P525/2
CHEMISTRY
Paper 2
2022
2Hrs:30 Minutes

MATIGO MOCK EXAMINATIONS 2022
UGANDA ADVANCED CERTIFICATE OF EDUCATION
PAPER 2
DURATION: 2Hours 30minutes.

INSTRUCTIONS TO CANDIDATES:

- Attempt **five** questions including **three** from section A and any **Two** questions from section B.
- Begin each question on a fresh page.

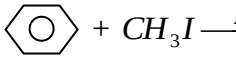
Where necessary use the following values:
C = 12, H = 1, Be = 9, Cl = 35.5, Ag = 108, N = 14, Cr = 52, O = 16, Fe = 56, Na = 23.
1 mole of a gas occupies 22.4 dm^3 at s.t.p.
1 mole of a gas occupies 24 dm^3 at s.t.p.
Gas constant,R = 8.314 $Jmol^{-1}k^{-1}$.

SECTION A (60 MARKS)

Answer only **three** questions from this section.

1 (a) Complete the following equations and write a mechanism for the reaction in each case.

(i) $CH_3COCH_3 + H_2NOH \xrightarrow{H^+}$ 4 Marks

(ii)  3 Marks

(b) Write equations to show how each of the following compounds can be prepared. In each case indicate the conditions for the reaction.

(i) Benzoic acid from benzene. 2 Marks
(ii) Ethyne from ethanol. 2 Marks
(iii) Propanoic acid from bromo ethane. 3 Marks
(iv) Propanoic acid to amino ethane. 3 Marks

(c) Complete each of the following equations. State one use of the product in each case.

(i) $nCH_2 = CH_2 \xrightarrow{Catalyst}$ 1½ Marks

(ii) $nH_2N(CH_2)_6NH_2 + nHOOC(CH_2)_4COOH \longrightarrow$ 1½ Marks

2. (a) (i) Explain the terms lattice energy, hydration energy and enthalpy of solution. 6 Marks.

(ii) Using potassium iodide, draw an energy diagram to show how the energy terms in a(i) are related. 2 Marks

(iii) The enthalpy of solution and lattice energy of potassium iodide are +21 KJ mol^{-1} and -642 KJ mol^{-1} respectively. Calculate the hydration energy for potassium iodide. 2 Marks.

(b) (i) State Hess's law. 1 Mark

(ii) Construct a Born Haber cycle for the formation of sodium oxide,Na_2O indicating all the energy changes involved. 3 Marks.

(iii) Use the data below to calculate the lattice energy of sodium oxide.

$Na(s) \longrightarrow Na(g)$ +107 KJ mol^{-1}

$Na(g) \longrightarrow Na^+(g) + e^-$ +496 KJ mol^{-1}

$O_2(g) \longrightarrow 2O(g)$ +249 KJ mol^{-1}

$O(g) + e^- \longrightarrow O^-(g)$ -141 KJ mol^{-1}

$O^-(g) + e^- \longrightarrow O^{2-}(g)$ +248 KJ mol^{-1}

$2\,Na(s) + \frac{1}{2}O_2(g) \longrightarrow Na_2O(s)$ -410 KJ mol^{-1} 3 Marks

(c) (i) Ethanol completely burns in excess oxygen. Write the equation of the reaction. 1 Mark

(ii) Using the data for enthalpy change of formation for ethanol(l) = -277 KJ mol^{-1}, Carbon dioxide(g) = 393.7 KJ mol^{-1}, Water(l) = -285.9 KJ mol^{-1}.Calculate the value of enthalpy of combustion of ethanol. 2 Marks

3. (a) (i) Write the electronic structure in the outermost shell of the atoms of each element in Group (**IV**) of the periodic table. (1 Mark)

(ii) Give the electronic configuration of Ge^{2+} given that the atomic number of Germanium is 32. (1 Mark)

(b) Although tetrachloromethane does not react with water, the tetrachlorides of the other elements in the group are readily hydrolysed.

(i) What is the nature of the bonding in these chlorides? (1 Mark)

(ii) Give the general molecular shape of the tetrachlorides of Group (IV) elements. (1 Mark)

(iii) Write an equation for the reaction of **ONE** of these tetrachlorides withwater. (1½ Marks)

(iv) Account for the fact that tetrachloromethane does not react with water whereas the other tetrachlorides do. (3½ Marks)

(c) Carbon dioxide is a gas whereas silicon dioxide is a solid of high melting point.

(i) Explain the difference in melting point. (3 Marks)

(ii) Draw the structures of the two oxides. (2 Marks)

(d) Lead shows an **Inert pair effect**. What do you understand by this statement? (2 Marks)

(e) Carbon forms a limitless number of stable hydrides but this tendency decreases rapidly with increase in atomic number down the group. Give an explanation for this. (4 Marks)

4. (a) The boiling point of water is 100 ^{0}C and that of ethanol is 80 ^{0}C. A mixture of the two liquids when distilled, gives a constant boiling mixture at 78.2 ^{0}C containing 95.6% ethanol.

