

P525/2
CHEMISTRY
Paper 2
July./Aug. 2022
2 $\frac{1}{2}$ hours.

S.5



THE CHEMISTRY DEPARTMENT

2022

CHEMISTRY

END OF TERM II, Paper 2

2 hours 30 minutes

INSTRUCTIONS:

Attempt only 3 questions in section A and only 2 questions in 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.

SECTION A : (60 MARKS)

Answer **three** questions from this section.

1. When 20cm^3 of a gaseous alkyne **P**, C_nH_{2n-2} , was exploded with 135cm^3 of excess oxygen and on cooling to room temperature, the residual gas occupied a volume of 105cm^3 . When the residual gas was passed through concentrated sodium hydroxide solution, the volume decreased by 80cm^3 .
- (a)(i) Write the equation for combustion of **P**. (1 $\frac{1}{2}$ marks)
- (ii) Determine the molecular formula of **P**. (3 $\frac{1}{2}$ marks)
- (b) Write the structural formulae and names of possible isomers of **P**. (03 marks)
- (c)**P** reacts with sodium metal in presence of liquid ammonia to form compound **Q**. Identify;
- (i) **P** (01 mark)
- (ii) **Q**. (01 mark)
- (d) **P** was bubbled through ammoniacal silver nitrate solution.
- (i) State what was observed ($\frac{1}{2}$ mark)
- (ii) Write equation for the reaction (01 mark)
- (e)Write equation and suggest a mechanism for the reaction between;
- (i) **P** and a solution of bromine in tetrachloromethane (3 $\frac{1}{2}$ marks)
- (ii) **Q** and 1-bromopropane (02 marks)
- (f)With the aid of an equation, describe how **P** reacts with water. (03 marks)

2. Some of the elements of group (II) of the periodic table are beryllium, magnesium, calcium, strontium and barium.

(a) Write a general outermost electron configuration for the elements (01 mark)

(b) The table below shows the variation in first ionisation energy and melting points of group II elements.

Element	Be	Mg	Ca	Sr	Ba
Atomic number	4	12	20	38	56
First ionization energy(kJmol^{-1})	899	738	589	549	502
Melting point(K)	1553	923	1123	1043	993

(i) On the same axes, plot graphs of first ionization energy and melting points of the elements against atomic number. (06 marks)

(ii) Explain the shapes of each of the graphs in (b)(i) above. (09 marks)

(c) Beryllium, although in group II exhibits some chemical properties similar to an element in period 3 of the periodic table. Name the element with which Beryllium has similar chemical properties and write ionic equations for the reactions of Beryllium and the element you have named with sodium hydroxide. (04 marks)

3. (a) (i) Explain what is meant by the term **lattice energy**

(02 marks)

(ii) State **two** factors that affect the magnitude of lattice energy

(02 marks)

(iii) Describe how the factors you have stated in a(ii) above affect lattice energy (04 marks)

(b) (i) Draw and label carefully a Born-Haber cycle for the formation of calcium oxide from its elements. (04 marks)

(ii) Use the data below to calculate the value of the lattice energies of calcium oxide and iron (II) oxide. (06 marks)

		$\Delta H^\theta \text{ (kJmol}^{-1}\text{)}$
Standard enthalpy change of formation	Calcium oxide	- 635
	Iron(II) oxide	-278
Standard enthalpy change of atomisation	Calcium	+178
	Iron	+ 416
Standard molar 1 st + 2 nd ionisation energies	Calcium	+1735
	Iron	+230
Standard molar 1 st + 2 nd electron affinities	Oxygen	+657

- (iii) Compare the stability of calcium oxide and iron(II) oxide and give a reason for your answer. (02 marks)

4. (a) Define the terms;

(i) **Relative atomic mass** (02 marks)

(ii) **Relative abundance** (02 marks)

(b) Briefly describe how the relative atomic mass of an element is determined by spectrometry with aid of a well labeled diagram. (10 marks)

(c) The mass spectrum of element Y shows four peaks of heights in ratio 2.1 : 4 : 2.2 : 1.6 with isotopic masses 10.692, 11.291, 10.928 and 12.029 a.m.u respectively. Determine the;

(i) relative abundances of the isotopes of Y. (04 marks)

