the investigation. **(2 marks)**
- b) Name the dependent and independent variables in this investigation. **(2 marks)**
- c) i) Write the ionic equation for the neutralising reaction. **(1 mark)**
- ii) Use a calculation to determine the unknown value. **(3 marks)**
- iii) Give the common name of salt formed. **(1 mark)**
- d) What will happen to the pH of the acid during this reaction? **(2 marks)**
- e) Is the reaction endothermic or exothermic? Explain. **(2 marks)**
- f) Supply the name of the method used for neutralising reaction. **(1 mark)**
- g) Define acid-base indicator. **(1 mark)**

22. A group of learners was asked to investigate the reactivity of alkanes and alkenes. They chose ethane and ethene as examples. They then carried out the following experiments.

Experiments A: The learners poured a few drops of ethane and ethene onto two separate watch glasses and lit the liquids in a fume cupboard.

Their observations are indicated in the table below:

Compound	Colour of flame	Sootiness
Ethane	Orange and blue flame	No soot observed
Ethene	Orange and blue flame	Slightly sooty

Experiments B: The learners perform the reaction of ethane and ethene firstly in a darkened room. They poured 2 cm³ of ethane and 2 cm³ of ethene into two separate test tubes and then added a few drops of bromine to the contents of each test tube. They then repeated the experiment in sunlight.

Their observations are indicated in the table below:

Compound	Action of liquid bromine in the dark	Action of liquid bromine in sunlight
Ethane	No visible reaction	Liquids mix and decolourise after a long time. A gas evolves
Ethene	Bromine decolourises slowly	Liquids mix and decolourise rapidly. No gas evolves

- a) Write down four safety precautions that the learners took during the experiment. **(2 marks)**
- b) Write down a possible hypothesis for investigation. **(2 marks)**
- c) What conclusion should the learners reach about the reactivity of the compounds as a result of
- the experiment A? **(1 mark)**
 - the experiment B? **(1 mark)**

- d) i) Write down the balanced equations for the combustion reactions involved in the experiment A. **(2 marks)**
- ii) Write down the balanced equations for the bromation reactions involved in the experiment B. **(2 marks)**
- e) Ethene molecules bond with one another to form long polymer chains. What are these ethene units known as? **(1 mark)**
- f) Give the general molecular formula of the alkenes. **(1 mark)**
- g) Calculate the mass of gas evolved in experiment B.
(Atomic mass: H: 1, C : 12, Br : 80; density of ethane = 1.212g/l). **(3 marks)**

CHEMISTRY I

003

10th Nov. 2009 08.30 – 11.30 am

RWANDA NATIONAL EXAMINATIONS COUNCIL



P.O BOX 3817 KIGALI-TEL/FAX : 586871

ORDINARY LEVEL NATIONAL EXAMINATION 2009

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS:

- This paper consists of **three** sections **A, B and C**
- Answer **ALL** questions in section A. **(55 marks)**
- Answer **THREE** questions in section B. **(30 marks)**
- Answer only **one** question in section C **(15 marks)**
- Calculators may be used.

SECTION A: ANSWER ALL QUESTIONS**(55 MARKS)**

1. Hydrogen gas is prepared by reacting Zinc metal with hydrochloric acid solution. The gas is collected by upward delivery.
 - a) Describe a chemical test for hydrogen gas. **(2 marks)**
 - b) From its method of collection, what can you conclude about the density of hydrogen compared to that of air? **(1 mark)**
 - c) Write a balanced chemical equation for the reaction of Zinc with hydrochloric acid. **(2 marks)**
2. Unpolluted air is a mixture of gases.
 - a) State the components of unpolluted air and their approximate percentage. **(2 marks)**
 - b) Carbon monoxide is known to be one of the pollutants of air.
 - i) What is the main source of carbon monoxide in air?
 - ii) Why is carbon monoxide poisonous? **(2 marks)**
3. The following methods may be used to separate mixtures: filtration, distillation, chromatography, evaporation. State which method you would use to separate:
 - a) Zinc chloride from sea water.
 - b) Pure water from sea water.
 - c) The components of chlorophyll. **(3 marks)**
4. The elements of W, X and y have the following atomic numbers W = 6, X = 8, Y = 19.
 - a) Write the electronic configuration of Y. **(1 mark)**
 - b) Write down the formula of a compound formed between Y and X. Use Y and X as symbols in the compound. **(1 mark)**
 - c) What type of bond is formed when w combines with X? Give a reason. **(2 marks)**
5. Dilute hydrochloric acid was electrolyzed using carbon electrodes.
 - a) Give the formulae of all the ions present in a solution of sulphuric acid. **(2 marks)**
 - b) Which gas is formed at the anode? **(1 mark)**
 - c) As electrolysis continues, does the solution become more or less acidic or the acidity remains unchanged? Give a reason. **(2 marks)**
6. An organic formula C_4H_8 was prepared by heating butanol with concentrated sulphuric acid.
 - a) Give the structural formula of butanol (butanol-1) **(2 marks)**
 - b) To what class of hydrocarbons does C_4H_8 belong? **(1 mark)**
 - c) Give the structural formulae of two isomers of C_4H_8 . **(1 mark)**
7. Ammonia gas is prepared by heating calcium hydroxide and ammonium chloride.
 - a) Write a balanced chemical equation for the reaction between calcium hydroxide and ammonia chloride. **(2 marks)**

- b) Why is ammonia gas not dried by using concentrated sulphuric acid? **(1 mark)**
c) State one large scale use of ammonia. **(1 mark)**
8. Organic compounds are classified according to their functional groups. From the compounds represented by the formulae:
A: $\text{CH}_3\text{CH}_2\text{COOH}$, B: $\text{CH}_3\text{CH}_2\text{OH}$, C: $\text{CH}_3\text{CH} = \text{CH}_2$,
D: $\text{CH}_3\text{COOCH}_2\text{CH}_3$, E: $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$.
Select a letter corresponding to the formula of:
a) An ester
b) A carboxylic acid
c) An alkene. **(3 marks)**
9. A scientist suspected that drinking water was contaminated by zinc sulphate.
How would the scientist show by chemical tests that the water contained:
a) Zinc ions? **(2 marks)**
b) Sulphuric ions? **(2 marks)**
In each case describe the reagents {chemicals} used and the expected observation for a positive result.
10. Poly(ethene) is a commonly used plastic polymer.
a) State one advantage of using Poly(ethene) plastic compared to other materials such as metals or glass. **(1 mark)**
b) Why is poly(ethene) plastic considered a pollutant in the environment? **(1 mark)**
11. 5.95g of tin (Sn: relative atomic mass = 19) were burned in oxygen to produce 7.55g of an oxide of tin.
a) Calculate the mass of oxygen in the oxide of tin. **(1 mark)**
b) Determine the empirical formula of the oxide of tin. (O: relative atomic mass = 16) **(2 marks)**
12. Sulphur dioxide is known to be one of the gases which cause acid rain.
a) Write an equation to show the reaction of sulphur dioxide with water. **(1 mark)**
b) In the contact process, sulphur dioxide is converted into sulphuric acid.
Give one large scale use of sulphuric acid. **(1 mark)**
- 13.a) Arrange the following metals in order of reactivity, starting with the most reactive: Zn, Cu, Mg, Ca, Pb. **(1 mark)**
b) A piece of magnesium was mixed with copper (II) sulphate and the mixture was left to stand for about an hour. What observation would be made after an hour? Explain your reasoning. **(2 marks)**
14. a) Name a process which removes carbon dioxide from the atmosphere. **(1 mark)**
b) Name a process which releases carbon dioxide into the atmosphere. **(1 mark)**

c) In recent years, human activity has caused a large increase of carbon dioxide in the atmosphere. Briefly explain what effect the increase amount of carbon dioxide has on the environment. **(2 marks)**

15. The table below shows some of the methods for the preparation of salts.

Reactants	Products
Magnesium oxide + A	Magnesium nitrate + B
C + Sodium sulphate	Barium sulphate + D

Identify the compounds A, B, C and D by writing their names. **(4 marks)**

A = B =

C = D =

SECTION B: Attempt any THREE questions in this section. (30 marks)

16. Iron is extracted from an iron ore called haematite (Fe_2O_3) in blast furnace. Iron ore is mixed with coke (carbon), calcium carbonate (limestone) and introduced into the furnace. A blast of hot air is blown in from the bottom of the furnace. Coke (carbon) burns to form carbon dioxide which reacts with more carbon to form carbon monoxide.

a) Write two balanced equations to show the formation of the two gases. **(2 marks)**

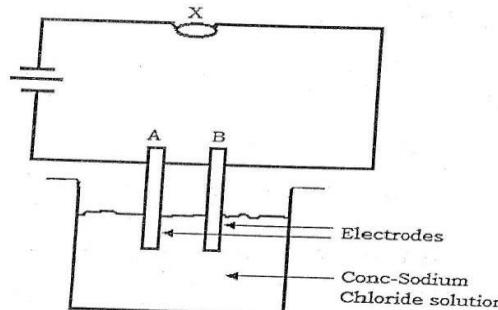
b) Write a balanced equation to show the reaction between Fe_2O_4 and carbon. **(2 marks)**

c) Identify the oxidizing agent and reducing agent in reaction of (b) above. **(2 marks)**

d) What is the function of calcium carbonate? Explain your answer using two equations. **(2 marks)**

e) What is galvanized iron? Why is iron sometimes galvanized? **(2 marks)**

17. A student carried out electrolysis of concentrated chloride solution using the apparatus shown below:

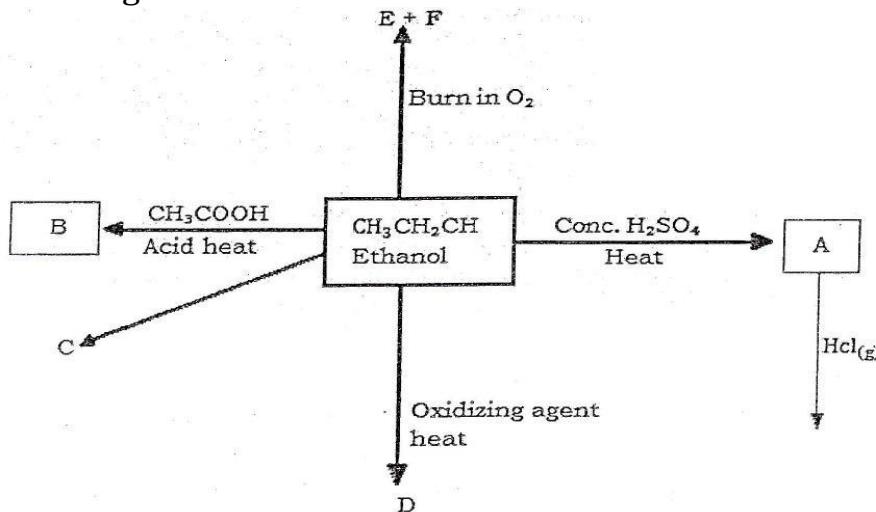


a) What apparatus could be connected at X to show that the solution is an electrolyte? **(1 mark)**

- b) Identify the electrodes labelled A and B. **(3 marks)**
 c) Which gas is formed at electrode B? Write an equation to show its formation. **(2 marks)**
 d) After some time, the solution around one of the electrodes was tested with a red litmus paper. The paper turned blue. Explain in terms of the electrolysis process, why the solution turned red litmus paper blue? **(2 marks)**
 e) Suppose the electrodes A and B are graphite and the electrode is a solution of copper (II) sulphate, give two observations that could be made as a result of electrolysis (apart from observing bubbles of gas). **(2 marks)**

18. Ethanol is a member of a family of organic compounds Alcohols (Alkanols). Ethanol is prepared by mixing a solution of glucose with yeast; leaving the mixture for a day at a temperature of about 37°C and then isolating ethanol from the mixture.

- a) Name the process in which ethanol is formed from a solution of glucose. **(1 mark)**
 b) What is the role of yeast? **(1 mark)**
 c) What functional group is present in all alcohols? **(1 mark)**
 d) The diagram below shows reactions of ethanol and other compounds.



- i) Identify the organic compounds (by name or formula) A, B, C and D? **(4 marks)**
 ii) The formation of E and F is an exothermic reaction. What is an exothermic reaction? **(1 mark)**
 c) Compound A reacts with hydrogen chloride. Write a chemical equation for the reaction. **(2 marks)**

19. An experiment was carried out to find the concentration of sulphuric acid solution and to prepare sodium sulphate crystals from the solution. In that experiment, it was found that 25 cm³ of 2 mol.dm⁻³ sodium carbonate solution neutralized 27 cm³ of sulphuric acid. After neutralization the solution was used to obtain crystals of salt.

- a) Write a balanced equation for the reaction of sodium carbonate and sulphuric acid. **(2 marks)**

- b) How many moles of Na_2CO_3 were in 25 cm^3 of $2 \text{ mole} \cdot \text{dm}^{-3}$ solution? **(1 mark)**
- c) Calculate the concentration of sulphuric acid in mol dm^{-3} (to 2 decimal places). **(2 marks)**
- d) State the name of one indicator you could use in the neutralization process. **(1 mark)**
- e) Briefly explain how crystals of sodium sulphate could be obtained from the solution after neutralization. **(2 marks)**
- f) Calculate the mass of sodium sulphate crystals which could be obtained from the solution. ($\text{Na} = 23, \text{S} = 32, \text{O} = 16$). **(2 marks)**
20. Magnesium is in group 2 of the periodic table and is represented by the symbol $^{24}_{12}\text{Mg}$, it combines with oxygen to form magnesium oxide. The symbol for oxygen is ^{16}O .
- a) What do the numbers 24 and 12 in the symbol of Mg represent? **(1 mark)**
- b) Another type of magnesium is represented by $^{26}_{12}\text{Mg}$. State the name given to the different types of magnesium atoms? **(2 marks)**
- c) Give the electronic configuration of magnesium and predict in which period of the periodic table it is. **(2 marks)**
- d) Magnesium combines with oxygen. State the type of bond which is formed and give two properties such a compound shows. **(3 marks)**
- e) Calcium is below magnesium in the same group of the periodic table. Compare the reactivities of the two metals with water. Write an equation to show how one of the two metals react with water. **(2 marks)**

SECTION C: Attempt one question from this section. (15 MARKS)

21. Chlorine gas is prepared by heating Manganese (IV) Oxide (Manganese dioxide) with concentrated hydrochloric acid. The gas is collected by downward delivery. It is highly reactive and a strong oxidizing agent.
- a) Describe a chemical test for chlorine gas. **(1 mark)**
- b) Chlorine is a member of halogens of group 7 in the periodic table. How does the reactivity of halogens change down the group and why? **(2 marks)**
- c) Using balanced equations, show the products formed when chlorine reacts with:
- i) Sodium iodide **(2 marks)**
 - ii) Sodium hydroxide solution at room temperature. **(2 marks)**
 - iii) Iron (II) chloride **(3 marks)**
- d) Aluminium chloride is prepared from chlorine by passing dry chlorine over hot aluminium. Aluminium chloride sublimes and is collected in the cooler part of the apparatus.
- i) What is sublimation? **(1 mark)**
 - ii) Write a balanced a balanced equation for the reaction of chlorine with aluminium. **(2 marks)**
 - iii) What mass of aluminium chloride is produced from 0.54 g of aluminium? ($\text{Cl} = 35.5, \text{Al} = 27$) **(2 marks)**

22. A student found a piece of rock which contained copper (II) carbonate. He carried out the following reactions in order to extract copper metal from the rock. Sulphuric acid was added to crush rock. When the reaction is over, the mixture was filtered. To precipitate containing copper (II) sulphate, sodium hydroxide solution was added. The precipitate obtained was filtered and the residue obtained was heated strongly to obtain copper (II) oxide which was reduced by heating with hydrogen gas.

