

P525/2  
CHEMISTRY  
Paper 2  
(Theory)  
Nov. /Dec. 2024  
2½ hours



UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 2  
(Theory)

2 hours 30 minutes

**INSTRUCTIONS TO CANDIDATES:**

*This paper consists of two Sections; A and B.*

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

*Write the answers in the answer booklet(s) provided. Any additional question(s) answered will **not** be marked.*

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

*Mathematical tables and graph paper are provided.*

*Silent non-programmable scientific electronic calculators may be used.*

*Use equations where necessary to illustrate your answers.*

*Where necessary, use the following:*

$[H = 1; C = 12; O = 16; Ca = 40; I = 127]$

### SECTION A: (60 MARKS)

Answer **three** questions in this section.

Any additional question(s) answered will **not** be marked.

1. (a) A compound **Z** contains 87.8 % of carbon and 12.2 % of hydrogen by mass.
- (i) Calculate the empirical formula of **Z**. (03 marks)
  - (ii) **Z** decolourises bromine -water and has a vapour density of 41. Determine the molecular formula of **Z**. (2½ marks)
- (b) Write the;
- (i) general formula of the homologous series to which **Z** belongs. (01 mark)
  - (ii) names and structural formulae of all possible isomers of **Z**. (03 marks)
- (c) **Z** reacted with ammoniacal silver nitrate to form a white precipitate.
- (i) Identify **Z**. (01 mark)
  - (ii) Write an equation for the reaction of **Z** with ammoniacal silver nitrate. (1½ marks)
  - (iii) Show how **Z** will be synthesized from 1-chlorobutane. (1½ marks)
- (d) Write an equation to show the reaction of **Z** with;
- (i) hydrogen bromide. (01 mark)
  - (ii) hydrogen bromide in the presence of a peroxide. (01 mark)
- (e) Write a mechanism for the reaction in (d)(i). (4½ marks)
2. (a) (i) Explain the principle that enables separation of mixtures by steam distillation. (05 marks)
- (ii) State any **two** advantages of steam distillation. (02 marks)
- (b) When a substance **Q** was steam distilled at 92 °C and a pressure of 101300 Nm<sup>-2</sup>, the distillate contained 65 % of **Q**. Calculate the relative molecular mass of **Q**. (04 marks)  
(Vapour pressure of water at 92 °C is 87000 Nm<sup>-2</sup>)
- (c) When phenol is reacted with a solution of bromine in carbon tetrachloride at 0 °C, a mixture of 2-bromophenol and 4-bromophenol is obtained.
- (i) Explain why a mixture of products is obtained. (04 marks)

- (ii) Describe how the mixture of 2-bromophenol and 4-bromophenol can be separated by steam distillation. (05 marks)  
(Boiling points of 2-bromophenol and 4-bromophenol are 194 °C and 236 °C respectively)

3. Carbon, Silicon, germanium, tin and lead are elements in group(IV) of the Periodic Table. The atomic radii and the melting points of the elements are shown in Table 1.

**Table 1**

Element	Carbon	Silicon	Germanium	Tin	Lead
Atomic radius (nm)	0.077	0.117	0.122	0.140	0.154
Melting point (°C)	3750	1420	950	232	327

- (a) Explain the general trend in the atomic radius and melting point down the group. (5½ marks)
- (b) Discuss the relative stability of the + 2 and + 4 oxidation states of group (IV) elements. (2½ marks)
- (c) Explain the reaction of lead(IV) oxide with;
- (i) hydrochloric acid. (2½ marks)
- (ii) sodium hydroxide. (02 marks)
- (d) Explain what would be observed when tin(II) chloride solution is added to;
- (i) iron(III) sulphate solution. (2½ marks)
- (ii) iodine solution. (2½ marks)
- (iii) acidified potassium manganate(VII) solution. (2½ marks)
4. (a) Explain the meaning of the term **molar conductivity** of an electrolyte. (02 marks)
- (b) Table 2 shows variation of molar conductivity of sodium chloride solution with dilution.

