

P525/2
CHEMISTRY
Paper 2
Oct./Nov. 2022
2 $\frac{1}{2}$ hours.

S.6

THE CHEMISTRY DEPARTMENT

2022

CHEMISTRY

TEST ELEVEN , TERM III, 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:

$$\left[\begin{array}{l} H = 1, \quad C = 12, \quad N = 14, \quad O = 16 \\ 1 \text{ Faraday} = 96500 \text{ Coulombs} \end{array} \right]$$

SECTION A : (60 MARKS)

Answer **three** questions from this section.

1. (a) Define the term **isotopes**. (01 mark)
- (b) One of the factors that affects nuclear stability of isotopes is neutron to proton ratio. State any two other factors. (02 marks)
- (c) Sketch a graph of number of neutrons versus number of protons and on it indicate;
- (i) the line at which $n/p = 1$
 - (ii) the stability region
 - (iii) three points in the unstability region (3 $\frac{1}{2}$ marks)
- (d) Describe briefly how the isotopes in the unstability region in the three points indicated in b(ii) can gain stability. (05 marks)
- (e) Gallium has two isotopes of mass numbers 69 and 71 in the ratio $x:y$. If the relative atomic mass of Gallium is 69.8. Determine the values of x and y . (3 $\frac{1}{2}$ marks)

(f) The table below shows the results of radioactive decay of $^{234}_{91}\text{Pa}$.

Time(seconds)	20	40	60	80	100	120
Mass of $^{234}_{91}\text{Pa}$ (g)	48.2	38.5	31.5	26.0	21.0	17.2

Plot a graph of $\log_{10}(\text{mass})$ against time and use it to determine the:

- (i) initial mass of $^{234}_{91}\text{Pa}$ (01 mark)
- (ii) decay constant of $^{234}_{91}\text{Pa}$ (02 marks)
- (iii) half-life of $^{234}_{91}\text{Pa}$ (02 marks)

2. (a) Define the terms:

- (i) electrolytic conductivity (01 mark)
- (ii) molar conductivity (01 mark)

(b) Conductivity measurement is one of the methods of determining solubility product of a sparingly soluble salt.

- (i) Describe how the method can be used to determine the solubility product of calcium phosphate. (05 marks)

(ii) The electrolytic conductivity of a saturated solution of calcium phosphate at 25°C is $3.1219 \times 10^{-5} \Omega^{-1}cm^{-1}$. The electrolytic conductivity of pure water is $1.519 \times 10^{-6} \Omega^{-1}cm^{-1}$. The molar ionic conductivities of calcium ions and phosphate ions at infinite dilution at 25°C are $119.0 \Omega^{-1}cm^2mol^{-1}$ and $240.0 \Omega^{-1}cm^2mol^{-1}$ respectively. Calculate the solubility product of calcium phosphate at 25°C and state its units. (05 marks)

(c) Explain each of the following observations.

(i) In the conductimetric titration of copper(II) sulphate solution against ammonia solution, the electrolytic conductivity of the mixture decreases to a minimum value and then increases gradually and finally almost levels off with excess ammonia. (04 marks)

(ii) The molar conductivity decreases with increase in concentration for both ethanoic acid and sodium chloride. (04 marks)

3. An organic compound, *P*, on complete combustion yielded 8.8g of carbon dioxide and 1.8g of water. 0.1g of *P* when vapourised at 273°C and 734 mmHg occupied a volume of $4.46 \times 10^{-2}dm^3$.

