Chemistry III
025
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RWANDA NATIONAL EXAMINATIONS COUNCIL

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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.

(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 pricipitate
(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)**

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)**

The molecular formula of ethanoic acid is $C_2H_4O_2$
(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)**

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

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

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

(a) Poly(ether e) is a polymer. Explain the meaning of the term Polymer. **(1mark)**

(b) Ethene is "unsaturated" where as poly(ethene) is saturated. What is meant by "unsaturated" with reference to ethene? **(1mark)**

(c) State one use of poly(ethene) **(1mark)**

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

$2\ Al_{(s)} + 3\ Cl_{2(g)} \rightarrow 2\ AlCl_{3(s)}$

(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 ($Ca(OH)_2$), 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 or a large scale by the Haber process according to the equation:

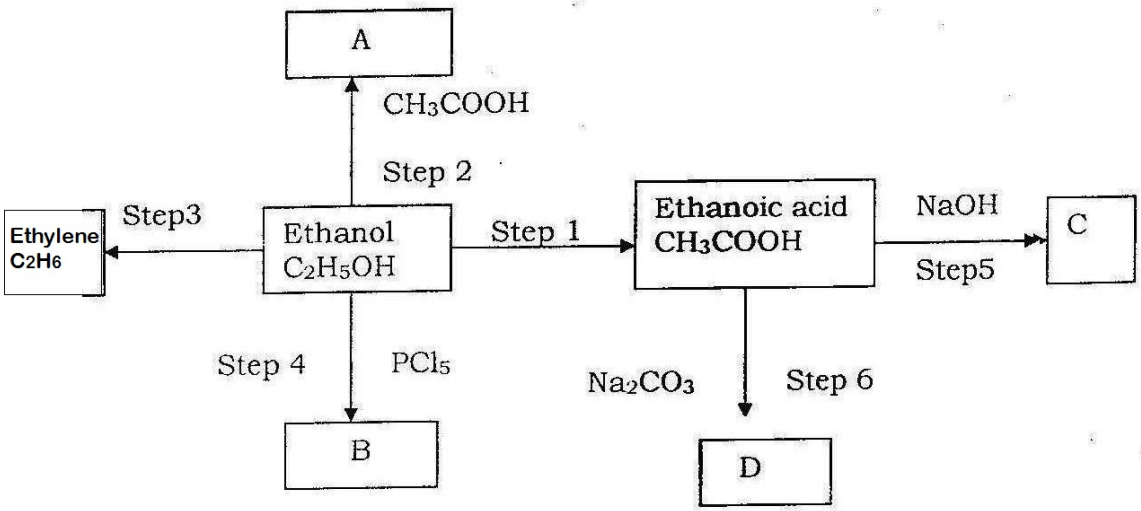
$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

(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)**

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)**

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:

(i) Graphite is soft and can be used as a lubricant while diamond is a very hard substance. **(4marks)**

(ii) Graphite is a good conductor of electricity while diamond is a poor conductor of electricity. **(4marks)**

(c) State one use of diamond. **(1mark)**

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 $Ca(OH)_2$ and HNO_3 is:

$$Ca(OH)_{2(aq)} + 2HNO_{3(aq)} \rightarrow Ca(NO_3)_{2(aq)} + 2H_2O_{(l)}$$

(i) Calculate the number of moles of nitric acid. **(1mark)**

(ii) How many moles of $Ca(OH)_2$ were in 25.0cm^3 of the solution? **(1mark)**

(iii) The number of moles of $Ca(OH)_2$ 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. **(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
(i) Cathode (ii) Anode **(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. **(2marks)**

SECTION C: Answer only ONE question from this section.

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)**

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)**

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 $ZnSO_4 . 7H_2O$.
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 $ZnSO_4 . 7H_2O$ (Zn = 65, S = 32, O = 16, H =1) **(2marks)**