For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

CHEMISTRY 6031/3

PAPER 3

SPECIMEN PAPER 2 hours 30 minutes

Additional materials:
- Answer paper
- Data Booklet
- Mathematical tables and/or electronic calculator

TIME: 2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **six** questions.

Answer **two** questions from Section A, **one** question from Section B, **two** questions from Section C and **one** question from section D.

Write your answers on the separate answer paper provided.

If you use more than one sheet of paper, fasten the sheets together.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

You are reminded of the need for good English and clear presentation in your answers.

This question paper consists of 13 printed pages and 3 blank pages.

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Section A

Answer any **two** questions from this section.

1 **(a)** **Fig.1.1** shows the trend in the boiling points of hydrides of Group (V) elements.

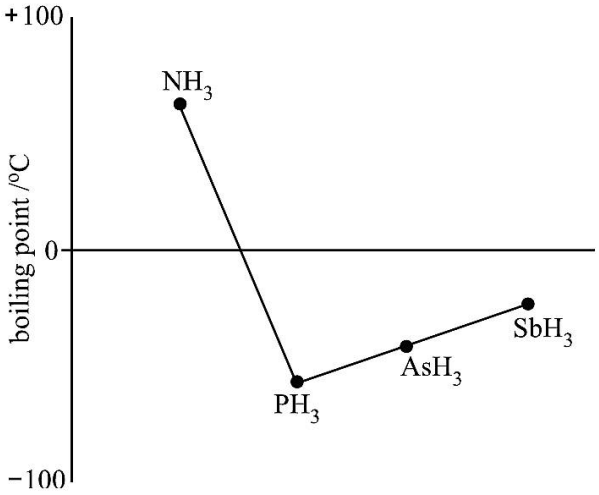


Fig.1.1

Explain the trend.

[2]

(b) Explain the following

(i) methanol is soluble in water but octanol is insoluble,

(ii) ethanoic acid has an apparent molar mass of $120\,gmol^{-1}$ in the vapour state just above its boiling point,

(iii) boron tri-chloride reacts with ammonia but carbon tetrachloride does not,

(iv) the bond angle in phosphorus tri-chloride is 107°,

(v) carbon dioxide is a gas whereas germanium (IV) oxide is a solid at room temperature.

[10]

(c) A titration was carried out using acidified potassium dichromate (VI) in a conical flask and a solution of iron (III) sulphate in a burette.

(i) Write a balanced chemical equation for the reaction.

(ii) Calculate E^{J}_{cell}.

(iii) Sketch a graph to show the *e.m.f.* change during the nitration. [3]

[Total:15]

2 **(a)** **(i)** Define the terms

1. *activation energy,*

2. *catalyst.*

(ii) Explain why the activation energy for the synthesis of ammonia in the Haber process is high.

[3]

(b) The equation for the Haber process is

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \quad DH^{q} = -92\ kJmol^{-1}$$

and the activation energy, for the uncatalysed decomposition of ammonia is $+335\ kJmol^{-1}$.

(i) Sketch, on the same axes, a labelled reaction pathway diagrams of the catalysed and uncatalysed reaction.

(ii) Determine the activation energy of the uncatalysed formation of ammonia.

[5]

(c) In an experiment, 120 mole of $H_{2(g)}$ were mixed with 40.0 mole of $N_{2(g)}$ and pressurised in a 2.0 dm^3 vessel until equilibrium was reached when there was 40 % conversion of the reactants to ammonia.

(i) Write the K_c expression for the formation of ammonia.

(ii) Calculate the K_c and state its units.

[4]

(d) Hydrogen carbonate ions provide a buffering action in biological systems.

(i) Define the term *buffer solution*.

(ii) Explain by means of equations the buffering action of hydrogen carbonate ions. [3]

[Total:15]

3 **(a)** **[Use of the Data Booklet is recommended in this question.]**

The standard zinc - copper cell is as shown:

$$Zn_{(s)} / Zn^{2+}_{(aq)} \,//\, Cu^{2+}_{(aq)} / Cu_{(s)}$$

(i) Define the term *standard cell potential.*

(ii) Calculate the standard cell potential for this cell,

(iii) Write the overall equation for the cell reaction.

(iv) Explain the effect of adding zinc granules on the value of E^{q}cell.