(ii) relative atomic mass of Y. (02 marks)

SECTION B : (40 MARKS)

Answer any two questions from this section

5. (a) Heptane (C_7H_{16}) and octane (C_8H_{18}) form an ideal solution. Heptane has a lower boiling point than octane

(i) State the reasons why heptane boils at a lower temperature than octane. (01 mark)

(ii) Explain what is meant by the term 'ideal solution' (02 marks)

(iii) State **Raoult's** law (01 mark)

- (iv) Calculate the vapour pressure of a solution containing 49.8g of heptane and 33.2g of octane. The vapour pressures of heptane and octane are 473.2Pa and 139.8Pa respectively.

(06 marks)

- (b) Compound X (**boiling point 370°C**) and compound Y (**boiling point 400°C**) form an ideal solution.

- (i) Sketch a well labelled boiling point-composition diagram for the mixture. (3 $\frac{1}{2}$ marks)

- (ii) Using the diagram, describe and explain how pure Y can be obtained from a mixture containing 50% compound Y.

(4 $\frac{1}{2}$ marks)

- (iii) Sketch a well labeled vapour pressure-composition diagram for a solution of compounds X and Y. (02 marks)

6. Explain the following observations

- (a) Carbonic acid (H_2CO_3) and sulphurous acid (H_2SO_3) are both weak acids but their molecules exhibit different bond angles.

(04 marks)

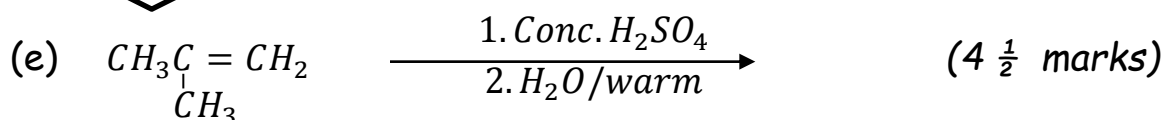
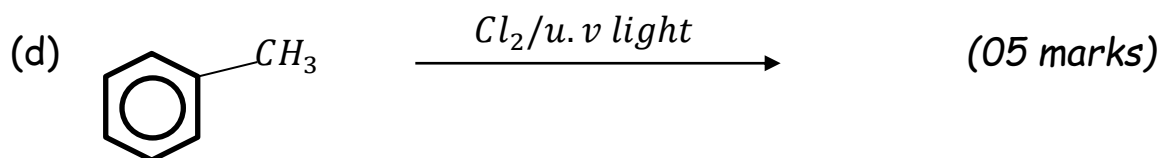
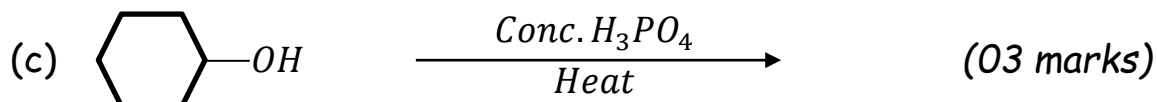
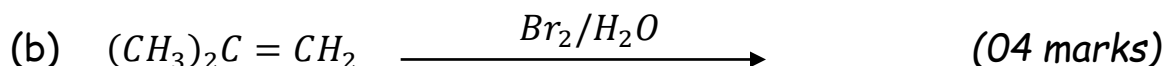
- (b) When an aqueous solution of sodium hydrogencarbonate is added to aluminium chloride solution, a white precipitate and bubbles of a colourless gas are observed. (05 marks)

- (c) The melting point of aluminium chloride is lower than that of aluminium fluoride. (04 marks)

- (d) The melting point of sulphur dioxide is much lower than that of silicon(IV) oxide. (03 marks)

- (e) Both 2-nitrophenol and 4-nitrophenol exhibit hydrogen bonding and yet the boiling points of the two compounds differ greatly. (04 marks)

7. Complete the following equations and in each case outline a mechanism for the reaction.



8. (a) (i) Describe the industrial manufacture of nitric acid starting from nitrogen and hydrogen as raw materials. (10 marks)

(ii) State **two** uses of nitric acid. (01 mark)

(b) State the conditions and write equations for the reaction(s) of nitric acid and:

(i) magnesium (04 marks)

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

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

END