- a) Write a balanced equation for the reaction (II) carbonate with sulphuric acid. **(2 marks)**
- b) How could the student tell if the reaction was complete? **(1 mark)**
- c) What products were formed when copper (II) sulphate was reacted with sodium hydroxide? **(2 marks)**
- d) Describe the colour of the mixture in (c) above. **(1 mark)**
- e) Write a balanced equation for the reaction which involves heating to give copper (II) oxide. **(2 marks)**
- f) Write down a balanced equation for the reaction between copper (II) oxide and hydrogen and identify the oxidizing agent. **(3 marks)**
- g) If 5.0g of copper (II) oxide was used, calculate:
 - i) The mass of hydrogen gas which reacted with copper (II) oxide. **(2 marks)**
 - ii) The mass of copper metal which was produced. **(2 marks)**

Chemistry III

003

10 Nov. 2008 8.30am-11.30am

RWANDA NATIONAL EXAMINATIONS COUNCIL



P.O.BOX 3817 KIGALI-TEL/FAX: 586871

ORDINARY LEVEL NATIONAL EXAMINATION 2008

SUBJECT : CHEMISTRY III

TIME: 3 HOURS

INSTRUCTIONS:

This paper consists of **THREE** sections: A, B and C.

- Answer all questions in section A. **(55 marks)**
- Answer three questions in section B. **(30 marks)**
- Answer one question in section C. **(15 marks)**
- You do not need the Periodic Table.**

Section A: Answer all questions (55 marks)

1. (a) Name two types of hardness of water. **(2marks)**
(b) (i) Give the causes of hardness of water.
(ii) Briefly explain how one of the types of hardness can be removed. **(2marks)**
(1mark)
2. Methane burns in oxygen to give carbon dioxide and water vapour only.
(a) Write a balanced equation for this reaction. **(1mark)**
(b) Calculate the volume of oxygen needed for the complete combustion of 100cm³ of methane. (All volumes of gases were measured at the same temperature and pressure). **(2marks)**
3. The following techniques are used for the separation of mixtures: evaporation, chromatography, filtration, fractional distillation and sublimation. Which of these is the most suitable technique for obtaining:
(a) Sodium chloride from a solution of sodium chloride?
(b) Ammonium chloride from a white powder composed of ammonium chloride and sodium chloride?
(c) Small pieces of metal from the engine oil of a car?
(d) The different pigments from an extract of flower petals? **(4marks)**
4. Calculate the number of water molecules in 900g of water (H₂O). (Relative atomic masses : H : 1, O: 16. Avogadro's number = 6.0x10²³ per mole). **(3marks)**
5. Sodium is manufactured by the electrolysis of molten sodium chloride containing calcium chloride in the Downs cell.
(a) Why is calcium chloride added? **(1mark)**
(b) (i) Name the product at the anode. **(1mark)**
(ii) Write an equation showing the discharge at the anode. **(1mark)**

6. In an experiment concerning the displacement of one metal from an aqueous solution of its salt by another metal, the results were tabulated as follows:

	Metal A	Metal B	Metal C	Metal D
Solution of Salt A	-	W	Reaction	X
Solution of Salt B	Reaction	-	Reaction	Reaction
Solution of Salt C	No Reaction	No Reaction	-	Y
Solution of Salt D	Reaction	No Reaction	Z	-

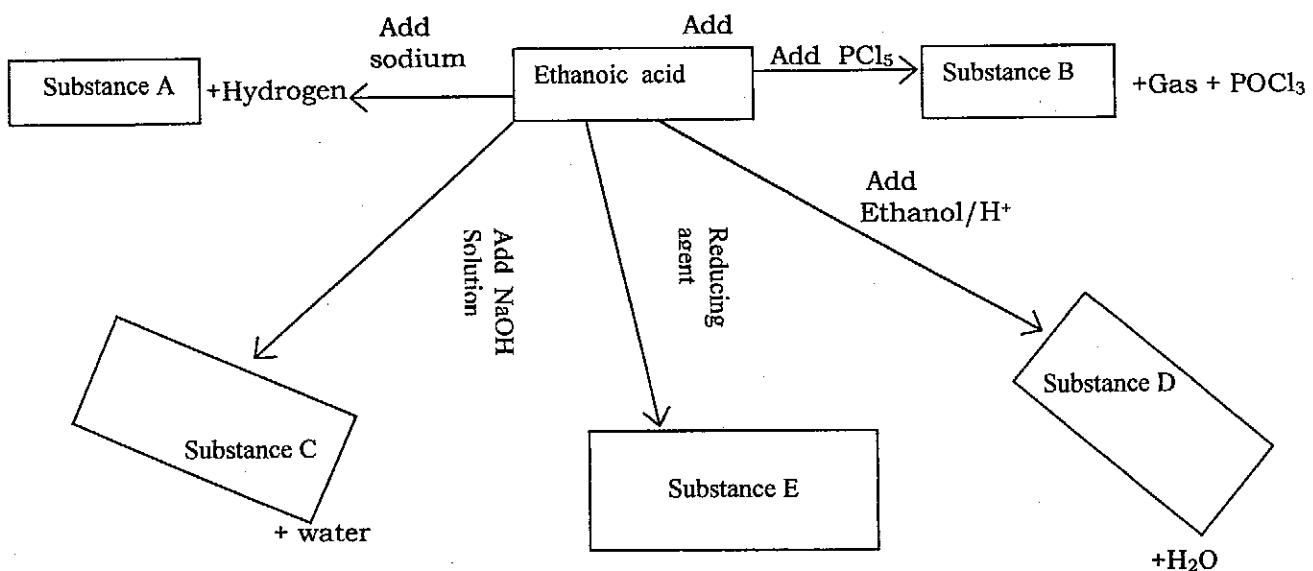
The table shows whether or not reaction occurs between the metal and a solution of another metal salt.

- (a) Arrange the metals in order of reactivity, giving the most reactive one first. **(2marks)**
- (b) State whether reaction will take place in the spaces labeled W, X, Y and Z. **(2marks)**
7. Solutions may be classified as basic, neutral or acidic. The information below shows the solutions and their pH values. Study the table and classify solutions A, B and C. **(3marks)**
- | Solution | pH value |
|----------|----------|
| A | 7 |
| B | 3 |
| C | 10 |
8. (a) Which method can be used to separate the components of air? **(1mark)**
- (b) What is meant by air pollution? **(1mark)**
- (c) Name two sources of air pollution. **(2marks)**
9. (a) What is the cause of inertness of nitrogen? **(1mark)**
- (b) The following reaction: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ takes place during Haber process. Give the optimum conditions used in the process (temperature, pressure, catalyst) for this reaction. **(3marks)**
- (c) What feature of the catalyst in (b) makes it efficient? **(1mark)**

10. (a) Give one example of (i) a reaction which shows effervescence.
(ii) an exothermic reaction. **(2marks)**
- (b) Complete the following equations:
(i) $\text{SO}_2 + \text{H}_2\text{O} \rightarrow$
(ii) $\text{Na} + \text{H}_2\text{O} \rightarrow$ **(2marks)**
11. (a) Write an equation for the reaction that takes place when hydrogen reacts with copper (II) oxide. **(1mark)**
- (b) (i) State which of the species is a reducing agent. Give a reason for your answer. **(2marks)**
(ii) Which is an oxidizing agent? **(1mark)**
12. Give three means of preventing the rusting of iron. **(3marks)**
13. Write the formula of:
(a) Ammonium phosphate
(b) Potassium chlorate
(c) Pentanol
(d) Butene. **(4marks)**
14. An organic compound contains 40% by mass of carbon, 13.3% hydrogen and 46.7% nitrogen.
(a) Calculate the empirical formula of the compound. **(2marks)**
(b) If the relative molecular mass of the compound is 60, determine its molecular formula.
(Relative atomic masses : C:12, H :1, N :14) **(1mark)**
15. Give one example of: (a) weak electrolyte
(b) Non-electrolyte
(c) Conductor. **(3marks)**

Section B: Answer any THREE questions (30 marks)

16. (a) The following question is about some of the reactions of ethanoic acid. Study the chart below and answer the questions that follow.



- (i) Write the structural or molecular formula of ethanoic acid. **(1mark)**
- (ii) Write an equation to show how ethanoic acid reacts with sodium carbonate. **(1mark)**
- (iii) Give the formula of substances A, B, C, D and E. **(5marks)**
- (b) Name one natural polymer and give its monomers. **(2marks)**
- (c) Write the structural formula of octane. **(1mark)**
17. Answer the following questions about the extraction of iron. (no diagrams are required).
- (a) Give the name and formula of one mineral from which iron is extracted. **(2marks)**
- (b) Explain how carbon monoxide is formed in the blast furnace. **(3marks)**
- (c) Write the equation for the reaction by which iron is formed in the furnace from its ore. **(1mark)**

- (d) Name two impurities likely to be present in the "Pig iron" formed in the blast furnace. **(2marks)**
- (e) Explain clearly why limestone (calcium carbonate) is used in the blast furnace. **(2marks)**
18. Sulphuric acid is manufactured by converting sulphur dioxide to sulphur trioxide and dissolving this in 95-98 per cent sulphuric acid, whilst adding an appropriate amount of water.
- (a) How is the sulphur dioxide obtained? (2 different methods) **(2marks)**
- (b) (i) Name one catalyst commonly used in this process. **(1mark)**
(ii) Name another catalyst not commonly used and explain why? **(2marks)**
- (c) Why is the sulphur trioxide not dissolved in water directly? **(1mark)**
- (d) Give two uses of sulphuric acid. **(2marks)**
- (e) Complete the following equations:
(i) $\text{H}_2\text{SO}_4 + \text{NaCl} \rightarrow$
(ii) $\text{Zn} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow$
19. What volume of 0.1M sodium hydroxide solution:
- (a) Contains 0.0025 mol of sodium hydroxide? **(3marks)**
- (b) Neutralizes 25cm³ of 0.05M sulphuric acid solution? **(4marks)**
- (c) Reacts exactly with 0.5mole of hydrochloric acid?
(Relative atomic mass: Na: 23, H: 1, O:16, S: 32, Cl: 35.5) **(3marks)**
20. (a) Write down the electronic configuration of chlorine. (Atomic number of chlorine = 17) **(1mark)**
(b) Explain why chlorine forms an ion Cl^- . **(2marks)**
- (c) Write the symbol for the magnesium ion.
(Atomic number of magnesium = 12) **(1mark)**
- (d) Write the formula and the name for the compound formed when these two elements combine. **(2marks)**
- (e) Would you expect this compound to have a high or low melting point? Give a reason. **(2marks)**
- (f) Indicate whether the bonding in the compound will be ionic or covalent. Give a reason for your answer. (Atomic number: Mg: 12, Cl: 17). **(2marks)**

Section C: Answer only one question. (15 marks)

21. In an experiment to determine the volume of hydrogen produced when magnesium powder reacts with dilute hydrochloric acid, the volume of hydrogen produced was measured at different intervals of time. The following results were obtained.

Time (seconds)	0	5	10	20	30	40	50	60
Volume of H_2 (cm^3)	0	32	52	78	93	95	95	95

- (a) Write down the equation for the reaction. **(1mark)**
- (b) Suggest three ways of speeding up this reaction. **(3marks)**
- (c) Plot a graph of volume of H_2 produced (on-y-axis) versus time (x-axis). **(8marks)**
- (d) Why is the volume of H_2 constant in the last three results? **(1mark)**
- (e) Why is the volume of $H_2 = 0\text{ cm}^3$ when the time = 0 seconds? **(1mark)**
- (f) Suggest one use of hydrogen gas. **(1mark)**
22. With the help of equations where possible, state the chemical test that would be used to distinguish each pair of the following substances and state the observation in each case.
- (a) $Fe^{2+}(aq)$ and $Cu^{2+}(aq)$
- (b) $Cl^-(aq)$ and $CO_3^{2-}(aq)$
- (c) $SO_2(g)$ and $Cl_2(g)$
- (d) $C_2H_4(g)$ and $C_2H_6(g)$
- (e) $C_5H_{12}(l)$ and $C_2H_5OH (l)$. **(3marks each)**

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CHEMISTRY III

003

15th Nov. 2007 08.30 – 11.30 am

RWANDA NATIONAL EXAMINATIONS COUNCIL



P.O BOX 3817 KIGALI-TEL/FAX : 586871

ORDINARY LEVEL NATIONAL EXAMINATION 2007

SUBJECT: CHEMISTRY III

DURATION: 3 HOURS

INSTRUCTIONS:

- This paper consists of **three** sections **A, B and C**
- Answer **ALL** questions in section A. **(55 marks)**
- Answer **THREE** questions in section B. **(30 marks)**
- Answer only **one** question in section C **(15 marks)**
- Calculators may be used.

SECTION A: ANSWER ALL QUESTIONS**(55 MARKS)**

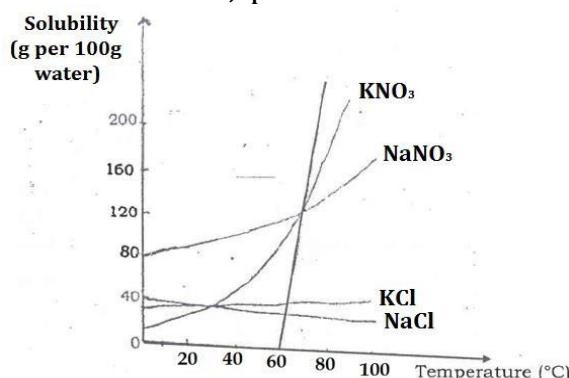
1. A compound contains 40% carbon, 6.67 % hydrogen and the rest is oxygen. If the molecular mass of the compound is 180, calculate the:
 - i) Empirical formula (2 marks)
 - ii) Molecular formula (1.5 marks)

(Relative atomic masses: H = 1, O = 16, C = 12)
2. Study the diagram below and answer the questions that follow:

a) What method of separating mixtures does the above diagram represent? (1 mark)

b) Name the parts labelled A, B and C. (3 marks)

c) When are you going to use this method? (1 mark)
3. a) Name two ways in which atmospheric nitrogen is fixed in the soil. (1 mark)
- b) Name two artificial fertilizers containing nitrogen. (1 mark)
- c) Which important nitrogen-containing compound is produced by the Haber process? (1 mark)
- d) Name the complex process by means of which plants build up carbohydrates from carbon dioxide. (1 mark)
4. The following graph shows the solubility curves for potassium nitrate, sodium nitrate, potassium chloride and sodium chloride.