**Table 2**

Dilution ( $\text{cm}^3 \text{mol}^{-1}$ )	Molar conductivity ( $\Omega^{-1} \text{cm}^2 \text{mol}^{-1}$ )
1	93.6
10	106.7
50	116.5
100	118.0
350	122.0
600	123.8
1000	124.0

- (i) Plot a graph of molar conductivity against dilution. (04 marks)
- (ii) Explain the shape of your graph. (4½ marks)



- (iii) From your graph determine the molar conductivity of sodium chloride at infinite dilution. (½ mark)
- (iv) Calculate the degree of dissociation of a 0.01 M sodium chloride solution. (03 marks)

(The electrolytic conductivity of sodium chloride is  $1.18 \times 10^{-3} \Omega^{-1} \text{cm}^{-1}$ )

- (c) Explain the effect of increasing temperature on the degree of dissociation and molar conductivity of;
  - (i) strong electrolytes. (02 marks)
  - (ii) weak electrolytes. (04 marks)

### SECTION B:(40 MARKS)

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

Any additional question(s) answered will **not** be marked.

5. (a) State;
    - (i) what is meant by the term solubility product. (01 mark)
    - (ii) how temperature affects the value of solubility product. (02 marks)
    - (iii) two applications of solubility product. (01 mark)
  - (b) Describe how the solubility product of calcium iodate(V) in water at 25 °C can be determined. (07 marks)
  - (c) The solubility of anhydrous calcium iodate(V) in water at 25 °C is 3.08 gdm<sup>-3</sup>. Calculate the;
    - (i) solubility product of calcium iodate(V) in water at 25°C. (3½ marks)
    - (ii) solubility in moldm<sup>-3</sup> of calcium iodate(V) in an aqueous solution of a 0.1 M sodium iodate. (2½ marks)
  - (d) Explain what would happen to the solubility of calcium iodate(V) when acidified potassium iodide solution is added to a saturated solution of calcium iodate(V). (03 marks)
6. Describe the reaction of each of the pairs of compounds and in each case, write a mechanism for the reaction.
    - (a) 2-chloropropane with sodium hydroxide. (07 marks)
    - (b) Benzene with chloroethane. (04 marks)

- (c) 2-methylpropene with bromine in tetrachloromethane. (03 marks)
- (d) Propanone with 2,4-dinitrophenylhydrazine. (06 marks)
7. (a) Describe how nitric acid is prepared on industrial scale. (06 marks)  
(Your answer should include equation(s) for the reaction(s) that take(s) place)
- (b) Explain why a freshly prepared nitric acid is a colourless liquid but appears yellow on standing. (02 marks)
- (c) Describe the reactions of nitric acid with;
- (i) zinc. (02 marks)
- (ii) tin. (02 marks)
- (iii) sulphur. (02 marks)
- (Your answer should include equations where applicable)
- (d) Explain what would be observed if concentrated nitric acid was added to;
- (i) iron(II) sulphate solution. (03 marks)
- (ii) copper and the mixture warmed. (03 marks)
8. Explain the following observations and illustrate your answer with equations where necessary.
- (a) The basic strength of amines in water is in the order;  
secondary > primary > tertiary. (2½ marks)
- (b) The decomposition temperatures of carbonates of group(II) elements increases down the group. (03 marks)
- (c) When sodium chloride solution was added to lead(II) nitrate solution, a white precipitate was formed. The precipitate dissolved to form a colourless solution on addition of excess concentrated hydrochloric acid. (04 marks)
- (d) In the titration of ammonia solution with dilute sulphuric acid, methyl orange (pH range 3-5) is used as the indicator, but not phenolphthalein (pH range 8-10). (04 marks)
- (e) The boiling points of alcohols are higher than those of amines of similar molecular masses. (03 marks)
- (f) When ammonia solution was added dropwise until in excess to nickel(II) ions, a green precipitate formed, soluble in excess to form a blue solution. (3½ marks)