TR. FELIX JS RUBANGAKENE GEOFREY JR.

NAME MARKING GUIDE | RUBTFW | COMBINATION S.5

P525/1
CHEMISTRY
Paper 1
Nov. 2022
2Hrs:45 MINS

S.5 EOT3-UACE EXAMS

For Examiner's Use Only	
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UGANDA ADVANCED CERTIFICATE OF EDUCATION
END OF TERM III EXAMINATION –, 2022
CHEMISTRY
Paper 1
(Principal Subject)

DURATION: 2 hours 45 minutes

INSTRUCTIONS TO CANDIDATES:

- ✓ This paper consists of two **sections A and B, Section A** is compulsory and attempt **only six** questions from **Section B.** *Any additional question(s) answered will **not** be marked.*
- ✓ Incorrect symbols, formulae and spellings of especially technical terms will lead to loss of marks. And **good hand writing** is **paramount** please Boys.
- ✓ The **periodic table**, with **relative atomic masses**, is **attached at the end** of the paper.
- ✓ Illustrate your answers with **equations where applicable**, ***Non-programmable scientific** calculators may be used.*
- ✓ **Assume where necessary, use the following values.**
  - — **Molar gas constant, R** = **8.314 JK^{-1} mol^{-1}.**
  - — **Molar volume of gas at S.t.p** = **22.4 litres.**
  - — **Standard temperature, T** = **273k.**
  - — **Standard pressure, P** = **101325Nm^{-2}.**

This paper consists of 21 pages. You should check the question paper to ensure that all pages are printed as indicated and no questions are missing.

SECTION A–46 MARKS
ATTEMPT ALL QUESTIONS IN THIS SECTION.

1. (a) Complete the following equations for nuclear reactions. (@01 mark)

(i) $^{239}_{94}Pu + {}^{4}_{2}He \longrightarrow {}^{216}_{83}Bi + {}^{27}_{13}Al$ ✓

(ii) $^{238}_{92}U$ ✓ $\longrightarrow {}^{234}_{90}Th + \alpha$

(iii) $^{214}_{83}Bi \longrightarrow {}^{206}_{82}Pb + {}^{0}_{-1}\beta$ ✓ $+ 2{}^{4}_{2}He$

(iv) $^{250}_{98}Cf + {}^{11}_{5}B$ ✓ $\longrightarrow {}^{257}_{103}Lw + 4{}^{1}_{0}n$ 04

b) Francium isotope $^{223}_{87}Fr$ emits beta particles at a rate of **14.0 counts per second**. The rate of emission decreased by **6.5 counts per second** in **80 seconds**. Calculate the **half-life** of the isotope. (02 marks)

OR:

$N_t = N_0 e^{-kt}$

$\frac{N_t}{N_0} = e^{-kt}$

$\frac{14.0-6.5}{14.0} = e^{-(80k)}$ ✓

$k = 7.80 \times 10^{-3} s^{-1}$ ✓

$\ln\left[\frac{N_t}{N_0}\right] = -kt$ or $\ln\left[\frac{N_0}{N_t}\right] = kt \Leftrightarrow \ln\left[\frac{14.0}{14.0-6.5}\right] = k \times 80$ ✓

$\ln[1.8667] = 80k \Leftrightarrow k = 0.624154309/80$

$k = 7.80 \times 10^{-3} s^{-1}$. ✓

$t_{0.5} = \frac{\ln 2}{k}$ ✓ $\Leftrightarrow t_{0.5} = \frac{0.693147\,18}{7.80 \times 10^{-3}} = \frac{0.693147\,18 \times 10^{3}}{7.80}$

$t_{0.5} = 88.9 s$. ✓ 02

2. Explain the following observations.

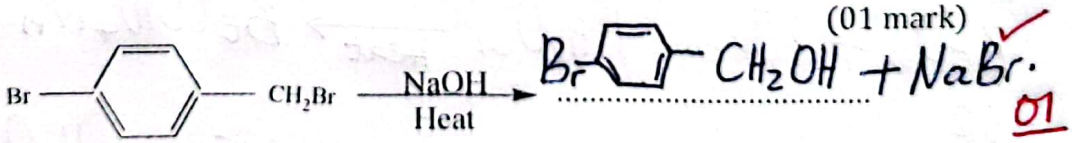
a. Magnesium carbonate decomposes when **strongly heated** while sodium carbonate does not. (03 marks)