Potassium nitrate can be prepared by mixing hot saturated solutions of potassium chloride and sodium nitrate. Use the solubility curves to answer the following questions:

- a) Which salt crystallizes first from solution at 80°C? **(1 mark)**
 b) Which salt crystallizes first from solution at 10°C? **(1 mark)**
- c) At which temperature are the solubilities of potassium nitrate and sodium nitrate the same? **(1 mark)**
- d) If a saturated solution of sodium nitrate, at 80°C, containing 150g of sodium nitrate in 100g water was cooled to 0°C, how much sodium nitrate would crystallize? **(1 mark)**
5. Insert the following oxides in their appropriate position in the table below: Zinc oxide (ZnO), carbon monoxide (CO), sodium oxide (Na₂O), carbon dioxide (CO₂).
- | Classification | Oxide |
|----------------|-------|
| Acidic | |
| Basic | |
| Amphoteric | |
| Neutral | |
6. State whether the following are physical or chemical changes: **(3 marks)**
- a) Alcohol fermentation
 b) Dilation of a solid
 c) Sublimation of iodine
7. Aluminium reacts with oxygen to form aluminium oxide.
- a) Write a balanced equation for this reaction. **(1 mark)**
 b) What mass of aluminium will burn in 1.6g of oxygen? **(2 marks)**
 (Atomic masses: Al = 27, O = 16)
8. For each of the following pairs of ions, identify the chemical test to distinguish them, stating clearly the observations.
- a) Cl⁻ (aq) and NO₃⁻ (aq) **(1 mark)**
 b) Fe²⁺ (aq) and Cu²⁺ (aq) **(1 mark)**
9. Give 3 reactions (equations) involved in the contact process. **(3 marks)**
10. Complete the following table: **(3 marks)**
- | Radical | Name | Valency |
|-----------------|--------------------|---------|
| NO ₃ | | |
| | Hydrogen carbonate | |
| PO ₄ | | |

11. This question refers to the elements of the periodic table with atomic masses from 3 to 18. Some of the elements are shown by letters but the letters don't represent the symbols of the elements:

3 A	4	5	6	7	8	9	10
11 C	12	13	14 D	15 E	18	17 F	18

- a) Which of the elements lettered A to G: **(3 marks)**

- i) Is a noble gas?
 ii) Is a halogen gas?
 iii) Would react most readily with chlorine?
 b) Give i) the formula of the hydride of D. (1 mark)
 ii) the formula of the oxide of C. (1 mark)
 c) Indicate whether the bonding in the oxide will be ionic or covalent. (3 marks)

12. Iron nails were placed in test tubes under different conditions. Show that both air and water are necessary for rusting. (3 marks)

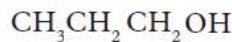
13. Complete the following table: (3 marks)

Particle	Mass	Charge
Proton		
		0
	1 1836	-1

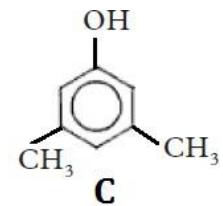
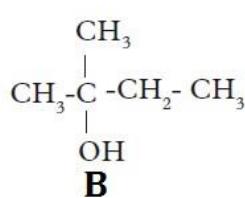
14. When solutions of potassium chloride (KCl) and silver nitrate (AgNO₃), are mixed, together, a precipitate of silver chloride forms.

- a) Write down a balanced equation for this reaction. (1 mark)
 b) Deduce from this the ionic equation. (1 mark)

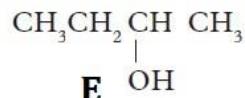
15. The compounds A to E are alcohols, phenols or ethers.



A



D



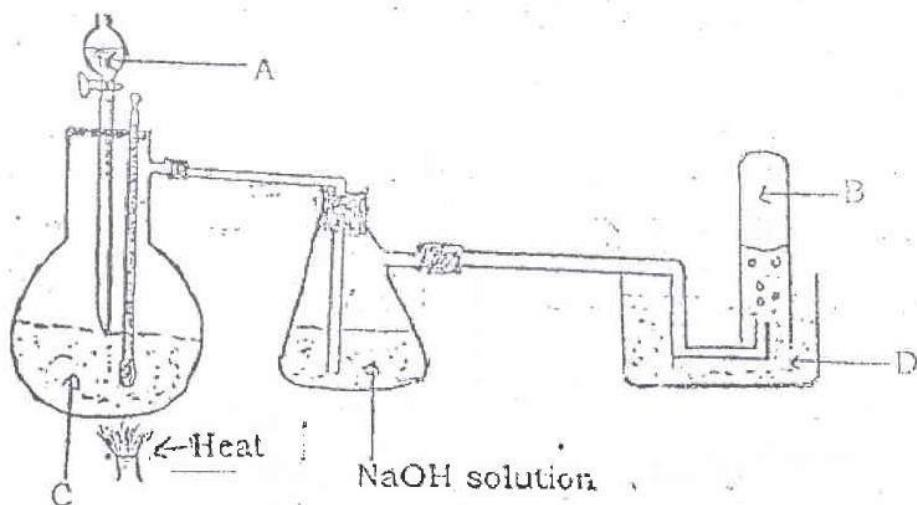
E

- a) Which of these is: (3 marks)
- i) A primary alcohol?
 ii) A phenol?
 iii) An ether?
- b) Name compound A. (1 mark)

SECTION B: Attempt any THREE questions in this section. (30 marks)

- 16.a) Write the name and formula of the principal ore of copper. **(2 marks)**
- b) Suggest one method by which the ore you have named may be concentrated. **(1 mark)**
- c) Outline, giving equations, the process by which impure copper is obtained from concentrated ore. **(3 marks)**
- d) Name the method by which impure copper is purified in industries. **(1 mark)**
- e) Give the formula of compounds that are obtained when copper reacts with concentrated HNO_3 . **(3 marks)**
17. a) Give 3 differences between ionic and covalent bonds. **(3 marks)**
- b) Compare the properties of ionic and covalent compounds. **(4 marks)**
- c) Give two examples of each type of compounds. **(3 marks)**
18. The electronic configuration of an element X is $1s^2 2s^2 2p^6 3s^2$.
- a) Find out the atomic number, the number of protons and the number of electrons for X. **(2 marks)**
- b) How many electrons are in i) K-shell **(1 mark)**
ii) L-shell **(1 mark)**
iii) M-shell **(1 mark)**
iv) N-shell **(1 mark)**
- c) i) To which group does the element belong? **(1 mark)**
ii) Give one reason for your answer. **(1 mark)**
- d) What is the valence of X?
- e) Give the formula of the compound formed between X and:
i) Hydrogen **(1 mark)**
ii) Sulphur **(1 mark)**
19. 20cm³ of sodium hydroxide was pipetted into a conical flask and titrated against 0.1M hydrochloric acid using phenolphthalein as an indicator. The indicator changed colour when 15.6cm³ of acid has been added.
- a) Define titration. **(1 mark)**
- b) State two basic pieces of apparatus that would be used in this experiment. **(2 marks)**
- c) What is the role of the indicator in this experiment? **(1 mark)**
- d.) i) Write the equation for this neutralization. **(1 mark)**
ii) Calculate the concentration of sodium hydroxide solution. **(3 marks)**
- e) Calculate the percentage composition of sodium in one mole of sodium hydroxide. **(2 marks)**

20. Study the diagram below and answer the questions that follow. Dehydration of ethanol (preparation of ethane from ethanol).



- a) Name the substances labelled A, B, C and D. (4 marks)
- b) What is the role of NaOH solution? (2 marks)
- c) What is the molar volume at room temperature and atmospheric pressure? (r.t.p) (2 marks)
- d) What is the volume of 2 moles of C_2H_4 gas at r.t.p? (2 marks)

SECTION C: Answer only one question in this section. (15 MARKS)

21.a) The following tests were carried out on some unknown organic compounds:

- Compound A was shaken with bromine (in tetrachloromethane). There was an immediate decolourization of the red bromine solution.
- Compound B was shaken with bromine (in tetrachloromethane). There was only a very slow decolourization of the red bromine solution and after a white pungent acid fumes could be detected.
- A small piece of freshly cut sodium was added to the non-acidic compound. A gas was liberated which formed an explosive mixture with air.

On warming compound D with ethanol and a few drops of concentrated sulphuric acid, a pleasant fruity smell could be detected which then was poured into water.

- i) Assign the following formulas to compounds A, B, C and D: (4 marks)

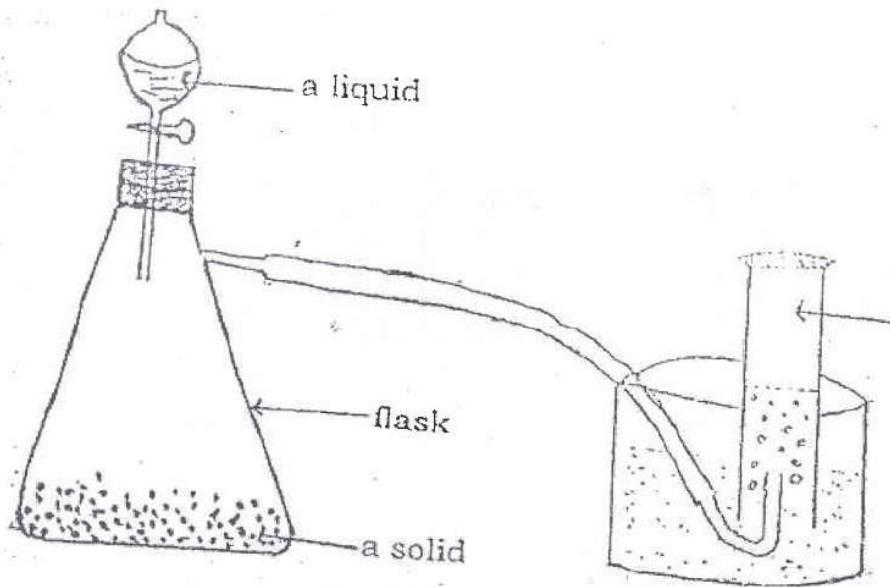


- ii) Write the equation for each observation. (2 marks)
- b) i) What are the basic raw materials used in the production of soap? (2 marks)
- ii) Write the equation for the reaction involved in the production of soap. (1 mark)
- iii) Which type of compound is used to separate soap from the mixture? (1 mark)
- iv) What other substances are used in the manufacture of soap?

(2 marks)

v) State any use of the by-products of the manufacture of soap.
(3 marks)

22. Gases are always made from the reaction between a solid and a liquid. The volume of gas made is controlled by the amount of liquid run into the flask holding the solid reactant. **(15 marks)**



Complete the table below:

Gas	Liquid	Solid	Reaction
Sulphur dioxide (SO_2)	Dilute hydrochloric acid	Sodium sulphate	$2\text{HCl} + \text{Na}_2\text{SO}_3 \rightarrow \text{SO}_2 + 2\text{NaCl} + \text{H}_2\text{O}$
Hydrogen (H_2)			
Oxygen (O_2)			
Carbon dioxide (CO_2)			
Hydrogen chloride (HCl)			
Ammonia (NH_3)			
Chlorine (Cl_2)			
Nitrogen dioxide (NO_2)			

Chemistry III

025

13th Nov.2006 8.30 - 11.30a.m

RWANDA NATIONAL EXAMINATIONS COUNCIL



B.P 3817 KIGALI-TEL/FAX : 586871

ORDINARY LEVEL NATIONAL EXAMINATION 2006

SUBJECT : CHEMISTRY III

DURATION : 3 HOURS

INSTRUCTIONS :

This paper has THREE sections : A, B, and C.

SECTION A : Answer ALL questions /55 marks

SECTION B : Answer THREE questions from this section /30marks

SECTION C : Answer ONE question from this section /15marks

Calculators may be used.

SECTION A: Answer ALL questions

1. Hydrogen gas was passed over hot copper(II) oxide until the reaction was over.

- (a) Write a balanced equation for the reaction. **(1mark)**
- (b) Identify the oxidising agent in the reaction. **(1mark)**
- (c) Name the salt formed when copper(II) oxide reacts with sulphuric acid. **(1mark)**

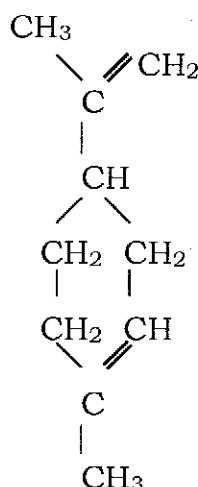
2. This question concerns the following solutions:

$\text{CuSO}_4\text{(aq)}$, $\text{KCl}_4\text{(aq)}$, $\text{H}_2\text{SO}_4\text{(aq)}$, $\text{AgNO}_3\text{(aq)}$, $\text{NH}_3\text{(aq)}$, $\text{MgSO}_4\text{(aq)}$.
Each solution may be used once or not at all.

Choose from the above list the formula of a solution which:

- (a) is alkaline **(1mark)**
- (b) is used to test for chloride ions **(1mark)**
- (c) forms a white precipitate when mixed with barium nitrate solution. **(1mark)**
- (d) produces hydrogen gas when added to magnesium. **(1mark)**

3. Limonene is a liquid hydrocarbon found in orange peel. Its structure is shown below:



- (a) What is meant by the term "hydrocarbon"? **(1mark)**
- (b) What is the molecular formula of limonene? **(1mark)**
- (c) Some limonene was mixed with a few drops of aqueous bromine (bromine water). What colour change would you see in the aqueous bromine. **(1mark)**
- (d) Which functional group present in the structure of limonene is responsible for reacting with bromine? **(1mark)**

4. (a) What is meant by 'hard water'? **(1mark)**

- (b) Explain the difference between permanent hardness and temporary hardness of water. **(2marks)**

- (c) Using a relevant equation, explain how temporary hard water can be changed into soft water. **(2marks)**
5. Magnesium and nitrogen combine to form a compound called magnesium nitride. Magnesium has atomic number 12 and nitrogen has atomic number 7.
- (a) Give the electronic arrangement of magnesium. **(1mark)**
- (b) State the type of bond formed when magnesium combines with nitrogen. **(1mark)**
- (c) Give the formula of magnesium nitride. **(1mark)**
6. Sodium (Na) obtained by the electrolysis of molten sodium chloride.
- (a) Explain why sodium chloride conducts electricity in the molten state but not in the solid state. **(2marks)**
- (b) Give an equation for the reaction at the cathode during this electrolysis. **(1mark)**
- (c) Give an equation for the reaction at the anode during this electrolysis. **(1mark)**
7. The table below shows the results of tests carried out on salt X. Study the table and answer the questions which follow.
- | Tests on salt X solution | Observations |
|---------------------------------|--|
| (a) Add dilute NaOH solution | A white precipitate which dissolves in excess reagent. |
| (b) Add dilute ammonia solution | A white precipitate which dissolves in excess reagent. |
| (c) Add barium nitrate solution | A white precipitate |
| (d) Add silver nitrate solution | No observable change |
- (a) Give the name or the formula of the cation in X. **(1mark)**
- (b) Give the name or the formula of the anion in X. **(1mark)**
- (c) What can you conclude from the test in (d) in the above table? **(1mark)**
- (d) What type of hydroxide is formed by the cation in X? **(1mark)**
8. C_4H_{10} is a hydrocarbon which belongs to a class of alkanes.
- (a) Give the name of the above alkane. **(1mark)**
- (b) Write down the structural formulae of 2 isomers of C_4H_{10} and name the branched isomer. **(2marks)**
9. Phosphine, PH_3 , is a compound which has similar properties to those of ammonia gas. The atomic number of P is 15 and that of H is 1.
- (a) What type of bond is formed between P and H? **(1mark)**

(b) Draw a diagram to show bonding in PH_3 . You may show electrons in the outer shell only. Use a cross (x) to show electrons from P and a dot (.) to show electrons from H **(2marks)**

10. The following methods are commonly used to separate mixtures:

Filtration, Chromatography, Simple distillation and Fractional distillation.