(a) Calculate:

(i) the empirical formula of *P*. (02 marks)

(ii) molecular formula of *P*. (04 marks)

(b) Write the structure and IUPAC name of *P*. (01 mark)

(c) Discuss the reactions of *P* with:

(i) sulphuric acid

(ii) bromine (08 marks)

(d) When *P* was ozonolysed followed by hydrolysis, compound *Q* was formed. *Q* gave no observable change with Fehlings solution. Write equation and suggest a mechanism for the reaction between *Q* and Brady's reagent. (05 marks)

4. Fluorine, Chlorine, Bromine and Iodine are some of the elements in group VII of the Periodic Table.

(a) Write the outermost electronic configuration of the elements. (01 mark)

(b) Discuss the reactions of the elements with:

(i) water (04 marks)

(ii) sodium hydroxide solution (5 $\frac{1}{2}$ marks)

(iii) sulphurous acid (2 $\frac{1}{2}$ marks)

(c) State what would be observed and write equation for the reaction when chlorine gas was bubbled through the following solutions:

(i) iron(II) chloride solution (2 $\frac{1}{2}$ marks)

(ii) sodium thiosulphate solution (2 $\frac{1}{2}$ marks)

(iii) potassium manganate(VI) solution (2 $\frac{1}{2}$ marks)

SECTION B : (40 MARKS)

Answer any two questions from this section

5. (a) Explain what is meant by the term **enthalpy of displacement**.

(01 mark)

(b) Describe an experiment that can be used to determine the enthalpy of displacement reaction between zinc and copper(II) sulphate. (09 marks)

(c) State what would be observed and write equation for the reaction when:

(i) copper metal is added to silver nitrate solution. (03 marks)

(ii) aluminium metal is added to iron(III) sulphate solution.

(2 $\frac{1}{2}$ marks)

(d) Calculate the Gibbs free energy in (c)(ii) above given that the standard reduction potential of aluminium half cell is $-1.66V$ and that of iron(III) half cell is $+0.77V$. (03 marks)

(e) Write the cell notation for the cell formed by combining the half cells in (d) above. (1 $\frac{1}{2}$ marks)

6. Using equations only, show how the following compounds can be synthesized.

(a) 2,2-dichloropropane from propan-1-ol (04 marks)

(b) Propan-1-ol from 2-bromopropane (04 marks)

(c) ethylamine from propanoic acid (04 marks)

(d) Phenylethanoate from aminobenzene (04 marks)

(e) $CH_3CH=N-OH$ from but-2-ene (04 marks)

7. (a) What is meant by **freezing point constant of a substance?**

(01 mark)

(b) (i) Describe an experiment to determine the molecular mass of naphthalene by freezing point depression method. (Diagram not required) (08 marks)

(ii) State four limitations of the method in (b)(i) above. (02 marks)

(c) The freezing points of solutions of various concentrations of naphthalene at 760 mmHg are shown in the table below.

Concentration ($g(1000g)^{-1}$ of cyclohexane)	10	20	30	40	50	60
Freezing point($^{\circ}C$)	4.93	3.36	1.79	0.22	-1.35	-2.92

(i) Plot a graph of freezing point against concentration. (04 marks)

(ii) Use your graph to determine the freezing point of pure cyclohexane. (01 mark)

(ii) Determine the slope of the graph and use it to determine the relative molecular mass of naphthalene.

(K_f for cyclohexane is $20.1^{\circ}Ckg^{-1}mol^{-1}$)

8. Explain the following observations

- (a) When potassium iodide solution was added to copper(II) sulphate solution, a white precipitate and a brown solution were formed, however when potassium bromide solution was used, there was no observable change. (05 marks)
- (b) When concentrated hydrogen peroxide solution was added to lead(II) sulphide, the black solid turned to a white solid. (03 marks)
- (c) When 60g of urea ($(\text{NH}_2)_2\text{CO}$) and 128g of naphthalene (C_{10}H_8) were separately added to 1000g of ethanol, both solutions boil at the same temperature and pressure. (04 marks)
- (d) When concentrated ammonia solution was added to cobalt(II) chloride solution, a blue precipitate was formed which dissolved in excess ammonia solution to form a pale brown solution. (05 marks)
- (e) Hydrogen chloride gas cannot be used to prepare anhydrous iron(III) chloride. However, hydrogen chloride gas is suitable for the preparation of anhydrous aluminium chloride. (04 marks)

END