[4]

(b) Outline how zinc impurities are removed during the electro-purification of copper. [2]

(c) A sample of impure zinc dust of mass 0.350 g was added to an excess of aqueous iron (III) sulphate. The iron (II) produced required 100 cm^3 of 0.0200 $moldm^{-3}$ potassium manganate (VII) for titration.

(i) Write the equation for the reactions which take place.

(ii) Calculate the percentage purity of the zinc dust.

[6]

(d) Explain why the solubility of MgO is low in water. [3]

[Total:15]

Section B

*Answer any **one** question from this section.*

4 **(a)** Describe, with aid of chemical equations, the reactions of calcium with

(i) air,

(ii) cold water. [3]

(b) Calcium carbonate occurs naturally as limestone and can be converted to other compounds as shown in **Fig. 4.1.**

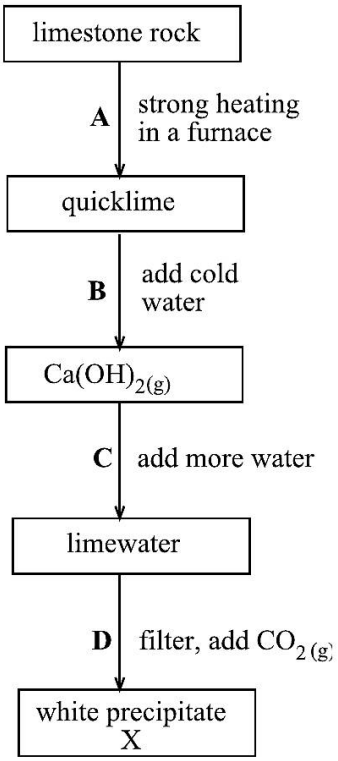


Fig. 4.1

(i) Write down the formula of X.

(ii) State the observation made in reaction **B**?

(b) **(iii)** Write the chemical equations for

1. reaction **A,**

2. reaction **D.**

(iv) Describe the difference in the observation made in reaction **C** if $Ca(OH)_2$ is replaced by $Mg(OH)_2$.

[7]

(c) State and explain the difference in the thermal stabilities of calcium carbonate and magnesium carbonate. [5]

[Total: 15]

5 Sodium hydroxide and chlorine are both products of the electrolysis of brine using a diaphragm cell.

(a) **(i)** Give **one** commercial use of NaOH.

(ii) Explain why during the electrolysis of brine the level of the electrolyte is higher in the anode compartment than it is in the cathode compartment.

[2]

(b) Two chlorine-containing products are formed when aqueous sodium hydroxide is reacted with chlorine at high temperature.

(i) Write the chemical equation for the reaction.

(ii) Name the type of chemical reaction undergone by chlorine in **(i)**.

(iii) Draw

1. the shape of the chlorate ion formed,

2. the structure of the other chlorine-containing product.

[4]

(c) Describe the observations made when chlorine is reacted with

(i) aqueous iron (II) sulphate,

(ii) hydrogen gas,

(iii) sodium thiosulphate. [5]

(d) Oxides of manganese in low oxidation states tend to be basic while in high oxidation states are acidic.

(i) State the oxidation state of Mn in

1. MnO,

2. Mn_2O_7.

(i) Write chemical equations to show

1. the acidic properties of Mn_2O_7,

2. basic properties of MnO.

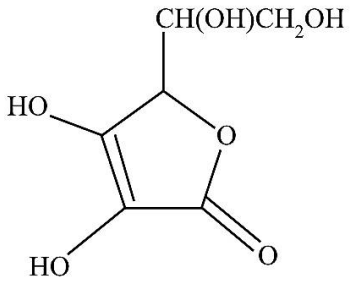
[4]

[Total : 15]

Section C

*Answer any **two** questions from this section*

6 **(a)** **Fig. 6.1** shows the structure of ascorbic acid, a white crystalline compound found dissolved in the juices of fresh fruits and vegetables.



ascorbic acid

Fig. 6.1

(i) Name

1. any **two** functional groups in ascorbic acid,
2. the type of isomerism exhibited by ascorbic acid.

(ii) Draw the structures of isomers of ascorbic acid.

(iii) Explain why ascorbic acid is soluble in water. [8]

(b) **(i)** State the observations made, when ascorbic acid is reacted with

1. cold dilute $KMnO_4$,
2. hot concentrated $KMnO_4$,
3. phosphorus pentachloride.

