

P525/2
CHEMISTRY
Paper 2

April./May. 2021

2 $\frac{1}{2}$ hours.

S.5

THE CHEMISTRY DEPARTMENT

TEST ONE- 2021

CHEMISTRY

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.

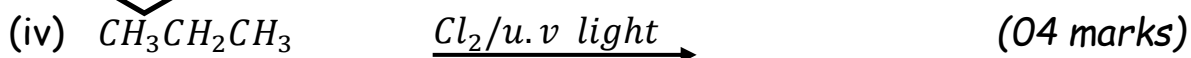
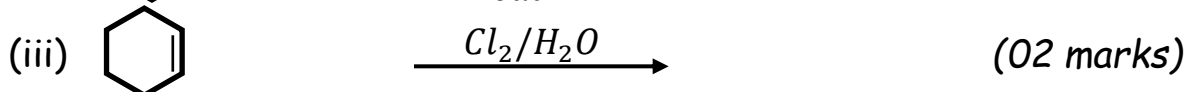
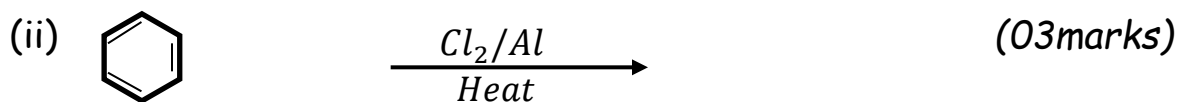
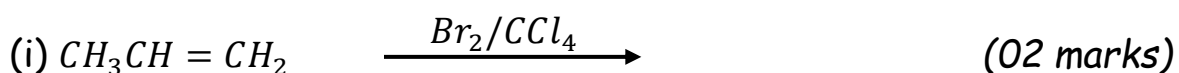
Where necessary, use the following:

[H=1 ; C=12 ; O=16 ; S=32].

SECTION A : (60 MARKS)

Answer **three** questions from this section.

1. (a) (i) What is **structural isomerism**? (01 mark)
- (ii) Describe the three types of structural isomerism giving a suitable example in each case. (08 marks)
- (b) Complete the following equations and in each case outline a mechanism for the reaction.



2. (a) Define the term **relative atomic mass**. (01 mark)

(b) (i) Briefly describe how the relative atomic mass of an element can be determined using a mass spectrometer. (No diagram required)

(08 marks)

(ii) Copper has a relative atomic mass of 63.55 and consists of two isotopes ^{63}Cu and ^{65}Cu . Determine the percentage composition of the two isotopes in the naturally occurring copper. (03 marks)

(iii) When chlorine gas was analysed in a mass spectrometer, peaks were recorded at mass numbers 70, 72 and 74. Explain this observation. ($2\frac{1}{2}$ marks)

(iv) State **one** advantage of using a mass spectrometer in the determination of relative atomic masses. (01 mark)

(a) The first, second, third and fourth ionisation energies of Y are 738, 1451, 7743 and 10541 respectively.

(i) Write equation to show the second ionisation of element Y.
(01 mark)

(ii) State and explain the trend in the ionisation energies of element Y.
(3 $\frac{1}{2}$ marks)

3. The lowering in vapour pressure of a volatile solvent is a colligative property.

(a)(i) Define the term **colligative property**. (01 mark)

(ii) State **three** other examples of colligative properties. (03 marks)

(b) The vapour pressure of carbon disulphide at a certain temperature is 400 mmHg. At the same temperature, a solution of 5g of sulphur in 63 cm³ of carbon disulphide has a vapour pressure of 392.58 mmHg. If the density of carbon disulphide at this temperature is 1.27 gcm⁻³.

(i) Calculate the relative molecular mass of sulphur. (03 marks)

(ii) Deduce the molecular formula of sulphur in carbon disulphide.
(01 mark)

(iii) State and explain the effect of increasing the concentration of sulphur on the boiling point of carbon disulphide. (03 marks)

(b) The vapour pressure of different solutions of solute Y dissolved in solvent X at 40°C are shown in the table below.

Concentration of Y (mol dm ⁻³)	0.00	0.10	0.20	0.30	0.40	0.50
Vapour pressure of solution (kNm ⁻²)	16.000	15.971	15.942	15.914	15.880	15.860

(i) Plot a graph of lowering in vapour pressure (ΔP) against concentration of Y.
(04 marks)

- (ii) Use your graph in b(i) above to determine the relative molecular mass of solvent X if its density is 1.0gcm^{-3} .