State the method that would be used to:

- (a) Separate ethanol and water. **(1mark)**
- (b) Separate the dyes in ink. **(1mark)**
- (c) Obtain pure water from sea water. **(1mark)**
- (d) Separate chalk particles and water. **(1mark)**

11. The molecular formula of ethanoic acid is $\text{C}_2\text{H}_4\text{O}_2$

- (a) Write the structural formula of ethanoic acid. **(1mark)**
- (b) What observation would be made if the above acid is mixed with sodium carbonate solution. **(1mark)**
- (c) What type of organic compound is formed when ethanoic acid is reacted with ethanol? **(1mark)**

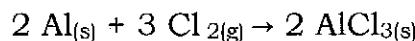
12. (a) State two conditions necessary for iron to rust. **(2marks)**

- (b) In which way is rusting similar to respiration? **(1mark)**

13. Ethene is a useful organic compound which can be converted into many other organic products. One such product is poly(ethene)

- (a) Poly(ethene) is a polymer. Explain the meaning of the term Polymer. **(1mark)**
- (b) Ethene is "unsaturated" whereas poly(ethene) is saturated. What is meant by "unsaturated" with reference to ethene? **(1mark)**
- (c) State one use of poly(ethene) **(1mark)**

14. Aluminium chloride is prepared by reacting chlorine with hot aluminium according to the equation:



- (a) Calculate the mass of AlCl_3 that would be produced from 0.54g of Aluminium. **(2marks)**
- (b) What is the volume of Cl_2 (measured at r.t.p.) that would react with 0.54g of aluminium. **(2marks)**

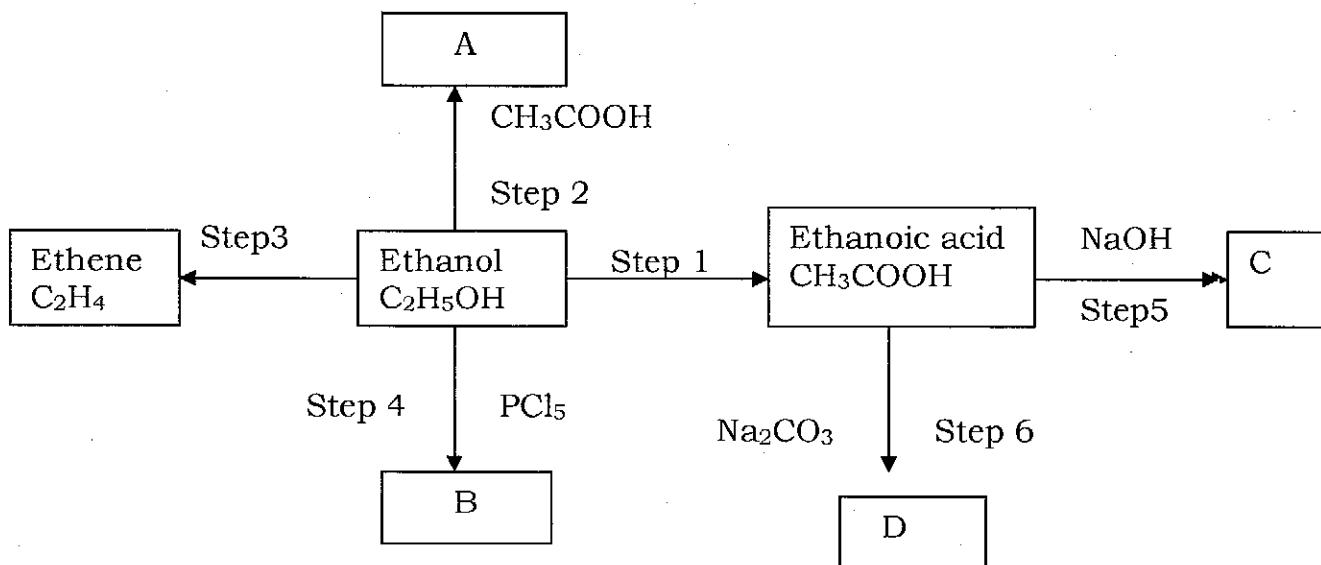
(Al = 27, Cl = 35.5, 1 mole of any gas at r.t.p. (room temperature and pressure) has a volume of 24dm^3 or 24000 cm^3)

15. Incomplete combustion of carbon produces carbon monoxide. Carbon monoxide is also produced by a charcoal stove (sigiri) when there is insufficient air (oxygen)
- (a) Why is carbon monoxide poisonous when it is inhaled (breathed in). **(2marks)**
- (b) Write a balanced equation for the reaction between carbon and oxygen to form carbon monoxide. **(1mark)**
- (c) Why is it advisable to use a charcoal stove (sigiri) in a well ventilated room? **(2marks)**

SECTION B: Answer THREE questions from this section.

16. (a) When ammonium chloride (NH_4Cl) is heated with calcium hydroxide ($\text{Ca}(\text{OH})_2$), a salt, water and ammonia gas are produced.
- (i) Write a balanced equation for the reaction between ammonium chloride and calcium hydroxide. **(2marks)**
- (ii) Ammonium salts often sublime when heated. What is meant by the term sublimation? **(1mark)**
- (iii) Calculate the percentage by mass of nitrogen in NH_4Cl .
(N = 14, H = 1, Cl = 35.5) **(3marks)**
- (b) Ammonia gas is manufactured on a large scale by the Haber process according to the equation:
- $$\text{N}_{2(\text{g})} + 3\text{H}_{2(\text{g})} \rightleftharpoons 2\text{NH}_{3(\text{g})}$$
- (i) How is nitrogen obtained for use in the Haber process? **(1mark)**
- (ii) State the temperature range and the catalyst used in the above process. **(2marks)**
- (iii) State one large scale use of ammonia. **(1mark)**

17. The chart below shows some reactions of ethanol and ethanoic acid.



- (a) Is step 1 reaction oxidation or reduction? **(1mark)**
- (b) Give the formula and name of the organic compound A formed in step 2. **(2marks)**
- (c) What type of reaction is step 3 and which reagent is used in that reaction. **(2marks)**
- (d) Give the name and formula of organic compound B formed in step 4. **(2marks)**
- (e) Give the name of the organic compound C. **(1mark)**
- (f) Write a balanced equation for the reaction in step 6. **(1mark)**
- (g) Give the name of one commercial product which contains ethanol. **(1mark)**

18. Diamond and graphite are macromolecular forms of carbon. Their physical properties are different because they have different structures.

- (a) What name is generally used to describe different forms of the element? **(1mark)**
- (b) In terms of their different structures, explain briefly the physical properties shown by graphite and diamond below:
- Graphite is soft and can be used as a lubricant while diamond is a very hard substance. **(4marks)**
 - Graphite is a good conductor of electricity while diamond is a poor conductor of electricity. **(4marks)**

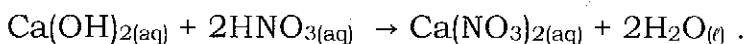
(c) State one use of diamond.

(1 mark)

19. An experiment was carried out to determine the mass of calcium oxide in a solid sample. The sample was dissolved in water to make 25.0cm^3 of calcium hydroxide. This solution required 7.50cm^3 of nitric acid to just neutralise it. The concentration of nitric acid was 0.050 mol dm^{-3} (0.050M)

(a) Write an equation for the reaction between calcium oxide and water to form calcium hydroxide. **(1mark)**

(b) The equation for the reaction between $\text{Ca}(\text{OH})_2$ and HNO_3 is:



(i) Calculate the number of moles of nitric acid.

(1mark)

(ii) How many moles of $\text{Ca}(\text{OH})_2$ were in 25.0cm^3 of the solution?

(1mark)

(iii) The number of moles of $\text{Ca}(\text{OH})_2$ is equal to the number of moles of calcium oxide (CaO).

Use your answer in (ii) to calculate the mass of CaO in the original sample (Ca = 40, O = 16)

(3marks)

(c) Carbon dioxide gas is passed through calcium hydroxide solution (lime water). A white precipitate is observed. More carbon dioxide is passed through the precipitate which dissolves to give a colourless solution.

Explain these observations as fully as you can, using equations to show the reactions taking place. (14)

(4marks)

20. Aluminium is a widely used metal. It is extracted by electrolysis of a molten mixture of aluminium oxide and cryolite. The electrolytic cell uses graphite anodes and a graphite lining as the cathode.

(a) Why is cryolite used in this process?

(1mark)

(b) Write equations to show what is formed at the

(4marks)

(c) Why do the graphite anodes have to be replaced after a period of time?

(1mark)

(d) How might this process of extraction affect the environment?

(2marks)

(e) Give one use of aluminium and explain one property of aluminium on which this use is based. (2)

(2marks)

SECTION C: Answer only ONE question from this section.

21. (a) Oxygen gas is prepared by adding hydrogen peroxide solution drop by drop to manganese (IV) oxide in a flat-bottomed flask. The gas is collected over water.
- (i) Draw a labelled diagram to show the preparation and collection of oxygen gas. **(5marks)**
- (ii) What is the role of manganese(IV) oxide in this reaction? **(1mark)**
- (b) Different elements are burned in gas jars of oxygen and each product is shaken with water. Each mixture is tested with litmus paper to find out if it is acidic or alkaline. In each case, state whether the mixture is acidic or alkaline and write an equation for the reaction between the oxide and water.
- (i) Sulphur **(2marks)**
(ii) Sodium **(2marks)**
(iii) Carbon **(2marks)**
- (c) Give one large scale use of oxygen **(1mark)**
- (d) Each year a lot of money is used to protect iron against corrosion/rusting. State two methods used to prevent rusting. **(2marks)**
22. (a) A salt consists of a metal cation (or ammonium ion, NH_4^+) and an anion derived from an acid. Therefore many salts are prepared by reacting acids with different substances. For each of the salts below, choose the acid and another substance that would be reacted together to produce that salt.
- (i) Magnesium chloride **(2marks)**
(ii) Lead nitrate **(2marks)**
(iii) Sodium ethanoate (acetate) **(2marks)**
- (b) Crystals of zinc sulphate were prepared using the method described below:
Excess zinc carbonate was mixed with aqueous sulphuric acid in a beaker. The mixture was warmed until the reaction stopped. The mixture was filtered to remove the un reacted zinc carbonate. The filtrate was evaporated until a small volume remained. The remaining solution was left to cool to form crystals.
- (i) Write a balanced equation for the reaction between zinc carbonate and sulphuric acid. **(2marks)**

- (ii) Why was an excess of zinc carbonate used. **(1mark)**
- (iii) Why would a similar method not be suitable for preparing lead(II) sulphate (lead sulphate)? **(2marks)**
- (iv) The salt zinc sulphate has the formula $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$. How would you show by a simple experiment that it contains water of crystallisation? **(2marks)**
- (v) Calculate the percentage of water by mass in the formula $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ (Zn = 65, S = 32, O = 16, H = 1) **(2marks)**

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Molar mass of $\text{NaOH} = 23 + 16 + 1 = 40 \text{ g/mole}$

Concentration of NaOH in $\text{g/dm}^3 = 3 \text{ mole/dm}^3 \times 40 \text{ g/mole} = 120 \text{ g/dm}^3$

c) i) Carbon and steam

ii) Ethene and water

iii) Sodium hydrogen sulphate and hydrogen chloride gas

iv) Fumes and a lot of heat.

17a) i) Cation is Y .

ii) Anion is X .

b) Electronic configuration of Z is $2, 8, 8, 1$.

c) Mass number of $Y = 12 + 12 = 24$

d) Z_4W

e) Z first reacts with water forming a hydroxide,

i.e. $2Z + 2\text{H}_2\text{O} \rightarrow 2\text{ZOH} + 2\text{H}_2$

ZOH is then reacted with HCl ,

i.e. $\text{ZOH} + \text{HCl} \rightarrow \text{ZCl} + \text{H}_2\text{O}$

Then the mixture i.e. $\text{ZCl} + \text{H}_2\text{O}$ are heated to drive off the water which evaporates leaving a pure sample of ZCl .

18. a) A: ZnCl_2 = Zinc chloride

B: ZnCO_3 = Zinc carbonate

C: ZnO = Zinc oxide

D: $\text{Zn}(\text{NO}_3)_2$ = Zinc nitrate

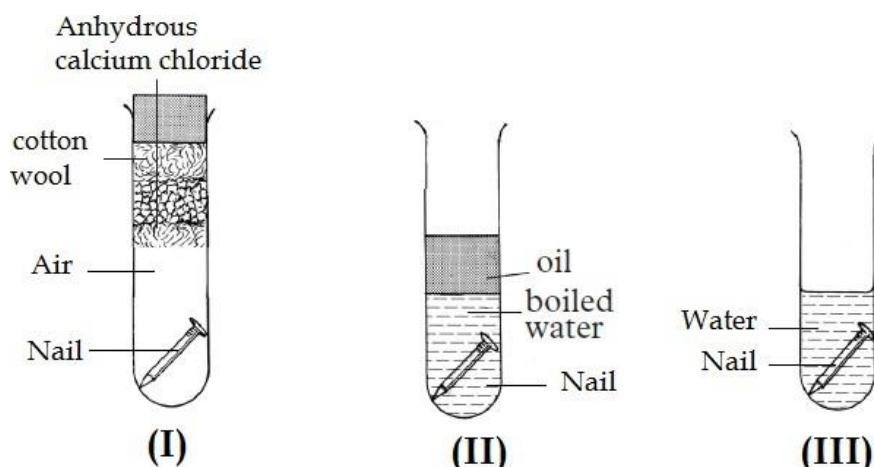
b) $2\text{Zn}(\text{NO}_3)_2 \rightarrow 2\text{ZnO} + 4\text{NO}_2 + \text{O}_2$

Observations: a yellow residue when hot and white on cooling (ZnO) observed.

A broom gas (NO_2) observed.

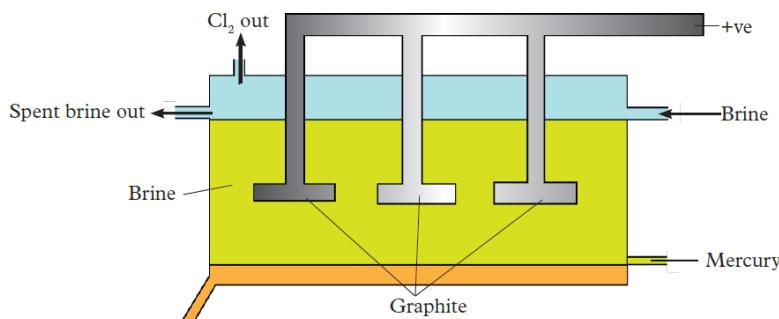
A colourless gas which relights a glowing splint (O_2) observed.

19. a)

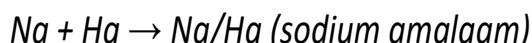


- In experiment (i), there is no moisture (water) since CaCl_2 is used to absorb any moisture that may be present. So, no rusting takes place.
 - In experiment (ii), there is no air. Oil is used to prevent the entry of air hence no rusting takes place.
 - In experiment (iii) nails will rust since the test-tube is exposed, so there is both moisture and air.
- b) By oiling / greasing
- By painting
 - Galvanizing
 - Tin plating.