Sodium, Na^+ ion has a larger ionic radius and smaller charge than Magnesium, Mg^{2+} ion. Therefore; Sodium, Na^+ ion has lower charge density; lower polarising power than Magnesium, Mg^{2+} ion. Hence sodium carbonate is more strongly ionic than magnesium carbonate. 03

b. 1-bromohexane undergoes nucleophilic substitution whereas bromobenzene does not. (04 marks)

In 1-bromohexane; the bonded pair of electron in the C–Br bond is more displaced towards the bromine atom since it more electronegative than carbon atom. The C–Br bond is polar with carbon and bromine atoms being partially +vely (positively) and –vely (negatively) charged. The C–Br bond becomes weaker since the electrons aren't equally or uniformly distributed.

3. (a). An **organic compound X** reacts with hot aqueous sodium hydroxide solution to give **compound W**. complete the **equation of reaction**. (01 mark)



01

Hence; when the hydroxyl group [Nucleophile] from sodium hydroxide solution attacks the carbon atom with partial positive charge; Bromine atom takes or breaks off.

The C-Br bond in bromobenzene is strong because the lone pair of electrons on bromine atom interacts with the delocalised pie or π-electron within the benzene ring hence forming a partial double bonds between the Carbon and bromine atoms. Therefore; The nucleophile or hydroxyl group can't displaced the bromine atom of the bromobenzene under reflux.

04

(b).Name the **type of reaction mechanism** for the reaction of **X** with hot aqueous sodium hydroxide solution. (0½ mark)

Nucleophic substitution bimolecular reaction mechanism. 0½

(c).Explain why **W still contains one bromine atom**. (02½ marks)

The bromine atom is bonded directly to the benzene ring and it's difficult to be displaced by the hydroxyl, OH^- ion under reflux, since the lone pair of electrons on the bromine atom interacts with the delocalised pie or π-electron of the ⬡ ring forming a partial double bonds between the carbon and bromine atom. The C–Br bond is strengthened hence bromine atom is strongly bonded to the ring. 02½

4. Write equations for the reaction of the following oxides with sodium hydroxide. (@01½ marks)

(a) Aluminium (III) oxide.

$Al_2O_{3(s)} + 2NaOH_{(aq)} + 3H_2O_{(l)} \xrightarrow{Heat} 2NaAl(OH)_{4\,(aq)}$

OR

(b) Beryllium oxide 03

$BeO_{(s)} + 2NaOH_{(aq)} \xrightarrow{Heat} Na_2BeO_{2\,(aq)} + H_2O_{(l)}$

OR

5. Draw the **structures** and name the **shapes** of the following molecules or ions. (04½ marks)

$Al_2O_{3(s)} + 6NaOH_{(aq)} + 3H_2O_{(l)} \xrightarrow{Heat} Na_3Al(OH)_{6\,(aq)}$ ✓✓

OR

$Al_2O_{3(s)} + 2NaOH_{(aq)} \xrightarrow{Heat} 2NaAlO_{2\,(aq)} + 3H_2O_{(l)}$ ✓✓

OR

$Al_2O_{3(s)} + 2\bar{O}H_{(aq)} + 3H_2O_{(l)} \xrightarrow{Heat} 2Al(OH)_4^-{}_{(aq)}$ ✓✓

OR

$Al_2O_{3(s)} + 6\bar{O}H_{(aq)} + 3H_2O_{(l)} \xrightarrow{Heat} 2Al(OH)_6^{3-}{}_{(aq)}$ ✓✓

OR

$Al_2O_{3(s)} + 2\bar{O}H_{(aq)} \xrightarrow{Heat} 2AlO_2^-{}_{(aq)} + H_2O_{(l)}$ ✓✓