(04 marks)

- (iii) State **two** assumptions made in b(ii) above. (01 mark)

4. (a) Distinguish between **first ionisation energy** and **first electron affinity**. (02 marks)

(b) State and explain how the following factors affect first ionisation energy and first electron affinity.

(i) nuclear charge (04 marks)

(ii) screening effect (04 marks)

(c) The first electron affinity of sodium is -71kJmol^{-1} while the first electron affinity of magnesium is $+50\text{kJmol}^{-1}$. Explain. (04 marks)

(c) The table below shows the successive ionisation energies of elements R and Q.

Element	Successive ionisation energies(kJmol^{-1})							
	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th
R	736	1450	7740	10500	13600	18000	21700	25600
Q	1060	1900	2920	496	6280	21200	25900	30500

(i) State the group in the Periodic Table to which R and Q belong. (01 mark)

(ii) Write the equation for the reaction between:

• R and oxygen (1 $\frac{1}{2}$ marks)

• Q and chlorine (1 $\frac{1}{2}$ marks)

(iii) Write equation for the reaction between the chloride of Q and water. (1 $\frac{1}{2}$ marks)

SECTION B : (40 MARKS)

Answer any **two** questions from this section

5. Explain the following observations.

(a) Aluminium chloride dissolves in methylbenzene whereas sodium chloride does not. (04 marks)

(b) When acidified potassium manganate(VII) solution is added to aqueous potassium iodide, the purple solution turned brown. (04 marks)

(c) When lead(IV) oxide is warmed with concentrated hydrochloric acid, effervescence of a greenish yellow gas occurs. (04 marks)

(d) The atomic radius of the group IIA metals increases down the group. (04 marks)

(e) Propan-1-ol is a liquid at room temperature whereas propene is a gas at the same temperature (04 marks)

6. When 142cm^3 of a hydrocarbon Y, of formula, C_aH_b and molecular mass 58g was exploded with excess oxygen and cooled to room temperature, the volume of the residual gas was 694cm^3 . On treatment with concentrated potassium hydroxide solution, the volume decreased to 126cm^3 .

(a) (i) Write the equation for combustion of Y. (1 $\frac{1}{2}$ marks)

(ii) Determine the molecular formula of Y. (03 marks)

(b) (i) Write the structural formulae and names of possible isomers of Y. (04 marks)

(ii) Predict and compare the boiling points of the two isomers in b(i) above. (01 mark)

(iii) Explain your answer in b(ii) above. (3 $\frac{1}{2}$ marks)

(c) Y, when heated at 80°C with dibenzoyl peroxide and sulphuryl chloride, formed 1-chlorobutane. Identify Y. (01 mark)

(d) Write equation(s), indicating conditions, for the conversion of:

(i) 1-chlorobutane to butan-2-ol (04 marks)

(ii) Butan-2-ol to $CH_3CHBrCHOHCH_3$ (02 marks)

7. (a) Name the structures exhibited by each of the following compounds:

(i) Calcium fluoride (01 mark)

(ii) Silicon(IV) oxide (01 mark)

(iii) Carbon dioxide (01 mark)

(b) Explain why:

(i) Carbon dioxide is a gas at room temperature whereas silicon(IV) oxide is a solid at the same temperature.

(03 marks)

(ii) Potassium chloride is insoluble in ethanol but very soluble in water.

(04 marks)

(iii) 2, 2-dimethyl propane boils at a lower temperature than n-pentane yet both are of the same molecular weight.

(04 marks)

(c) State and briefly explain any **two** factors that in each case determine the strength of a:

(i) Covalent bond (03 marks)

(ii) Metallic bond. (03 marks)

8. Magnesium, Aluminium, Phosphorus and chlorine are elements of Period 3 of the Periodic Table. Their atomic numbers and melting points are given in the table below.

Element	Atomic number	Melting point(°C)
Magnesium	12	649
Aluminium	13	661
Phosphorus	15	44
Chlorine	17	-101

(b) Explain the trend in melting point of the elements. (06 marks)

(c) Discuss the reactivity of the elements with;

(i) Water (08 marks)

(ii) Sodium hydroxide (06 marks)

END