(i) Draw a labeled diagram of boiling point against composition for the water – ethanol mixture. Explain the shapes of the curves in the diagram. 9 Marks

(ii) Describe what would happen if a mixture containing less than 95.6% of ethanol is fractionally distilled. 4 Marks

(b) The vapour pressure of ethanol at 20 ^{0}C is 43.6 mmHg while that of benzene at the same temperature is 75.2 mmHg. The mole fraction of benzene is 0.09 for a mixture of benzene and ethanol at 20 ^{0}C. Calculate:

(i) the vapour pressure of the mixture. 4 Marks

(ii) the mole fraction of ethanol in the vapour phase. 3 Marks

SECTION B (40 MARKS)

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

5. (a) Explain the following:

(i) Hydrolysis. 2 Marks

(ii) Common ion effect. 2 Marks

(b) Sodium benzoate undergoes hydrolysis when dissolved in water.

(i) Write an equation for the hydrolysis of sodium benzoate.

1 Mark

(ii) Write an expression for the hydrolysis constant, K_h of sodium benzoate. 1 Mark

(iii) The hydrolysis constant of sodium benzoate is 1.6×10^{-10} mol dm^{-3}. Calculate the pH of a 0.1 M sodium benzoate solution at 25 ^{0}C. ($K_w = 10^{-14}$ mol^2 dm^{-6}) 6 Marks

(c) Silver chromate is sparingly soluble in water.

(i) Write an expression for the solubility of silver chromate in water. 1 Mark

(ii) Write an expression for the solubility product, K_{sp} of silver chromate. 1 Mark

(iii) The solubility of silver chromate at a certain temperature is 2×10^{-5} mol dm^{-3}. Calculate the solubility product of silver chromate at that temperature. 2 Marks

(iv) Calculate the solubility of silver chromate in one litre of 0.1 M silver nitrate solution in mol dm^{-3}. 4 Marks

6. (a) Write the name and formula of the ore from which aluminium metal is extracted. (2 Marks)

(b) Outline the steps used in the extraction of aluminium from its ore. Your answer should include all necessary equations. No diagram is required. (12 Marks)

(c) In the extraction of aluminium, state

(i) why a low voltage is used. (1 Mark)

(ii) one disadvantage involved (1 Mark)

(d) State two uses of aluminium in relation to its properties. (2 Marks)

(e) How and under what conditions does aluminium form aluminium chloride, Al_2Cl_6? (2 Marks)

7. (a) You are provided with solution **P** containing 1.48 gdm^{-3} of substance $M(OH)_n$. The formula mass of $M(OH)_n$ is 74. 25 cm^3 of **P** required 20 cm^3 of 0.05 M hydrochloric acid solution for complete reaction.

(i) Write the equation for the above reaction. 1½ Marks

(ii) Determine the value of n. 2 Marks

(iii) Determine the relative atomic mass of M. 2 Marks

(b) 25 cm^3 of a solution containing a mixture of sodium carbonate and sodium hydrogen carbonate required 15 cm^3 of 0.5 M hydrochloric acid for complete reaction using phenolphthalein indicator. 25 cm^3 of the solution of the mixture required 34.5 cm^3 of the acid using methyl orange indicator.

Calculate the mass of sodium carbonate and sodium hydrogen carbonate in the solution in grams per litre. 6 Marks

(c) 0.792g of a sample of iron ore were dissolved in dilute hydrochloric acid and all the iron was converted to Fe^{2+} and the solution made upto 250 cm^3 in a volumetric flask. 23.2 cm^3 of 0.01 M potassium manganate (VII) solution. Calculate the percentage of iron in the ore. 6 Marks

(d) Concentrated nitric acid is 70%(w/w) and has a density of 1.42g cm^{-3}. Calculate the molarity of the concentrated nitric acid. 3 Marks

8. (a) (i) What is meant by the term'd-block element'? 1 Mark

(ii) Write the electronic configurations of Cu, Fe^{2+} and Mn^{2+}. (Atomic numbers of Cu, Fe and Mn are 29, 26 and 25 respectively). 3 Marks

(iii) Explain why Fe^{2+} is readily oxidized to Fe^{3+}, but Mn^{2+} is readily oxidized to Mn^{3+}. 2 Marks

(b) **Z** is a purple salt which dissolves in water to give a solution which turns green on warming. When sodium hydroxide solution is added to a solution of **Z**, a green precipitate **Y** is formed soluble in excess of the alkali. On adding hydrogen peroxide to the alkaline solution, the colour turns to yellow. On adding more hydrogen peroxide and acidifying with dilute sulphuric acid, the colour turns blue and later turns green with evolution of oxygen gas on standing. The solution of **Z** gives a white precipitate **X** with barium chloride, which is insoluble in dilute hydrochloric acid.

(i) Identify **X, Y** and **Z.** 3 Marks

(ii) Account for the colour changes involved. 4 Marks

(c) (i) Write the possible oxidation states of manganese. 2 Marks

(ii) Write the half equation for the reduction of potassium manganate (VII) solution in acidic medium. 1½ Marks

(iii) State the change in the oxidation state of manganese in the reaction in b(i) above. ½ Mark

(d) Name a reagent that can be used to distinguish Mn^{2+} from Ni^{2+}. State what would be observed if each of them is separately treated with the reagent you have named. 2 Marks

(e) State **one** advantage of using potassium manganate (VII) in volumetric analysis. 1 Mark

END