20. a)



Concentrated sodium chloride (brine) is the electrolyte. The anodes are graphite. The cathode is mercury.



N.B: Sodium amalgam is passed through water where sodium reacts with water to form sodium hydroxide.

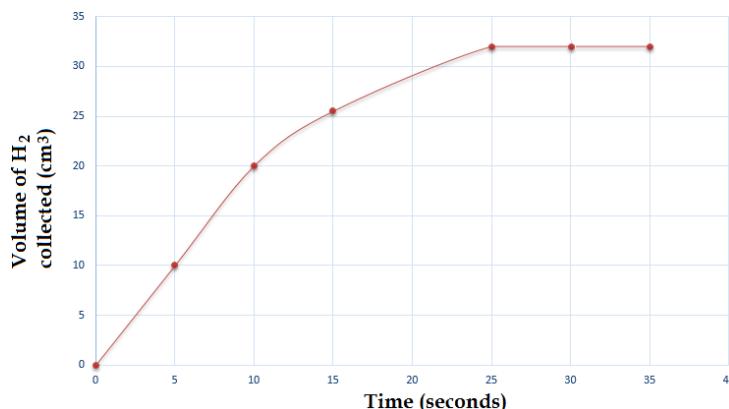
b) Used in the laboratory for absorbing CO_2 and other acidic gases.

Used in the manufacture of soap.

SECTION C: Attempt one question from this section

21. a) Copper II sulphate

b)



c) When the reaction is proceeding, the volume of the gas increases until the reaction is over. When the reaction is over, the volume of the gas remains constant.

d) Zn^{2+} ; CO_3^{2-}

22a) P: Copper (II) oxide, CuO

Q: Copper (II) sulphate, $CuSO_4$

R: Copper (II) hydroxide, $Cu(OH)_2$

S: Copper (II) carbonate, $CuCO_3$

b) i) $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

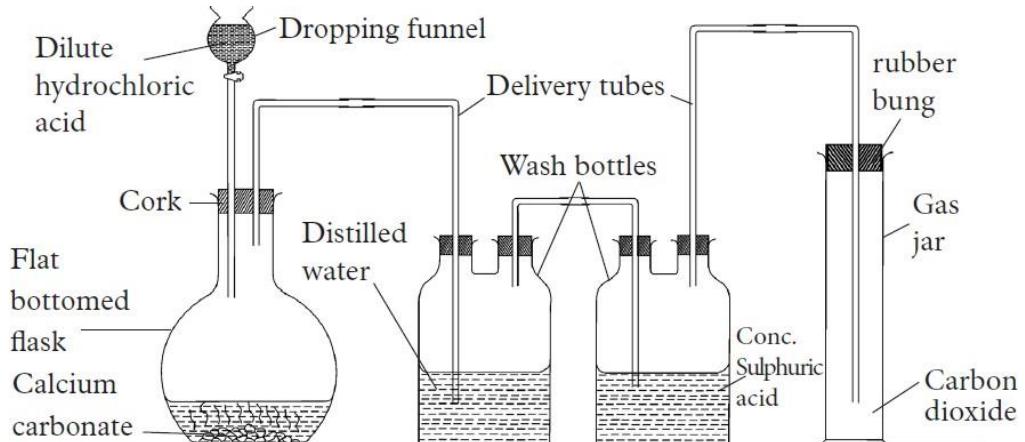
ii) $CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

iii) $CuSO_4 + Na_2CO_3 \rightarrow CuCO_3 + Na_2SO_4$
 Δ

iv) $Cu(OH)_2 \xrightarrow{\Delta} CuO + H_2O$

v) $CuCO_3 \xrightarrow{\Delta} CuO + CO$

23. a)



b) Dilute H_2SO_4 can't be used in this experiment because when H_2SO_4 reacts with $CaCO_3$, they form $CaSO_4$ which is insoluble and, hence prevents further reaction between the acid and the carbonate.

c) i) $CO_2 + H_2O \rightarrow H_2CO_3$

ii) $2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

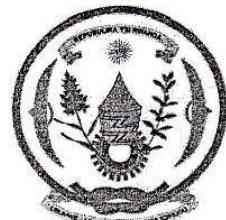
d) Uses of CO_2 : used in fire extinguishers; used in breweries; used by plants to make food.

CHEMISTRY III

025

22nd Nov. 2005 08.30 – 11.30 am

REPUBLIC OF RWANDA



NATIONAL EXAMINATIONS COUNCIL
P.O.BOX 3817 KIGALI

ORDINARY LEVEL NATIONAL EXAMINATION 2005

SUBJECT: CHEMISTRY III

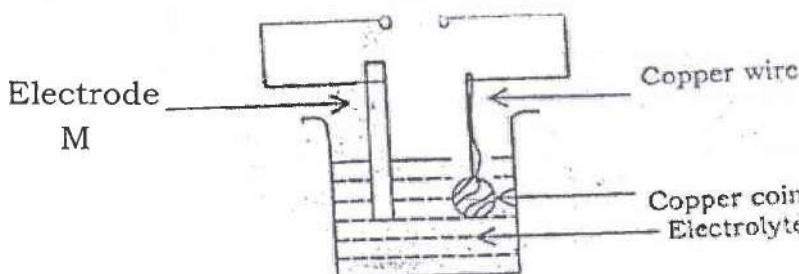
DURATION: 3 HOURS

INSTRUCTIONS:

- This paper consists of **three** sections **A, B and C**
- Answer **ALL** questions in section A. **(55 marks)**
- Answer **THREE** questions in section B. **(30 marks)**
- Answer only **one** question in section C **(15 marks)**
- Calculators may be used.

SECTION A: ANSWER ALL QUESTIONS**(55 MARKS)**

1. Element X has atomic number 13 and element Y has atomic number 8.
 - a) Give the electronic arrangement of element X. **(1 mark)**
 - b) In which group of periodic table is element X? **(1 mark)**
 - c) State the name of the bond formed when X combines with Y. **(1 mark)**
 - d) Give the formula (using X and Y as symbols) of the compound formed when X combines with Y. **(1 mark)**
2. Acid rain can cause damage to plant life and animal life. It is formed when gases produced in industries are allowed to escape and react with moisture in the atmosphere. If this rain has a PH of less than seven then it is acidic. Sulphur dioxide and an oxide of nitrogen are the main gases responsible for acid rain.
 - a) Give the name of the acid formed when sulphur dioxide dissolves in water. **(1 mark)**
 - b) Write a balanced equation for the reaction of sulphur dioxide with water. **(1 mark)**
 - c) Give the name of the oxide of nitrogen that dissolves in water to form an acid. **(1 mark)**
 - d) Give the name of an acid produced in the reaction in (c). **(1 mark)**
3. This question concerns the following compounds: Ammonium Chloride, Barium chloride, Copper (II) nitrate, Hydrated copper (II) sulphate, Potassium nitrate.
 - a) From the above list of compounds select one which, on heating
 - i) Changes from blue to white. **(1 mark)**
 - ii) Gives off brown fumes. **(1 mark)**
 - iii) Forms two gases as the only products. **(1 mark)**
 - b) Aqueous solutions of two of the above compounds were mixed and a white precipitate was formed.
 - i) Give the names of the two compounds. **(1 mark)**
 - ii) Write an ionic equation for the reaction including state symbols. **(2 marks)**
4. The diagram below shows a copper coin electroplated with silver.



- a) Name the electrolyte which should be used in this process. **(1 mark)**
- b) Name the metal used as electrode M. **(1 mark)**
- c) Give the polarities of the two electrodes, that is, the positive and the negative electrodes. **(2 marks)**
- d) Give an ionic equation for the reaction which occurs on the surface of the copper coin. **(1 mark)**

5. The table below shows the results of tests carried out on salt P. Study the table and answer the questions which follow.

Tests on salt P solution	Observations
Add dilute NaOH solution	A white precipitate which dissolves in excess
Add dilute ammonia solution	A white precipitate which dissolves in excess
Add dilute H_2SO_4 solution	No change
Add aqueous HNO_3 followed by $AgNO_3$ solution.	A white precipitate

- (a) State the name or the formula of the cation in P. **(1 mark)**
 (b) State the name or the formula of the anion in P. **(1 mark)**
 (c) Give the formula of the white solid formed in test (d). **(1 mark)**
 (d) Classify the hydroxide of the cation in P as basic or acidic or neutral or amphoteric. **(1 mark)**
6. An oxide of copper was reduced to copper by passing dry hydrogen gas over the hot oxide. After the reduction process, more hydrogen was allowed to pass over the solid product as it cooled. 0.4g of the oxide of copper was decreased to 0.32g of copper.
- a) Calculate the number of moles of copper produced. **(2 marks)**
 b) Calculate the number of moles of oxygen atoms produced. **(2 marks)**
 c) In what ratio does copper combine with oxygen? **(1 mark)**
 (Atomic mass: Cu = 64, O = 16)
7. Ammonia gas is prepared by heating ammonium chloride with calcium hydroxide. It is dried by passing it over calcium oxide and collected by upward delivery.
- i) Why is conc sulphuric acid not used to dry ammonia gas? **(2 marks)**
 ii) Describe a chemical test for ammonia gas. **(1 mark)**
 iii) A student attempted to collect ammonia gas over water. Why did the student not succeed? **(1 mark)**
 iv) What can be deduced about the density of ammonia from the method which was used to collect it in the above experiment? **(1 mark)**
8. Calculate the percentage of oxygen in the salt $CuSO_4 \cdot 5H_2O$. **(4 marks)**
 (Cu = 64, S = 32, O = 16, H = 1)
9. Give the meaning of the following terms. **(4 marks)**
 i) Isotopes ii) Allotropes.
10. Iron is extracted from haematite (Fe_2O_3) by reduction using carbon monoxide.
- a) Write a balanced equation for the reaction. **(2 marks)**
 b) Give two ways in which the environment is affected by the process of extracting iron. **(2 marks)**

11.a) An organic compound of molecular formula C_4H_8 reacts with bromine water (aqueous bromine) to form a colourless product. Write the structural formula of C_4H_8 . **(1 mark)**

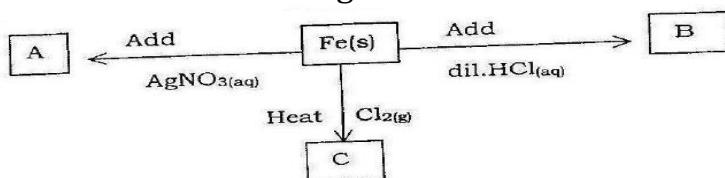
b) One of the members of a family of organic compounds has the formula C_5H_{12} . Give the name of the organic compound whose formula is C_5H_{12} . **(1 mark)**

12. An organic compound contains 40% of carbon, 53.3% of oxygen and 6.7% of hydrogen by mass.

a) Calculate the empirical formula of the compound. **(3 marks)**

b) Given that its relative molecular mass is 90, determine its molecular formula. **(2 marks)**

13. Some reactions involving iron are shown below:



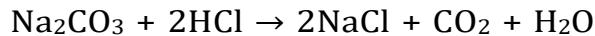
a) Give the formulae of the products formed in box A. **(1 mark)**

b) Give the formulae of the products formed in box B. **(1 mark)**

c) What is the formula of the compound formed in box C? **(1 mark)**

SECTION B: Attempt any THREE questions in this section. (30 marks)

14. In an experiment, it was found that 25cm^3 of sodium carbonate solution reacted with 20cm^3 of $2\text{ mole} \cdot \text{dm}^{-3}$ hydrochloric acid (2M HCl) as follows:



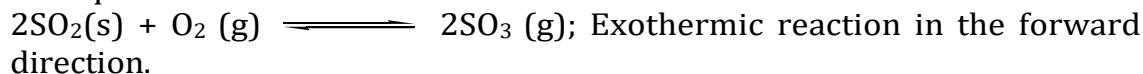
a) Calculate the number of moles of HCl in 20cm^3 of $2\text{ mole} \cdot \text{dm}^{-3}$ HCl. **(2 marks)**

b) Calculate the concentration of sodium carbonate $\text{mole} \cdot \text{dm}^{-3}$. **(3 marks)**

c) Calculate the mass of sodium carbonate in grams present in 1 dm^3 of solution. ($\text{Na} = 23$, $\text{C} = 12$, $\text{O} = 16$). **(2 marks)**

d) Describe how a pure dry sample of sodium chloride would be obtained from a mixture of sodium carbonate and hydrochloric acid assuming that the two reagents have reacted completely leaving none of the two regents in excess. **(3 marks)**

15. Sulphur dioxide and oxygen react to form sulphur trioxide according to the equation:



a) What does the symbol \rightleftharpoons mean? **(1 mark)**

b) What is the effect of increasing temperature:

- i) On the rate of the reaction? **(1 mark)**
 ii) On the amount of sulphur trioxide present at equilibrium? **(1 mark)**
 c) i) This reaction forms the basis of the industrial manufacture of sulphuric acid.
 ii) State the temperature and pressure at which the reaction is carried out. **(1 mark)**
 iii) How is the sulphur trioxide converted into sulphuric acid? **(4 marks)**
 d) State 2 large scale uses of sulphuric acid. **(2 marks)**

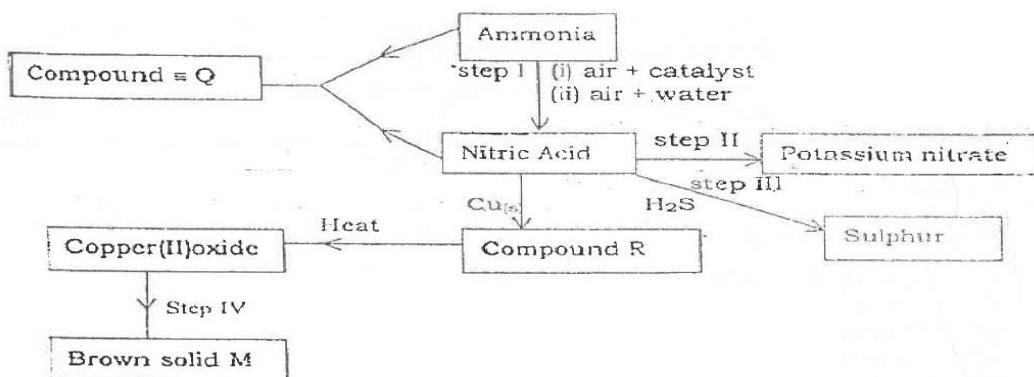
16.a) With the aid of a well labelled diagram, describe the preparation of dry hydrogen chloride gas from concentrated sulphuric acid and sodium chloride. **(8 marks)**

- b) Write balanced equations to show how hydrogen chloride gas reacts with: **(2 marks)**
 i) Ammonia gas
 ii) Hot iron metal

17.a) With aid of a labelled diagram, describe how you would prepare dry carbon dioxide gas from calcium carbonate (marble chips). **(6 marks)**

- b) Write balanced equations to show how carbon dioxide reacts with
 i) Hot magnesium
 ii) Hot carbon. **(2 marks)**
 c) Briefly explain the effect of carbon dioxide as a "greenhouse gas". **(2 marks)**

18. The chart below shows some reactions starting with ammonia. Study it and answer the questions that follow.



- a) Give the name of the catalyst used in step I. **(1 mark)**
 b) Name the process that takes place in step II. **(1 mark)**
 c) Is the change from H_2S to sulphur oxidation or reduction? Give a reason for your answer. **(2 marks)**
 d) Give the chemical name of a compound that would react with the aqueous solution of R to form solid M. **(1 mark)**
 e) Give the chemical formula of compound Q. **(1 mark)**
 f) Calculate the percentage by mass of nitrogen present in compound Q. $(\text{H} = 1, \text{N} = 14, \text{O} = 16)$ **(2 marks)**
 g) Give the names of three elements found in most artificial fertilizers.

