P525/2
CHEMISTRY
Paper 2

Oct./Nov. 2022

2 ½ hours.

S.6

# THE CHEMISTRY DEPARTMENT

**2022**

CHEMISTRY

**TEST IV , TERM II, Paper 2**

2 hours 30 minutes

## INSTRUCTIONS:

Answer **five** questions including **three** questions from section **A** and any **two** from *section* **B**.

Write the answers in the answer booklet(s) provided.

**Begin each question on a fresh page**.

Mathematical tables and graph papers are provided.

Non-programmable scientific calculators may be used.

Use equations where necessary to illustrate your answers.

Where necessary, use the following;

$$[H = 1, C = 12, O = 16, Br = 80]$$

## SECTION A : ( 60 MARKS)

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

1.  (a) What do you understand by the terms:
    (i)       equilibrium constant                                    (01 mark)
    (ii)      dynamic equilibrium                                    (01 mark)

    (b)   Describe an experiment to determine the equilibrium constant for the reaction between ethanoic acid and ethanol.        (07 marks)

    (c) When 8.28g of ethanol were heated with 60g of ethanoic acid, 49.74g of the acid remained at equilibrium. Calculate the;
    (i) value of the equilibrium constant.                        (04 marks)
    (ii) mass of ester present in the equilibrium mixture formed from 13.8g  of ethanol and 12g of ethanoic acid.        (04 marks)

    (d)   Explain how the amount of ethylethanoate and position of the equilibrium in (c) would be affected if:        (03 marks)
    (i)       some ethanol is added to the system.
    (ii)      some sodium hydroxide solution is added

2.  (a) Copper pyrites is one of the principle ores of copper.
    (i)       Define the term ore.                                      (01 mark)
    (ii)      Describe how copper can be extracted from copper pyrites.
                                                                              (06 marks)

    (b) Briefly describe how copper reacts with:
    (i)          oxygen                                                  (02 marks)
    (ii)         nitric acid                                              (05 marks)
    (iii)        sulphuric acid                                        (03 marks)

    (c) Excess aqueous ammonia was added to a solution of copper(II) sulphate dropwise. State what was observed and write equation(s) for the reaction.                                                          (03 marks)

3. Write equations, indicating the reagents and conditions to show how the following compounds can be synthesized.
   (a) Pent-1-yne from ethene                                    (4 ½ marks)
   (b) Cyclohexanone from cyclohexene                            (03 marks)
   (c) Ethanoylchloride from ethene                              (04 marks)
   (d) Propylamine from 2-chloropropane                          (04 marks)
   (e) Methylphenylamine from benzene                            (4 ½ marks)

4. (a) The standard electrode potentials for some half cells are shown below:
$$Fe^{3+}(aq)/Fe^{2+}(aq) \qquad\qquad +0.76V$$
$$I_2(aq)/I^-(aq) \qquad\qquad +0.54V$$
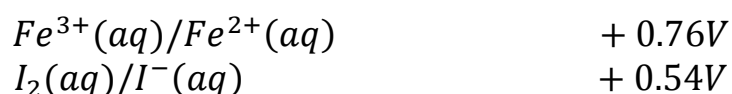
   (i)   What is meant by the term **standard electrode potential?**
                                                                 (01 mark)
   (ii)  Using a well labeled diagram, describe how standard electrode potential of the magnesium electrode can be determined.                                        (06 marks)
   (iii) Explain why it is not possible to measure standard electrode potential absolutely.          (02 marks)

   (b) (i) Write the cell convention and equation for the overall cell reaction that occurs when the half cells in (a) above are combined.
                                                                 (2 ½ marks)
   (ii) Calculate the emf of the cell in b(i)                    (1 ½ marks)
   (iii)    State whether the reaction in c(i) is feasible or not. Give a reason for your answer.                           (01 mark)
   (c) A current of 32.2A was passed through molten lead(II) bromide for 5 hours and the bromine liberated reacted with 94g of hydroxybenzene. Calculate the number of moles of:

(i) bromine liberated

(ii) hydroxybenzene that reacted                                    *(04 marks)*

(d) State what is observed and write equation for the reaction that took place between bromine and hydroxybenzene in (c) above.

