THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA
ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/2

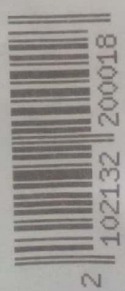
CHEMISTRY 2
(For Both School and Private Candidates)

Time: 3 Hours **Year : 2021**

Instructions

1. This paper consists of a total of **six (6)** questions.
2. Answer **five (5)** questions.
3. Each question carries **twenty (20)** marks.
4. Mathematical tables and non-programmable calculators may be used.
5. Cellular phones and any unauthorised materials are **not** allowed in the examination room.
6. Write your **Examination Number** on every page of your answer booklet(s).
7. For calculations you may use the following:

   Gas constant, R = 8.31 J mol^{-1} K^{-1} or 0.082 atm mol^{-1} K^{-1} dm^3
   GMV = 22.4 dm^3
   1 litre = 1dm^3 = 1000 cm^3
   1 Faraday = 96,500 $Cmol^{-1}$
   Standard temperature = 273 K
   Standard pressure = 760 mmHg = 1 atm = 1.0 x 10^{-5} NM^{-2}
   Velocity of light, c = 3.0 x 10^8 m/s
   Atomic masses: Ag = 108, Cl = 35.5.



Answer a total of **five** (5) questions.

1. (a) (i) Distinguish between an electrolytic cell and a galvanic cell. **(1 mark)**

(ii) Lead rods are placed in each of the following solutions: $AgNO_3$, $CuSO_4$, $FeSO_4$ and $ZnSO_4$. In which solution would you expect a coating of one metal on lead rod? Give a reason. (Given ε° $Zn^{2+}/Zn = -0.76$ V, ε° $Pb^{2+}/Pb = -0.13$ V, ε° $Cu^{2+}/Cu = +0.34$ V, ε° $Ag^{+}/Ag = +0.81$ V and ε° $Fe^{2+}/Fe = -0.44$ V). **(3 marks)**

(b) Why the Kohlrausch's law of independent migration of ions applies at infinite dilution of electrolytes? Briefly explain. **(1 mark)**

(c) Show that for the cell reaction

$Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$ with different cell concentrations and the temperature 298 K, the cell potential is given by; $\varepsilon = \varepsilon^{\circ}_{cell} - 0.0295\log\frac{[Zn^{2+}(aq)]}{[Cu^{2+}(aq)]}$. **(7 marks)**

(d) A galvanic cell consists of metallic zinc and lead plates immersed in 0.1 M $Zn(NO_3)_2$ and 0.02 M $Pb(NO_3)_2$ solution.

(i) Write the chemical equations for the electrode reactions.

(ii) Write the cell notation for the reaction.

(iii) Calculate the e.m.f of the cell. **(8 marks)**

2. (a) Write a mathematical expression for distribution law. **(2 marks)**

(b) Compound **P** has a partition coefficient of 4.00 between ethoxyethane and water. Given that 2.0 g of **P** is obtained in solution, in 50 cm^3 of water, calculate the mass of **P** that can be extracted from the aqueous solution by

(i) 50 cm^3 of ethoxyethane.

(ii) two successive extractions of 25 cm^3 of ethoxyethane each. **(8 marks)**

(c) Comment on the variation of the amount extracted in (b) (i) and (ii). **(2 marks)**

(d) When 500 cm^3 of an aqueous solution containing 4 g of a solute **G** per litre was shaken with 100 cm^3 of pentan-1-ol, 1.5 g of the solute **G** was extracted. Assuming a molecular state of the solute remains the same in both solvents, calculate:

(i) The partition coefficient of the solute **G** between pentan-1-ol and water.

(ii) Mass of the solute **G** which will remain in the aqueous solution after a further shaking with 100 cm^3 of pentan-1-ol. **(8 marks)**

3. (a) To a solution containing 0.1 M Cl^- and 0.01 M $C_{}O_4^{2-}$, a solution of $AgNO_3$ is added slowly.

(i) Which salt will precipitate first between AgCl and Ag_2CrO_4? Show clearly how you arrived to your answer.

(ii) Find the concentration of the ion that will precipitate first at the time the second ion will start precipitating. Use $K_{sp}(AgCl) = 2.72 \times 10^{-10}$ and $K_{sp}(Ag_2CrO_4) = 2.4 \times 10^{-12}$. **(8 marks)**

(b) Calculate the solubility of Ag_2CrO_4 in water if the value of solubility product K_{sp} is 1.3×10^{-11} $(mol/L)^3$. **(4 marks)**

(c) A standard solution of AgCl(aq) at 36 °C has a conductivity of 1.32×10^{-6} Ω^{-1} cm^{-1} mol^{-1}. If its molar conductivity at infinite dilution is 120 Ω^{-1} cm^2 mol^{-1}, calculate;

(i) the solubility of AgCl in g/dm^3.

(ii) the solubility product of AgCl at the given temperature. **(8 marks)**

4. (a) State the reason(s) for the following facts;

(i) Although Na^+, Mg^{2+} and Al^{3+} ions have the same electronic configuration, they have different radii.