(1 mark)

- h) State one environmental disadvantage of using artificial fertilizers. **(1 mark)**

SECTION C: Answer only one question in this section. (15 MARKS)

19. A student reacted metal H with a colourless liquid in a beaker. A vigorous reaction was observed and a colourless gas J was given out. On standing, a white precipitate L was formed. He filtered the precipitate L and collected the colourless filtrate M. He dried the solid L. On heating, the solid L gave out a vapour which condensed into a colourless liquid I and a solid O remained. When cold liquid I was added to solid O, heat was given out. When carbon dioxide was bubbled through liquid M, a white precipitate P was observed which disappeared on further bubbling of carbon dioxide. A colourless solution Q remained.

NB: The letters used in this question are not the actual symbols of any elements implied.

- a) Identify the substances represented by the following letters: H, I, J, K, M, O, P, Q. **(8 marks)**
- b) Using the actual symbols or formulae of the substances identified, write an equation for the reaction that occurred between:
- i) Metal H and substance I. **(2 marks)**
 - ii) Substance P, water and carbon dioxide. **(2 marks)**
 - c) Chlorine gas is bubbled through a colourless aqueous solution of potassium bromide. Describe what is observed and write an equation for the reaction that occurs. **(3 marks)**

20.a) Draw a well labelled diagram showing electrolysis of dilute sulphuric acid (so called electrolysis of water). **(7 marks)**

b) Write equations to show the reactions taking place at the cathode and anode. **(2 marks)**

c) If 5ml of gas are collected at the cathode, what volume of gas is collected at the anode? **(1 mark)**

- d) Give one example of:
- i) A strong electrolyte
 - ii) A weak electrolyte
 - iii) A Conductor
 - iv) A non-conductor
 - v) A non-electrolyte **(5 marks)**

CHEMISTRY III

025

12th Nov. 2004 08.30 – 11.30 am

RWANDA NATIONAL EXAMINATIONS COUNCIL



P.O.BOX, 3817 KIGALI-TEL/FAX : 86871

ORDINARY LEVEL NATIONAL EXAMINATION 2003 / 2004

SUBJECT: CHEMISTRY III

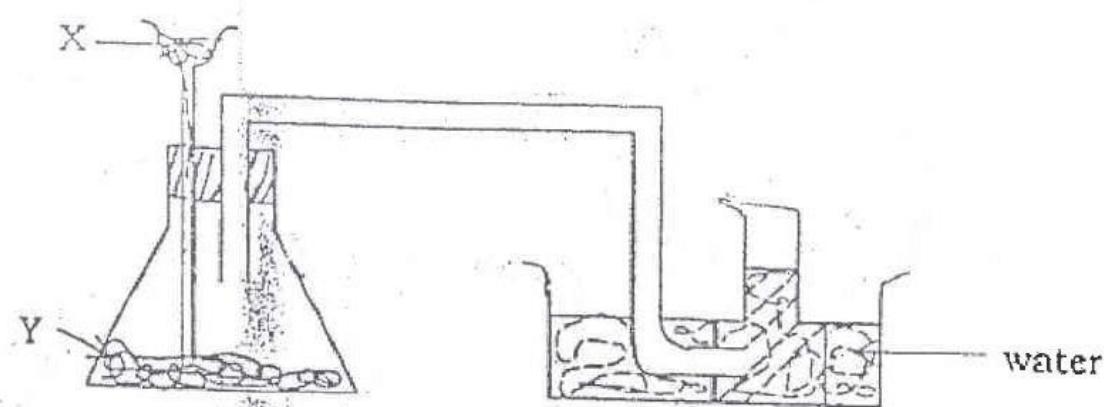
DURATION: 3 HOURS

INSTRUCTIONS:

- This paper consists of **three** sections **A, B and C**
- Answer **ALL** questions in section A. **(55 marks)**
- Answer **THREE** questions in section B. **(30 marks)**
- Answer only **one** question in section C **(15 marks)**
- Calculators may be used.

SECTION A: ANSWER ALL QUESTIONS**(55 MARKS)**

1. a) The figure below is a set-up of apparatus for the preparation of hydrogen.



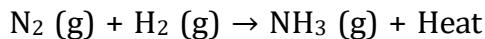
- a) Identify X and Y:

X is: (1 mark)

Y is: (1 mark)

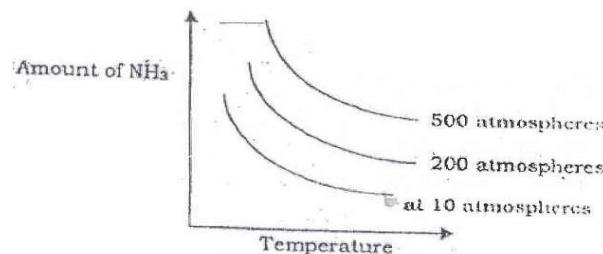
- b) Write an equation for the formation of hydrogen. (1 mark)

2. Nitrogen reacts with Hydrogen to produce ammonia as shown by the following equation.



The sketch graph below shows the amount of ammonia produced at various temperatures and pressures.

- a) How does the amount of ammonia vary with temperature? (1 mark)
b) How does the amount of ammonia vary with pressure? (1 mark)



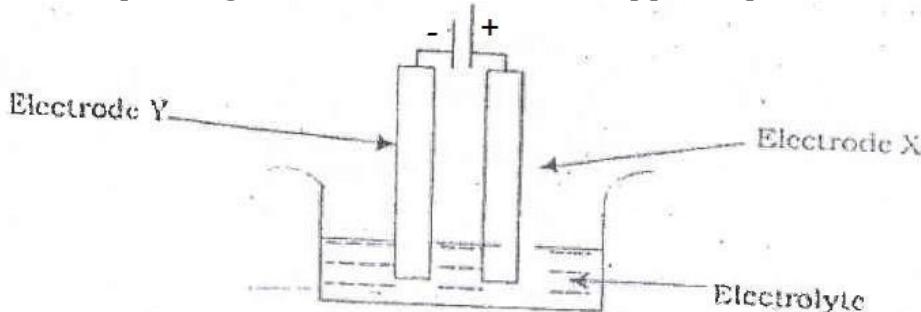
- c) Suggest the catalyst for the reaction between nitrogen and hydrogen. (1 mark)

3. The table below shows an experiment carried out on an aqueous solution of salt A. Study the table and answer the questions that follow.

Experiment on salt A	Observation
Add dilute NaOH solution	A white precipitate which doesn't dissolve in excess
Add aqueous ammonia	A white precipitate insoluble in excess.
Add dilute HCl solution	A white precipitate that dissolves on boiling.

- i) What is the cation in salt A? **(1 mark)**
 ii) Write a balanced equation for the reaction in experiment (c) as shown in the table above. **(1 mark)**
 iii) How would you obtain a dry sample of the precipitate in experiment (a)? **(2 marks)**

4. The simple diagram below shows how copper is purified.



- a) State which electrode is the anode. **(1 mark)**
 b) Name the substance that is used as the cathode. **(1 mark)**
 c) Name the electrolyte used in the process. **(1 mark)**
 d) Write an equation to show the reaction taking place at the cathode. **(1 mark)**
5. a) Write the formula of the oxides of:
 i) Sulphur **(1 mark)**
 ii) Iron **(1 mark)**
 b) State the type of bond that exists in the oxide of:
 i) Sulphur: **(1 mark)**
 ii) Iron: **(1 mark)**
6. Dry hydrogen gas was passed over 6.85 g of heated lead II oxide. When the reaction was over, the solid residue was weighted.
 a) Write a balanced equation of the reaction. **(1 mark)**
 b) Calculate the mass of the residue. The atomic masses are: Pb = 207; O = 16; H = 1) **(3 marks)**
7. Element M belongs to group III of the periodic table.
 a) How many electrons does M have in the outer shell? **(1 mark)**
 b) Write the formula for:
 i) The oxide of M. **(1 mark)**
 ii) The chloride for M. **(1 mark)**
 iii) Nitride of M. **(1 mark)**
8. An oxide of X can be reduced by metal Q but not by metal R.
 a) Show the order of reactivity of the three metals starting with the least reactive.
 b) If metal Q is in group I of the periodic table, write the formula of the chloride of Q.

- c) State **yes** if X will displace Q from its chloride solution or **no** if it will not displace it.
9. A compound X of molecular mass 42 contains 85.7% carbon and the rest is hydrogen.
- a) Calculate the empirical formula of X: (C = 12, H = 1). **(3 marks)**
 b) Determine the molecular formula of X. **(2 marks)**
10. Oxygen can be prepared from hydrogen peroxide in the presence of a catalyst.
- a) Name the catalyst that is used in the above preparation. **(1 mark)**
 b) Write a balanced equation for the reaction. **(1 mark)**
 c) State two ways of increasing the rate of formation of oxygen. **(2 marks)**
11. Copy the following table in your answer booklet and match the ions in list A with their corresponding confirmatory chemical tests in list B. **(4 marks)**
- | List A | List B |
|-----------------------|---------------------------------------|
| a) SO_4^{2-} | Aqueous ammonia |
| b) CO_3^{2-} | HCl (aq) and BaCl_2 |
| c) Zn^{2+} | H^+ |
12. Match the substances in List A with the corresponding environmental problems in List B. **(3 marks)**
- | List A | List B |
|-----------------------------|----------------------------|
| a) Carbon dioxide | Ozone layer depletion |
| b) Sulphur dioxide | Greenhouse effect |
| c) Chlorofluorohydrocarbons | Acid rain
Soil erosion. |
13. Suggest the structural formulae for the following organic substances.
- a) Methanoic acid
 b) Sodium ethanoate
 c) Propene **(3 marks)**
14. Sulphur dioxide and oxygen gases react according to the following equation:
- $$2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3 + \text{Heat}$$
- 100 liters of SO_2 were mixed with 100 liters of oxygen.
- a) Calculate the volume of SO_3 produced. **(1 mark)**
 b) Calculate the total volume of the gas present after the reaction. **(2 marks)**
15. Calculate the percentage of sulphur in $\text{Fe}_2(\text{SO}_4)_3$. **(3 marks)**
- $\text{Fe} = 56, \text{S} = 32, \text{O: 16.}$

SECTION B: Attempt any THREE questions in this section. (30 marks)

16. 20 cm³ of sodium hydroxide solution reacted with 30cm³ of 1M of sulphuric acid.

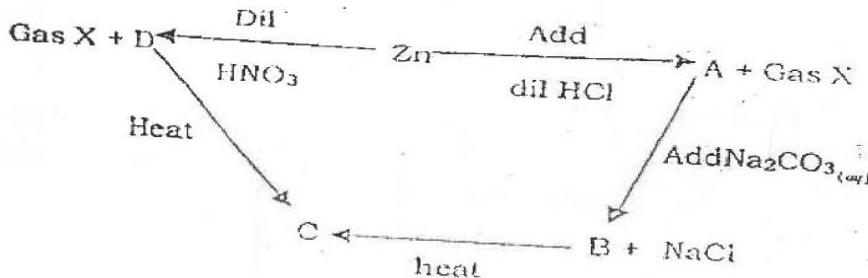
- a) Write a balanced equation for the reaction. **(1 mark)**
- b) Calculate the molarity of sodium hydroxide and hence its concentration in gr/dm³. (Na = 23, O = 16, H = 1) **(5 marks)**
- c) Name the products formed when concentrated sulphuric acid reacts with the following:
- i) Boiling it with sugar
 - ii) Heating with ethanol at 170°C
 - iii) Heating with sodium chloride.
 - iv) Adding water to it. **(4 marks)**

17. The table below shows the number of protons, neutrons and electrons in substances W, X, Y and Z. Use the table to answer the following questions.

Substance	Number of Protons	Number of Neutrons	Number of Electrons
W	6	6	6
X	9	10	10
Y	12	12	10
Z	19	20	19

- a) Which of the substances is:
- i) A cation? **(1 mark)**
 - ii) An anion? **(1 mark)**
- b) Write the electronic configuration of Z. **(1 mark)**
- c) What is the mass number (relative mass) of Y? **(1 mark)**
- d) Write a chemical formula between Z and W when they have chemically combined. **(1 mark)**
- e) Z reacts very vigorously with water to make an alkaline solution. With the aid of relevant equations, explain how a pure sample of Z chloride can be obtained starting with Z, H₂O and HCl. **(5 marks)**

18. The following question is about some of the reactions of Zinc and its compounds. Study the chart below and answer the questions that follow.



- a) Name substances A, B, C, D and Gas X. **(5 marks)**
 b) Write a balanced equation to show how substance D is converted to C on heating and state all the observations you would make when D is changing to C. **(5 marks)**

19. With aid of relevant diagrams, describe:

- a) An experiment to show that rusting of iron requires both oxygen and water. **(6 marks)**
 b) State four ways of preventing rusting. **(4 marks)**

20. With aid of a well labelled diagram,

- a) Explain how sodium hydroxide can be manufactured (prepared on a large scale). **(8 marks)**
 b) Suggest two uses of sodium hydroxide. **(2 marks)**

SECTION C: Answer only one question in this section. (15 MARKS)

21. The table below shows results of an experiment to determine the rate of reaction between Zinc and Sulphuric Acid in presence of a catalyst. Study the table below and answer the questions that follow.