*(02 marks)*

## SECTION B : (40 MARKS)

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

5. (a)    Explain the terms:

    (i)    **Partition coefficient**                                    *(02 marks)*

    (ii)   **Solvent extraction**                                    *(01 mark)*

  (b) Describe an experiment to determine the partition coefficient for benzoic acid between water and benzene at room temperature.                                    *(06 marks)*

(c) In an experiment to find the partition coefficient of ammonia between water and carbon tetrachloride, $10.0cm^3$ of the aqueous layer required $13.2cm^3$ of 0.25M nitric acid for complete reaction. $25cm^3$ of organic layer required $6.6cm^3$ of 0.05M nitric acid. Calculate the partition coefficient of ammonia between water and carbon tetrachloride.                                    *(05 marks)*

(d) $2.5 \times 10^{-2}$ $moldm^{-3}$ of zinc sulphate was allowed to reach equilibrium with excess ammonia and carbon tetrachloride. The aqueous layer was found to contain 0.4M ammonia and the organic layer had 0.012M ammonia. Using your answer in (c) above, determine the formula of a complex ion formed between ammonia and zinc ions.

*(03marks)*

(e) An aqueous solution containing $10.0 gdm^{-3}$ of compound **E** was shaken with $500cm^3$ of ether. Calculate the mass of E that remains in water. ($K_D$ of E between water and ether is 0.0111)          *(03 marks)*

6. A compound Q contains 76.32% carbon, 6.38% hydrogen and the rest being oxygen. A solution of Q in water turns blue litmus paper pink but does not liberate carbon dioxide from carbonates. A solution of 1.50g of Q in 20.90g of benzene freezes at 1.3°C while pure benzene freezes at 5.50°C.

   (a) Determine;

     (i)    the empirical formula of Q.          *(1 ½ marks)*

     (ii)   the molecular formula and write the structural formula of Q. ($K_f$ *of benzene is* $5.49°C$ *per* $1000g\ mol^{-1}$)          *(03 marks)*

   (b) Explain why a solution of Q in water turns blue litmus pink.

*(2 ½ marks)*

   (c) Describe the reaction between Q and bromine water.  *(02 marks)*

   (d) Write equation, indicate conditions and outline mechanism for the reaction between Q and ethanoylchloride.          *(03 marks)*

     (e)    Write equations to show how Q can be;

     (i)    prepared from benzene and propene.          *(03 marks)*

     (ii)   converted to methylcyclohexane.          *(03 marks)*

    (f)    Name a reagent that when separately treated with Q and ethanol;

     (i)      gives a similar observation          *(01 mark)*

     (ii)     can be used to distinguish Q and ethanol          *(01 mark)*

           (In each case, state what would be observed)

7. (a) Define the term **first electron affinity**. (01 mark)

(b) The first electron affinities of group (VII) elements are given below:

| Element | $F$ | $Cl$ | $Br$ | $I$ |
|---|---|---|---|---|
| **Electron affinity** $(KJmol^{-1})$ | -328 | -349 | -325 | -295 |

(i) Explain the trend of first electron affinities of the elements. (03 marks)

(ii) Fluorine differs from the rest of the elements. State **three** other reasons for the anomalous behavior of fluorine. (03 marks)

(c) Describe the reactions of:

(i) fluorine, chlorine and bromine with sodium hydroxide. (06 marks)

(ii) hydrides of group (VII) elements with concentrated sulphuric acid. (04 marks)

(d) A solution containing chlorate(V) ions and dilute sulphuric acid was added to a solution containing iodide ions. Explain what was observed. (03 marks)

8. Explain the following observations

(a) Bromocyclohexane undergoes nucleophilic substitution reaction whereas bromobenzene does not. (05 marks)

(b) The bond dissociation energies of group IV hydrides are in the order $CH_4 > SiH_4 > GeH_4 > PbH_4$. However, their boiling points are in the reverse order. (05 marks)

(c) Oxygen is a gas whereas sulphur is a solid at room temperature. (05 marks)

(d)  When ammonia solution is added to aqueous manganese (II) sulphate, a white precipitate is formed but when ammonia solution is added to manganese (II) sulphate in the presence of ammonium chloride, there is no observable change.     *(05 marks)*

**END**