(ii) At ordinary temperature, phosphorous pentachloride (PCl_5) is a white solid with unexpected high melting point.

(iii) Sodium chloride (NaCl) and unhydrous aluminium chloride ($AlCl_3$) are both chlorides of metals of period (III). Molten sodium chloride can be electrolysed while molten unhydrous aluminium chloride can not.

(iv) The first ionization energy increases from left to right across a period but the first ionization energy of magnesium is larger than that of aluminium.

(v) Lithium and potassium are metals of group (I). In aqueoues solution, lithium is a poor conductor of electricity while potassium is a good conductor.

(vi) Boiling point of water (H_2O) is higher than that of hydrogen sulphide (H_2S). All are hydrides of group (IV) elements. **(11 marks)**

(b) (i) Which factors are used to classify elements in the periodic system of elements?

(ii) Account for the fact that the third period of the periodic system of elements has only eight elements and not eighteen as expected. **(3 marks)**

(c) Ammonia, NH_3 and phosphene, PH_3 are hydrides of the first two elements in group VA. Some physical properties of ammonia and phosphene are given in the following table:

Compound	Boiling point (°C)	Solubility in water (Mol/dm^3)
Ammonia, NH_3	-33	31.1
Phosphene, PH_3	-88	8.88×10^{-4}

(i) Suggest one reason for the difference in boiling temperature.

(ii) Why ammonia is more soluble in water than phosphene? Give a reason. **(2 marks)**

(d) Why do elements exhibit diagonal relations? Briefly explain by giving two examples. **(4 marks)**

5. (a) From the knowledge you have on hydroxyl group, write the chemical reaction equations with their IUPAC names showing what happen when propan-1-ol is treated with;

(i) excess HBr under reflux.

(ii) a small amount of concentrated H_2SO_4.

(iii) acidified $KMnO_4$.

(iv) ethanoic acid in the presence of concentrated H_2SO_4.

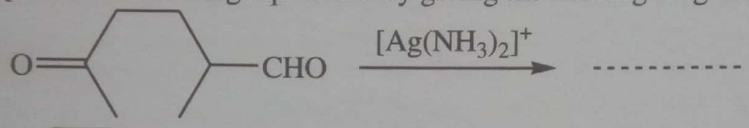
(v) $SOCl_2$. **(10 marks)**

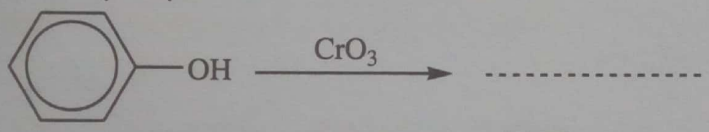
(b) Compound **A** ($C_{10}H_{12}O$) gives off oxygen on treatment with sodium metal and also decolorizes Br_2 in CCl_4 to give organic compound **B**. Compound **A** on treatment with I_2 in NaOH gives Iodoform and a salt **C** which after acidification gives a white solid **D**($C_7H_6O_2$). Using knowledge of organic chemistry, identify structures **A**, **B**, **C** and **D**. **(10 marks)**

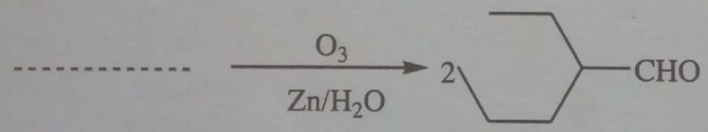
6. (a) How can you distinguish the following? Support your answer with chemical equation.
   (i) Propanal and propanone.
   (ii) Ethanal and benzaldehyde.
   (iii) Pentanal and pentan-2-one.
   (iv) 3-pentanone and 2-pentanone. **(8 marks)**

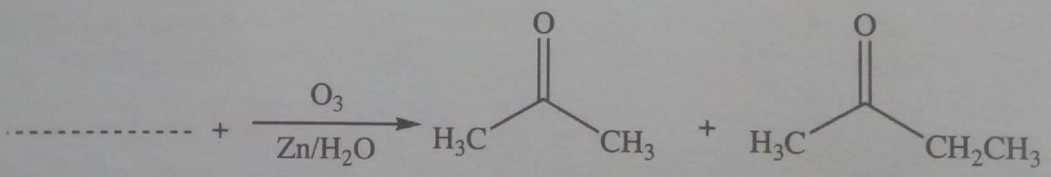
   (b) An organic compound **A** which has a characteristic odour is treated with 50% NaOH to give **B** (C_7H_8O) and **C** which is a sodium salt of an organic acid. Oxidation of **B** gives back **A**. Heating **C** with soda lime yields an aromatic hydrocarbon **D**. Deduce the structures **A**, **B**, **C** and **D**. **(8 marks)**

   (c) Complete the following equations by giving the missing reagents/products;

(i) 

(ii) 

(iii) 

(iv) 

(4 marks)