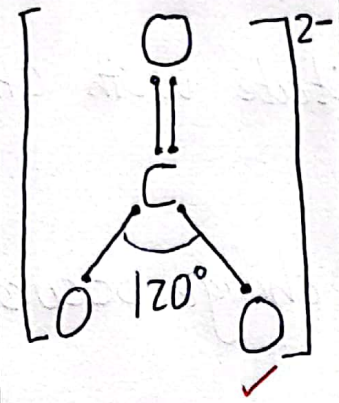
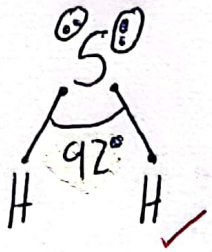
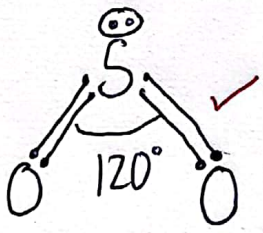
$BeO_{(s)} + 2NaOH_{(aq)} + H_2O_{(l)} \xrightarrow{Heat} Na_2Be(OH)_{4\,(aq)}$ ✓✓

OR

$BeO_{(s)} + 2\bar{O}H_{(aq)} + H_2O_{(l)} \xrightarrow{Heat} Be(OH)_4^-{}_{(aq)}$ ✓✓

OR

$BeO_{(s)} + 2\bar{O}H_{(aq)} \xrightarrow{Heat} BeO_2^{2-}{}_{(aq)} + H_2O_{(l)}$ ✓✓

Molecules/ions	Structure	shape
CO_3^{2-}		Trigonal planar ✓
H_2S		V-shaped ✓
SO_2		Bent or V-shaped ✓

04½

6. Name a **reagent** that can be used to **distinguish** between the following pairs of compounds and in each case, **state what would be observed** if each member of the pair was treated with the named reagent.

a) $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}}\, C \equiv C\, CH_3$ and $CH_3CH_2\, \underset{\displaystyle CH_3}{\underset{|}{CH}}\, C \equiv CH$

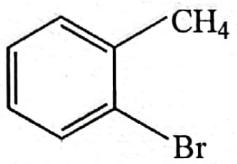
Reagent (01 mark)

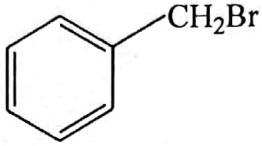
[Copper (I) chloride solution in ammonia solution]

Ammoniacal copper (I) chloride solution. ✓

Observations (02 marks)

- Red precipitate with $CH_3CH_2\underset{CH_3}{CH}C\equiv CH$. ✓
- No observable ✓ change occurs with

b) 

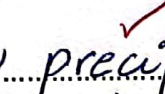
and 

$CH_3CH(CH_3)-C\equiv C-CH_3$ 03

Reagent (01 mark)

Hot sodium hydroxide solution, dilute nitric acid and silver nitrate solution. ✓

Observations (02 marks)

Yellow ✓ precipitate with  .

No observable ✓ change occurs with  .

03

7. (a). State:
   (i) Raoult's law. (01 mark)

Raoult's law states that the relative lowering of the vapour pressure is equal to the mole fraction of solute. ✓

OR

Raoult's law states that the partial pressure of any volatile component of solution is equal to the mole fraction of that component multiplied by vapour pressure of pure component. ✓ 01

OR

Ammoniacal silver nitrate solution [Silver nitrate solution in ammonia solution or Tollen's reagent]

White precipitate with $CH_3CH_2\underset{\displaystyle CH_3}{\underset{|}{C}}H\,C\equiv CH$.

No observable change occurs with $CH_3\underset{\displaystyle CH_3}{\underset{|}{C}}H-C\equiv C-CH_3$.