Time (seconds)	0	5	10	15	25	30	35
Volume of H ₂ collected (cm ³)	0	10	20	25.5	32	32	32

- a) Suggest the catalyst for the reaction. **(1 mark)**
 b) Plot a graph of volume of gas evolved (Y-axis) against time (X-axis). **(9 marks)**
 c) Explain why the volume of the gas increases and then remains constant after 25 minutes. **(2 marks)**
 d) Suggest the ions present in the mixture at the end of the experiment. **(3 marks)**

22. Read the following passage and answer the questions that follow: To a black powder, P was added dilute H₂SO₄ and a blue solution Q was

formed. When NaOH solution was added to solution Q, a blue precipitate & was formed. When R was strongly heated, the black powder L was formed. When Na_2CO_3 solution was added to Q, a green-blue precipitate S was formed. When S was strongly heated, a black powder was formed.

a) Name and write the formula of substances P, Q, R and S. **(8 marks)**

b) Write balanced equations for the reactions mentioned in the passage. **(7 marks)**

23.a) With the aid of a well labelled diagram, describe an experiment to prepare dry carbon dioxide gas from solid calcium carbonate and dilute HCl Acid. **(9 marks)**

b) Why can't dilute H_2SO_4 be used in this experiment?

c) Write balanced equations to show how CO_2 reacts with the following:

i) H_2O **(2 marks)**

ii) NaOH . **(2 marks)**

d) State two uses of carbon dioxide. **(2 marks)**



P.O.BOX, 3817 KIGALI-TEL/FAX : 86871

NATIONAL EXAMINATION 2002/2003

SUBJECT: CHEMISTRY III

LEVEL : ORDINARY LEVEL

DURATION: 3 HOURS

INSTRUCTIONS:

Answer ALL questions in Section A,

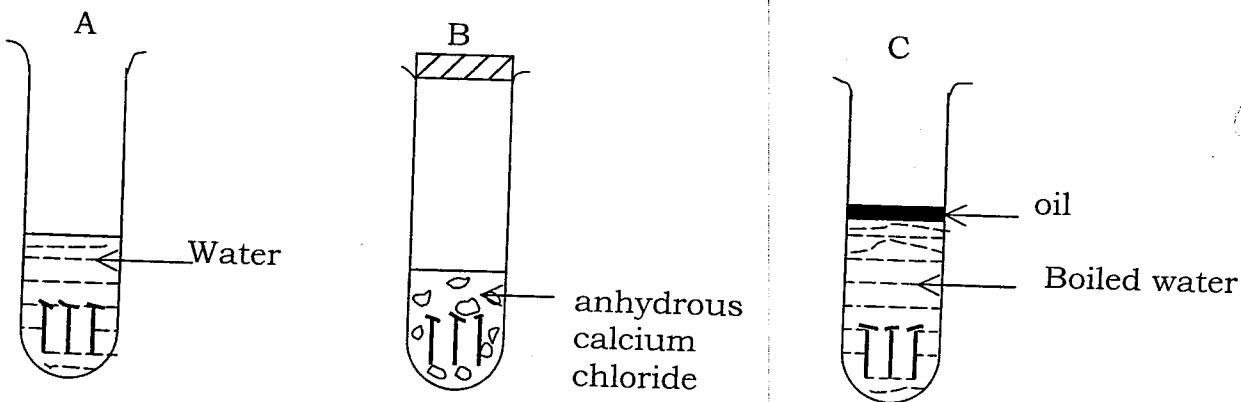
Choose THREE questions from Section B and ONE question
from Section C.

Calculators may be used.

SECTION A: Answer ALL questions in this section.

1. Air is a mixture of several different gases.
- Name a gas in air that supports combustion. (1mark)
 - Name a gas that causes global warming. (1mark)
 - Name a gas that is chemically inactive. (1mark)
 - Name a gas that makes the biggest part of air. (1mark)

2. The iron nails were placed in test tubes under different conditions. Study the diagrams carefully and answer the questions that follow.



- In which of the test tubes will be nails rust? (1mark)
 - What is the purpose of anhydrous calcium chloride in tube B? (1mark)
 - Why is boiled water used in tube C? (1mark)
3. The table below shows the melting points and boiling points in degrees centigrade of substances A to C. Study the table carefully and answer the questions that follow.

Substance	Melting point	Boiling point
A	1009	2506
B	- 256	- 248
C	- 10	63

- What do you understand by melting point? (2marks)
 - Which substance is a gas at room temperature of 20°C? (1mark)
 - Which substance is a metal? (1mark)
4. (a) Write the chemical formulae for the following compounds.
- Sulphuric Acid. (1mark)
 - Sodium Phosphate. (1mark)

(b) Complete the following word equation. (1½marks)
Sulphuric Acid + Sodium Carbonate \longrightarrow

5. Study the following equation and answer the questions that follow.



- (a) Name the oxidising agent in the above reaction. (1mark)
- (b) Calculate the mass of Fe_2O_3 that would be required to produce 112 grams of Fe. (2½marks)
Atomic masses are: Fe = 56, O = 16, C = 12

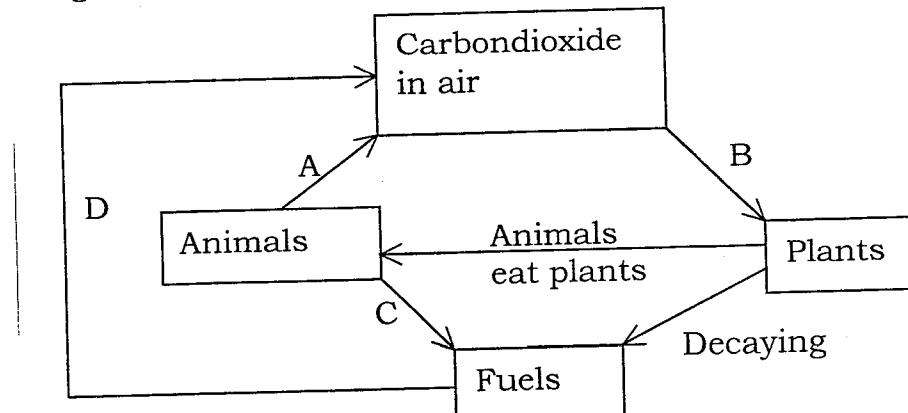
6. (a) Copy and complete the table below which is about electrolysis of 2 electrolytes.

Electrolyte	Product at Anode	Product at cathode
Dilute H_2SO_4		
CuSO_4 solution using Copper electrodes		

(2marks)

- (b) For both electrolytes in the above table, write Ionic equations to show the reactions taking place at the Cathode. (2marks)

7. The diagram below shows Carbon cycle



- (a) Name the processes A, B, C and D. (2marks)

- (b) What does the word fuel mean? (1mark)

- (c) Give one example of a fuel that is used in your home. (½mark)

8. (a) What do you understand by the word catalyst? (2marks)

- (b) Give the name of the catalysts used in the following reactions: (½mark)
(i) Decomposition of Hydrogen peroxide (H_2O_2). (½mark)
(ii) Reaction between Zinc (Zn) and dilute Sulphuric acid (H_2SO_4). (½mark)
(iii) Contact process. (½mark)

9. A Hydrocarbon contains 82.8% by mass of Carbon and the rest is Hydrogen.

(a) Calculate the empirical formula of the hydrocarbon.

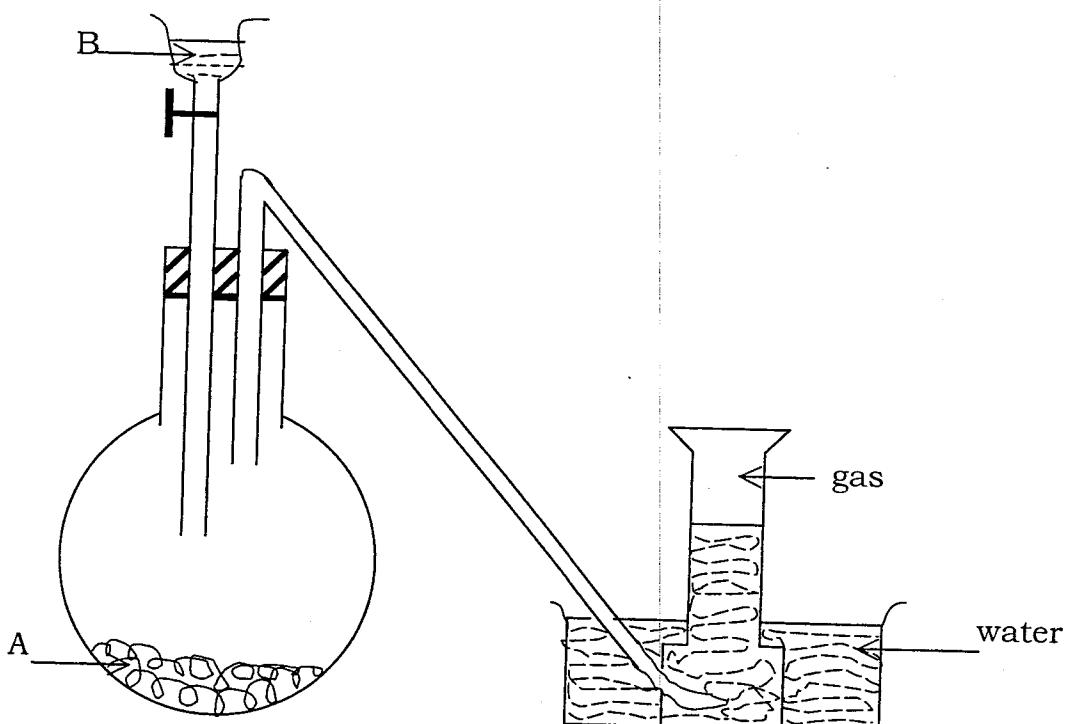
(2marks)

(b) If the relative molecular mass of the Hydrocarbon is 58, calculate its molecular formula. (Relative atomic masses are: C = 12, H = 1)

(2marks)

10. The apparatus below is used to prepare only one of the two gases mentioned below.

Hydrogen, Ammonia.



(a) Which of the mentioned gases can be prepared in the laboratory using the apparatus (diagram) shown?

(1mark)

(b) State the names of the substances A and B indicated in the diagram.

(2marks)

(c) Give a reason why the other gas can not be prepared using the apparatus shown.

(1mark)

11. When most nitrates are heated, **one** or **two** gases may be given off from the nitrates of the metals Potassium, Zinc, Sodium, Copper.

(a) Choose two nitrates that give off 2 gases on heating.

(2marks)

(b) Choose one nitrate that gives off one gas on heating and write a balanced equation for the reaction.

(1mark)

12. The table below shows part of the periodic table. Use it to answer the following questions.

H						He	
Na			C	N	O		
K						Cl	Ar
						Br	

- (a) Which of the elements Na and K is more reactive? **(1mark)**
- (b) Which of the elements Cl and Br is more reactive? **(1mark)**
- (c) Select one element that will form Ionic bond (electrovalent bond) with O. **(1mark)**
- (d) Write the electronic configuration of K. **(1mark)**

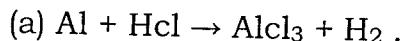
13. Name the following organic substances.



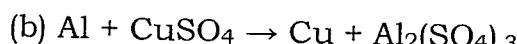
14. Complete the following table

Experiment	Observation	Inference (Conclusion)
(a) Add NaOH solution to solution X	A blue precipitate	
(b) Add NaOH solution to solution Y		Solution Y contains Fe^{2+}
(c) Add NaOH solution to solution Z	A white precipitate that Dissolves in excess NaOH	
(d) Add H_2SO_4 solution to solution W		Solution W contains CO_3^{2-}
		(4marks)

15. Balance the following equations



(2marks)



(2marks)

SECTION B: Choose THREE questions from this section.

16. (a) State **one** anion that causes permanent hardness of water and **one** anion that causes temporary hardness of water.

(2marks)

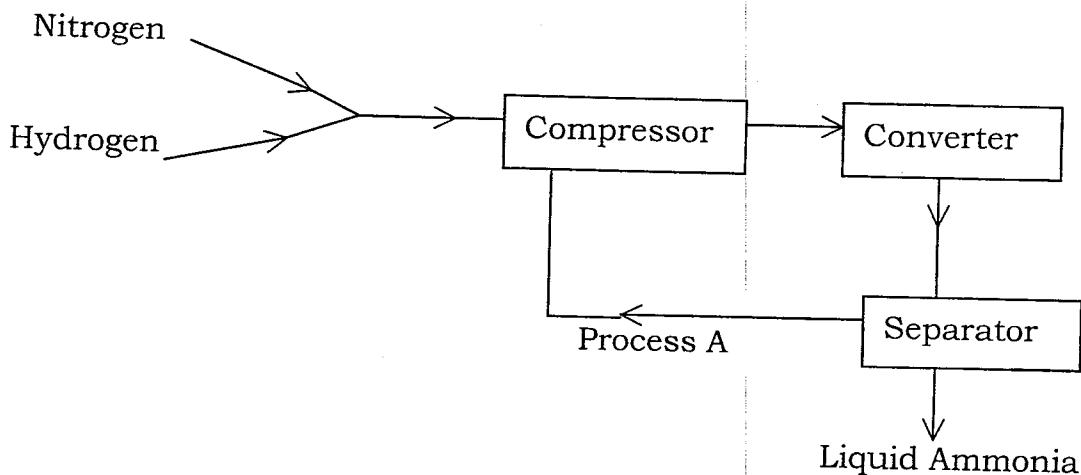
(b) State a simple chemical test that can be carried out to distinguish the anion in temporary hard water from the anion in permanent hard water. You must clearly state the observations that would be made.

(2marks)

(c) With the help of balanced equations, state the observations made when Carbon dioxide is bubbled into lime water for a long time and the solution is then boiled.

(6marks)

17. Study the simplified flow diagram below and answer the questions that follow.



(a) Name the source of Nitrogen and Hydrogen.

(2marks)

(b) The reaction takes place in the converter under certain conditions of temperature and pressure in presence of a catalyst.

(i) What is the name of the catalyst used?

(1mark)

(ii) State the optimum temperatures and pressure used in the converter.

(2marks)

(iii) Name process A and give a reason why it is important.

(2marks)

(c) Write balanced equations to show how Ammonia reacts with:

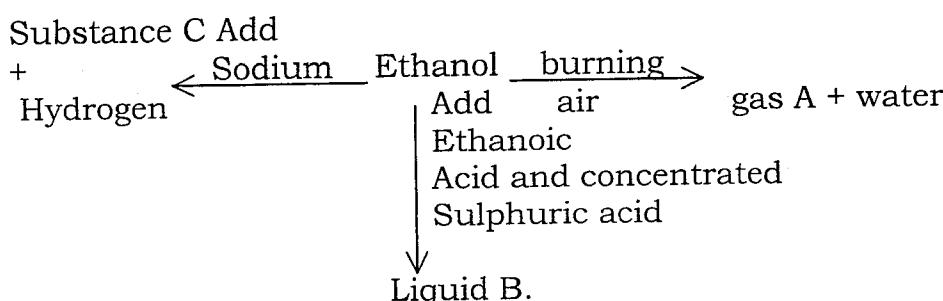
(i) HCl

(ii) CuO

(iii) H₂O

(3marks)

18. The following question is about some of the reactions of Ethanol.
Study the chart below and answer the questions that follow.



- (a) Write the structural formula of Ethanol. **(1mark)**
- (b) Write an equation to show how Ethanol reacts with ethanoic acid. **(2marks)**
- (c) Give the names of substances or compounds A, B and C. **(3marks)**
- (d) Describe the steps taken during fermentation of Alcohol. **(4marks)**
19. (a) With the help of relevant equations describe how Copper can be extracted and purified. **(7marks)**
- (b) State three similarities between Copper and Aluminium.
You may consider uses as similarities also. **(3marks)**
20. (a) What is Polymerization. **(2marks)**
- (b) By choosing only **two** Polymers you are familiar with:
- (i) Write an equation to show how each Polymer is prepared from the monomer. **(2marks)**
- (ii) State two uses of each Polymer. **(4marks)**
- (c) Explain why exposing some Polymer products is an environmental hazard. **(2marks)**

SECTION C:

21. If you are only given distilled water, (H₂O) dilute hydrochloric acid (HCl), solid Sodium Carbonate (Na₂CO₃), Zinc metal (Zn) and Magnesium Sulphate solid (MgSO₄)

N.B: The order of reactivity series is Sodium, Magnesium, Zinc and Hydrogen.

By use of equations, outline how you would prepare pure samples of:

- (a) Zinc Carbonate.
(b) Magnesium chloride.

(7½marks)
(7½marks)

22. Read the following passage and answer the questions that follow.

To a black powder A was added dilute H₂SO₄ and a blue solution B was formed. When NaOH solution was added to B, a blue precipitate C was formed. When C was strongly heated the black powder A was formed. When Na₂CO₃ solution was added to B a green-blue precipitate D was formed. When D was strongly heated, the black powder A was formed.