(ii) Give the displayed structured formulae of the organic product formed for each of the reactions in **(i)**.

[7]
[Total:15]

7 **(a)** The molecular formula of a compound, **A,** is C_6H_7N. When **A** is reacted with excess hydrochloric acid and sodium nitrite below 5 °C, an organic compound, **B,** is formed which produces phenol when poured into hot water.

(i) Deduce the structural formula of

1. **A,**

2. **B.**

(ii) Write the chemical equation for the reaction of **B** with hot water.

(iii) Give a **two-step** reaction for the formation of **A** from benzene. State the reagents and conditions for each step.

[8]

(b) **Fig. 7.1** shows how phenol can be converted to other organic compounds, **E** and **F.**

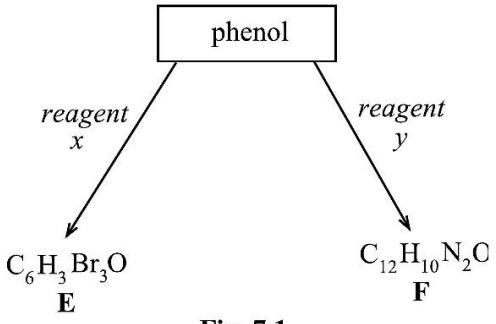


Fig. 7.1

(i) Give the structures of

1. **E,**

2. **F.**

(ii) Name the type of reaction undergone by phenol with *reagent y* and state the conditions used.

(iii) Describe the observations made during the production of **E.**

[7]
[Total:15]

8 **(a)** State any **two** differences between addition and condensation polymerisation. [2]

(b) **(i)** Draw **two** repeat units of

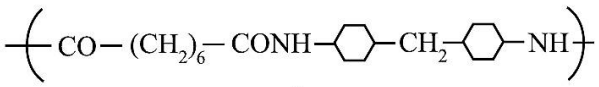
1. nylon 6,

2. nylon 66.

(ii) Deduce from the units in **(i) one** difference between the two polymers.

[6]

(c) Quiana is a polymer that has a silk-like feel while polyacrylonitrile is a fabric which is stronger than wool. The structure of quiana is shown



quiana

(i) Name the type of linkage that is present in quiana.

(ii) Draw **two** repeat units of polyacrylonitrile given that the structure of acrylonitrite is $CH_2 = CH\text{-}C \equiv N$,

(iii) Compare the reactivities of quiana and polyacrylonitrile with aqueous sodium hydroxide.

(iv) Draw the structure(s) of any organic product(s) formed in **(iii).**

[7]

[Total:15]

Section D

*Answer any **one** question from this section*

9 Hwange thermal power station contributes a great deal of sulphur dioxide into the atmosphere.

(a) **(i)** Give the source of SO_2 at Hwange.

(ii) Write an equation to show how SO_2 is formed.

(iii) Using equations state and explain **two** methods that could be employed in controlling SO_2 emission.

(iv) Describe the effects of SO_2 emission into the atmosphere.

[7]

(b) **(i)** Define the term *incineration.*

(ii) State **any two** advantages and any **two** disadvantages of incineration.

(iii) Describe the effects of ozone depletion.

[8]
[Total : 15]

10 **(a)** Define the term

(i) *partition,*

(ii) *partition coefficient.*

[2]

(b) Butanoic acid of mass 1.20 g was shaken with a mixture of 100 cm^3 of water and 100 cm^3 of ether. After equilibration, the ether layer had 0.024 moles of butanoic acid whilst the water layer had 0.16 moles.

(i) Calculate the partition coefficient for butanoic acid between ether and water.

(ii) State and explain any **two** factors which affect the magnitude of the partition coefficient in **b(i).**

(iii) State, with a reason, whether a mixture of ethanoic acid dissolved in water obeys the partition law when added to benzene.

[8]

(c) At 1 atm pressure, HCl and H_2O form an azeotropic mixture containing 20.22% HCl, that boils at 109 °C.

Draw

(i) the vapour pressure composition curve for HCl and H_2O,

(ii) the boiling composition curve for HCl and H_2O.

In each case show the liquid curve, the vapour curve and the azeotropic composition.

[4]

(d) Describe how a constant boiling point $HCl_{(aq)}$ solution can be prepared in a laboratory. [1]

[Total : 15]