03

(ii) **Two conditions** under which the law is **valid**. (01 mark)

Liquid must be miscible. ✓
Liquid must be valotile. ✓
Liquid should not associate or dissociate. ✓
Liquid should not react with one another. ✓ 01

(b) The vapour pressure of heptane and octane are **472.2Pa** and **139.8Pa** respectively at a temperature of **20°C**.Calculate the:

(i) The vapour pressure of the mixtures containing **0.50 moles** of heptane and **0.25 moles** of octane at a temperature of **20°C**.[Assuming the two solutions forms an ideal solution] (02 marks)

Total moles $= 0.50 + 0.25 = 0.75$ moles. ✓

$\therefore P_{C_7H_{16}} = X_{C_7H_{16}} \cdot P^o_{C_7H_{16}} \Leftrightarrow P_{C_7H_{16}} = \frac{0.50}{0.75} \times 472.2 = 314.8\,Pa.$ ✓

$P_{C_8H_{18}} = X_{C_8H_{18}} \cdot P^o_{C_8H_{18}} \Leftrightarrow P_{C_8H_{18}} = \frac{0.25}{0.75} \times 139.8 = 46.6\,Pa.$ ✓

$P_T = P_{C_7H_{16}} + P_{C_8H_{18}} \Leftrightarrow P_T = 314.8 + 46.6 = 361.4\,Pa.$ ✓ 02

(ii) Vapour composition. (01 mark)

%age Vapour composition of $C_7H_{16} = \frac{314.8}{361.4} \times 100 = 87.12$. ✓

%age Vapour composition of $C_8H_{18} = \frac{46.6}{361.4} \times 100 = 12.89$. ✓ 01

Diagonal relationship is the similarity in chemical properties between elements in period two to their diagonal neighbors in period III and adjacent groups. ✓ 01

8. (a) State what is meant by the term **diagonal relationship?** (01 mark)

Are elements adjacent to one another and right angle to each other in the periodic table having similar chemical properties. ✓ 01

(b) State **three reasons** why lithium and magnesium resemble. (01½ marks)

They both have almost similar atomic radii. ✓
They both have similar electronegativity. ✓
Their ions have similar polarising power. ✓
They both have almost similar standard electrode. ✓ 01½

(c) Mention **three properties** to show the diagonal relationship between lithium and magnesium. (03 marks)

Both form nitrides when heated in air. ✓
Both form normal oxides when burnt in air. ✓
Their halides are soluble in organic solvents and ✓
Both reacts with carbon to form ionic carbides. ✓ 03
Their hydroxides are weak bases. ✓
Their phosphates, flourides and carbonates are sparingly or slightly soluble or insoluble in water. ✓
Their hydroxides, carbonates and nitrates decompose on heating easily. ✓

9. Complete the following reaction equations and write the accepted mechanism.

a) $CH_3C{\equiv}CH \xrightarrow[Hg^{2+}\,60^{\circ}C]{H_2O/H^+} CH_3-\overset{O}{\overset{\|}{C}}-CH_3$ (03 marks)

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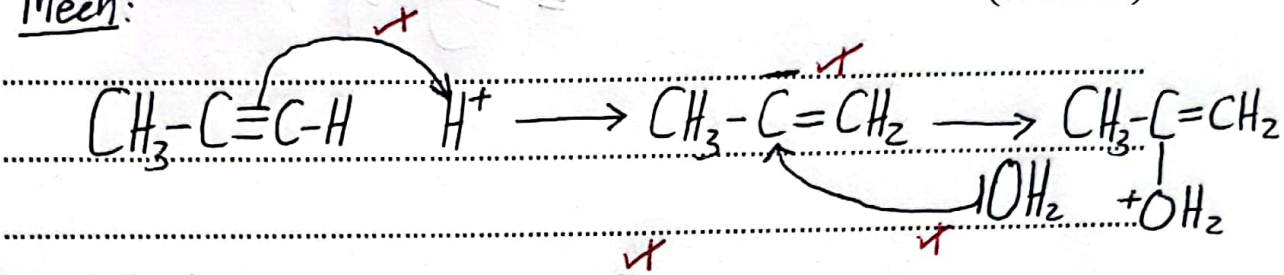
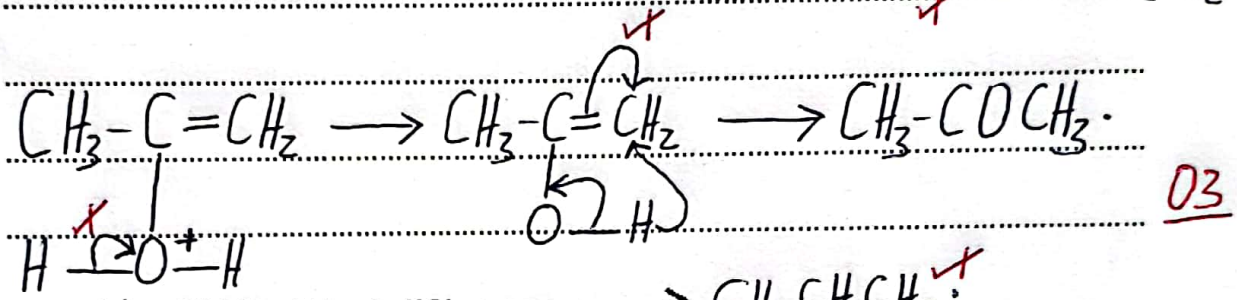
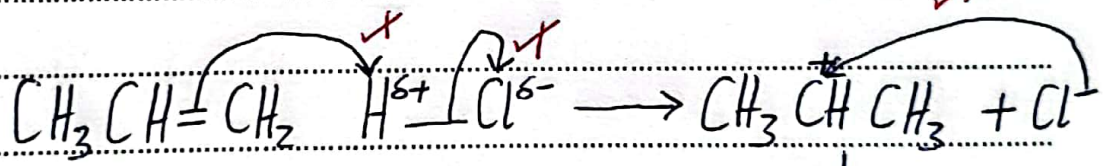