- (a) Name and write the formulae of substances A, B, C and D.

(8marks)

- (b) Write balanced equations for the reactions mentioned in the passage.

(7marks)

23. (a) With the aid of a well labelled diagram, describe an experiment to prepare chlorine gas from Manganese IV oxide (MnO₂).

(9marks)

- (b) Write equations to show how Cl₂ reacts with:

- (i) Iron (Fe)
(ii) Iron II chloride (FeCl₂)
(iii) H₂O
(iv) NaOH

(4marks)

- (c) State two uses of Chlorine.

(2marks)

CHEMISTRY III

025

12th Nov. 2002 08.30 – 11.30 am

RWANDA NATIONAL EXAMINATIONS COUNCIL



P.O.BOX, 3817 KIGALI-TEL/FAX : 86871

ORDINARY LEVEL NATIONAL EXAMINATION 2001 / 2002

SUBJECT: CHEMISTRY III

DURATION: 3 HOURS

INSTRUCTIONS:

- This paper consists of **three** sections **A, B and C**
- Answer **ALL** questions in section A. **(55 marks)**
- Answer **THREE** questions in section B. **(30 marks)**
- Answer only **one** question in section C **(15 marks)**
- Calculators may be used.

1. The table below contains some information about two elements.

Elements	Protons	Neutrons	Electrons
Sodium	11	12	
Oxygen		10	8

- (a) Complete the table. **(1 mark)**
 (b) What is the isotopic mass (mass number) of oxygen? **(1 mark)**
 (c) Write the electronic configuration of sodium. **(2 marks)**
 (d) Sodium reacts with oxygen to form sodium oxide. Write a balanced equation of the reaction. **(1 mark)**
2. Limestone (CaCO_3) is a mineral that is heated to produce lime (CaO). Lime is used in the manufacture of iron, cement and glass.
- a) What is the chemical name for limestone? **(1 mark)**
 b) The decomposition of Limestone is shown in the equation

$$\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$$
 Calculate the mass of lime (CaO) that would be produced from 2kg of limestone (CaCO_3). (Relative atomic masses: C = 12, O = 16, Ca = 40). **(2 marks)**
3. Air is a mixture of many gases, some of which are shown in the table below. **(1.5 marks)**
- a) Complete the table below.
- | Name | Chemical formula | Approximate percentage in air |
|----------------|------------------|-------------------------------|
| Nitrogen | | |
| Carbon dioxide | CO_2 | |
| Inert gases | Ne, Ar etc. | 1 |
- b) Mention one way in which carbon dioxide is removed from the atmosphere and one way in which it is supplied to the atmosphere. **(2 marks)**
4. Hydrogen peroxide (H_2O_2) is used as a bleaching agent and as a source of oxygen.
- (a) What is a bleaching agent? **(1 mark)**
 (b) Write a balanced equation for the production of oxygen from hydrogen peroxide. **(1 mark)**
 (c) The rate of decomposition of H_2O_2 is very slow at room temperature; suggest two ways of speeding up the decomposition. **(2 marks)**
5. The following is an exothermic reaction and takes place in presence of iron as a catalyst.
- $$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3$$
- (a) What do you understand by exothermic reaction? **(1 mark)**
 (b) What does the sign \rightleftharpoons mean in the equation? **(1 mark)**
 (c) What would be the effect on the amount of ammonia produced if the pressure was increased beyond 600 atm? **(1 mark)**

- (d) What would be the effect on the amount of ammonia produced if the temperature was increased beyond 600°C ? **(1 mark)**
6. Some reactions involving carbon dioxide, CO_2 are shown below. Study the chart below and answer the questions that follow.
-
- a) What are the chemical names and chemical formulae for substances A, B and C? **(3 marks)**
- b) Write a balanced equation for the formation of substances A, B and C. **(1 mark)**
7. The molecular formulae of two organic substances X and y are given below.
 $\text{X} = \text{C}_4\text{H}_{10}$, $\text{Y} = \text{C}_4\text{H}_8$
- a) Write two structural formulae of substance X and give their chemical names. **(2 marks)**
- b) Write one structural formula of Y and give its chemical name. **(1 mark)**
- c) Write a balanced chemical equation for the reaction of X with chlorine. **(1 mark)**
8. The diagram below shows the direction of movement of ions during electrolysis of dilute sodium chloride solution (NaCl).
-
- a) Which of the electrode A and B is the anode? **(1 mark)**
- b) Which element (substance) is formed at electrode B? Write an equation for the reaction taking place at B. **(2 marks)**
- c) At electrode A, there are two different gases that are likely to form. What chemical test would you use to show the presence of a gas which is the main product? **(1 mark)**
9. The table below shows the reactivity of some metals with water and dilute sulphuric acid. Study the table very carefully and answer the questions that follow.

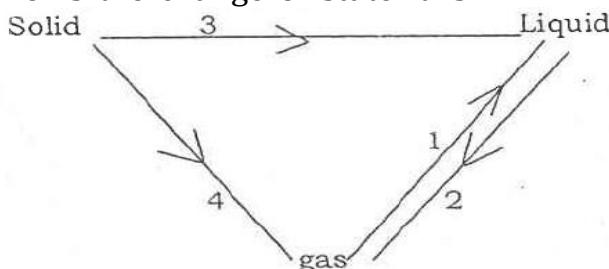
Metal	Reaction with water	Reaction with dilute sulphuric acid
Calcium	Hydrogen formed fast	Not advisable
Copper	No reaction	No reaction
Iron	Rust was formed slowly	Hydrogen formed slowly.
Magnesium	Hydrogen formed slowly	Hydrogen formed quickly.

- a) Which of the above substances is the most reactive? **(1 mark)**
 b) Which of the above substances is the least reactive? **(1 mark)**
 c) Why is it not advisable to react calcium with dilute sulphuric acid? **(1 mark)**
 d) How would you show that hydrogen is evolved when magnesium reacts with dilute sulphuric acid? **(1 mark)**

10. Copper can be extracted from an ore called copper pyrites whose formula is CuFeS_2 .

- a) Give the chemical names of the elements present in copper pyrites. **(1 mark)**
 b) Copper is obtained by heating the ore in controlled supply of air with sand (SiO_2).
 The reaction is $2\text{CuFeS}_2 + 5\text{O}_2 \rightarrow 2\text{Cu} + 4\text{SO}_2 + 2\text{FeSiO}_3$. **(2 marks)**
 How much copper would be obtained by heating 36.7g of CuFeS_2 ?
 Atomic mass: Cu = 63.5, Fe = 56, S = 32.

11. The figure below shows some changes of state. The direction of the arrow shows the change of state it is.



- a) Name changes or processes 1, 2, 3 and 4. **(2 marks)**
 b) State two differences between a solid and a gas. **(2 marks)**

12. Calculate the percentage composition of oxygen in one mole of Aluminium sulphate $\text{Al}_2(\text{SO}_4)_3$. Relative atomic masses are: Al = 27, S = 32, O = 16. **(3 marks)**

13. Study the table below and answer the questions that follow.

Substance	Melting point (°C)	Boiling point (°C)
Methanol	- 94	65
Ethanol	- 117	79
Water	0	100

- a) Which of the three substances is the most volatile? **(1 mark)**
 b) Which substance becomes a liquid at the highest temperature?

c) Write the chemical formula for ethanol.

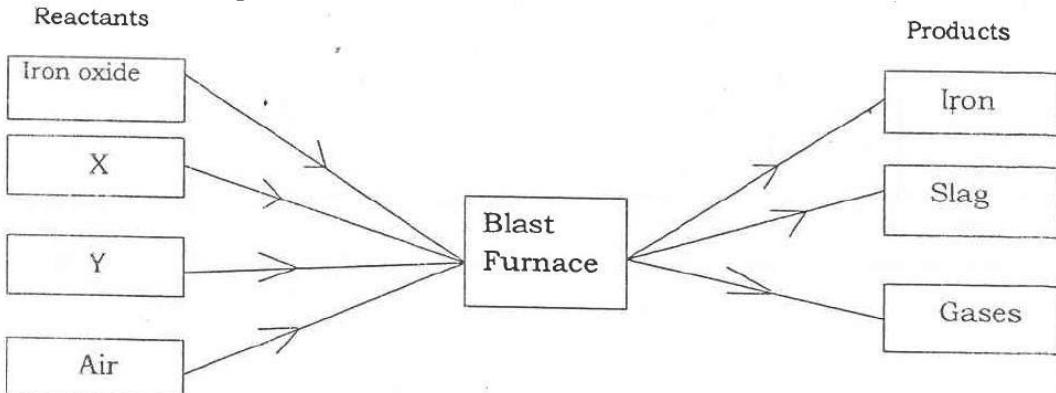
(1 mark)
(1 mark)

14. An organic compound contains 52.17% of carbon, 13% of hydrogen and the rest being oxygen.

- a) Calculate the empirical formula of the compound. (3 marks)
b) Given that the relative molecular mass is 92, determine its molecular Formula. (2 marks)

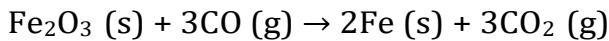
SECTION B: Attempt any THREE questions in this section. (30 marks)

15. The ore haematite contains iron oxide. The following flow diagram (chart) shows how iron is extracted from its ore haematite. Study the diagram and answer the questions that follow.



a) Name substances X and Y. (2 marks)

b) The chemical reaction for the formation of iron is

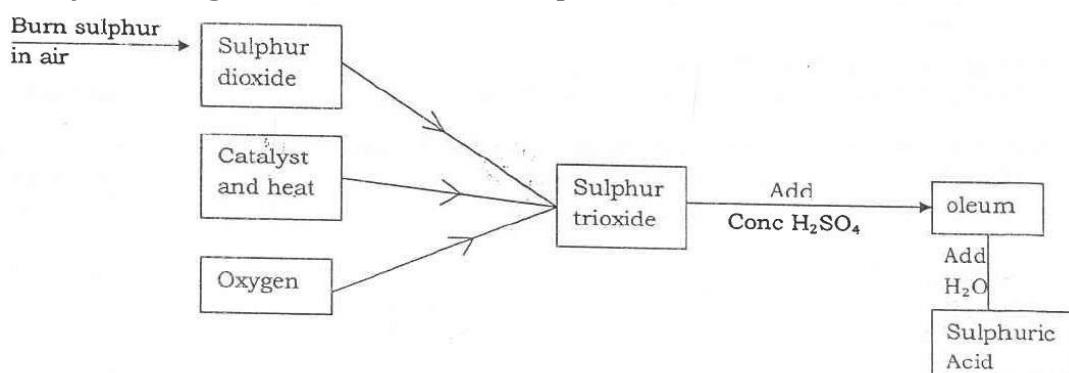


From the above equation, identify which substance is a reducing agent and which substance is an oxidizing agent. (2 marks)

c) Give the chemical names of three substances in the slag. (3 marks)

d) The blast furnace should be located (built) where conditions are suitable for an industry. Mention three conditions to consider before deciding where to put the industry. (3 marks)

16. Below is a simplified flow diagram for the manufacture of sulphuric acid. Study the diagram and answer the questions that follow.



a) Write a balanced equation for the formation of sulphur dioxide from oxygen and sulphur dioxide. (2 marks)

- b) Starting with 50cm³ of sulphur dioxide and 50cm³ of oxygen.
- Calculate the volume of sulphur trioxide formed. (2 marks)
 - Calculate the volume of oxygen that remains unreacted. (1 mark)
- c) Name the catalyst used in the formation of sulphur trioxide. (1 mark)
- d) Write an equation to show how concentrated sulphuric acid reacts with:
- Copper (1 mark)
 - Carbon (1 mark)
- e) Name two environmental problems that can be caused by the presence of sulphur dioxide in the atmosphere. (2 marks)

17. The following is a periodic table showing some elements. Use the table and the elements shown to answer the equations that follow.

1	2	groups										3	4	5	6	7	8
H																	He
Na	Mg											Al	C	N	O	F	
K	Ca												P	S	Cl		Br

- a) How many electrons does an atom of element F contain? (1 mark)
- b) Write the electronic configuration of the element C. (1 mark)
- c) Give the symbols of two elements that belong to alkaline metals. (1 mark)
- d) Give the formula of the compound formed between elements Mg and P. (2 marks)
- e) Select one element that will form a basic oxide, one element that will form an acidic oxide and one element that will form an amphoteric oxide. (3 marks)
- f) Use a dot and a cross to show the bonding in CH₄. (2 marks)

18. a) Explain how you would obtain a pure sample of zinc sulphate and a pure sample of copper powder. (8 marks)
- b) Write an ionic equation from the following chemical reaction.
- $$\text{ZnSO}_4 \text{ (aq)} + \text{BaCl}_2 \text{ (aq)} \rightarrow \text{ZnCl}_2 \text{ (aq)} + \text{BaSO}_4 \text{ (aq)}.$$
- (2 marks)

- 19.a) With the aid of a well labelled diagram, describe an experiment to prepare hydrogen chloride gas (HCl) from sodium chloride (NaCl). (8 marks)
- b) Write an equation to show how HCl reacts with:
- Ammonia gas (1 mark)
 - Manganese IV oxide. (MnO₂) (1 mark)

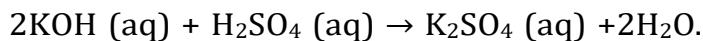
SECTION C: Answer only one question in this section. (15 MARKS)

20. To determine the concentration of a solution of sulphuric acid, 25cm³ of sulphuric acid was added to 2M of potassium hydroxide solution. The volume of potassium hydroxide required was 34 ml.

a) State three pieces of apparatus that would be used in this experiment. (3 marks)

b) How would you tell that the acid is completely neutralized by the base? (1 mark)

Given that the equation of the reaction is:



c) Calculate the number of moles of potassium hydroxide used in the titration. (2 marks)

d) Calculate the concentration of sulphuric acid in g/dm³. (5 marks)

Relative atomic masses are H = 1, S = 32, O = 16, K = 39.

e) Suggest two uses of sulphuric acid and two uses of potassium hydroxide. (4 marks)

21. In an experiment to determine how hydrogen is produced when magnesium powder reacts with dilute hydrochloric acid, the volume of hydrogen produced, was measured at different intervals. The following results were obtained.

Time (seconds)	0	5	10	20	30	40	50	60
Volume of H ₂ collected (cm ³)	0	32	52	78	93	95	95	95

a) Plot a graph of volume of H₂ produced (on the y-axis) versus time (x-axis). (9 marks)

b) Why is the volume of H₂ constant in the last three results? (1 mark)

c) Suggest a suitable instrument or piece of apparatus that can be used to measure the volume of H₂. (1 mark)

d) Why is the volume of H₂ = 0cm³ when the time = 0 seconds? (1 mark)

e) How would you prove that hydrogen gas is evolved in each experiment? (1 mark)

f) State two industrial uses of hydrogen gas. (2 marks)

22. With the help of equations where possible, state the chemical test that would be used to distinguish each pair of the following substances and state the observation in each case:

a) Zn(NO₃)₂ (aq) and Fe(NO₃)₂ (aq).

b) NaCl (aq) and Na₂CO₃ (aq)

c) Ethane and Ethanol

d) SO₂ and Cl₂ gases,

e) Pb(NO₃)₂ and Cu(NO₃)₂ (s)