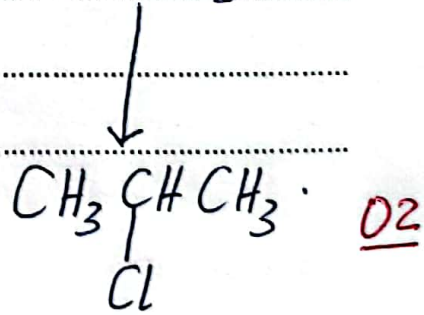


03

b) $CH_3CH=CH_2 + HCl \longrightarrow CH_3\underset{Cl}{C}HCH_3$ (02 marks)

Mech:





02

SECTION B–54 MARKS

ATTEMPT ANY SIX QUESTIONS IN THIS SECTION.

10. (a) Define the term solvent extraction. (01 mark)

Solvent extraction is the removal of solute from one solvent to another solvent in which it's more soluble. both solvents being immiscible to each other or in contact with one another. ✓ 01

(b) An aqueous solution contains **10.0g** of hydroxybenzene per litre.When **100.0cm³** of this solution is shaken with **20.0cm³** of ether, the layer extracts **0.8g** of hydroxybenzene.Calculate the mass of hydroxybenzene extracted when **500.0cm³** of aqueous layer was shaken with **50.0cm³** of ether. (03 marks)

$1000cm^3$ of water contains 10g of phenol. ✓

$100cm^3$ " " " $\left[\frac{10 \times 100}{1,000}\right]g$ " " $\triangleq$ 1g of  ✓

Mass of hydroxybenzene left in Water = 1.0 − 0.8 $\triangleq$ 0.2g. ✓

$\therefore$

$K_D = \frac{[\text{phenol}]_{ether}}{[\text{phenol}]_{water}} \Leftrightarrow K_D = \frac{0.8}{20} \times \frac{100}{0.2} \Leftrightarrow K_D = 20$ ✓

Mass extracted by $50cm^3$ of ether = x(g). ✓

" of left in aqueous Layer = (5 − x)g. ✓

→ Using that formula.

(c) State any two other application of the partition law. (02 marks)

$20 = \frac{x}{50} \times \frac{500}{5-x} \Leftrightarrow 20 = \frac{500x}{250-50x}$

$20[250-50x] = 500x \Leftrightarrow 5,000 - 1,000x = 500x$

$1,500x = 5,000 \Leftrightarrow x = 3.33g$ ✓ 03½

$1{,}000\,cm^3$ of water contains 10g of phenol.

$500\,cm^3$ " " " $\frac{500\,cm^3 \times 10g}{1{,}000\,cm^3}$ of phenol.

$= 5g$ of phenol.

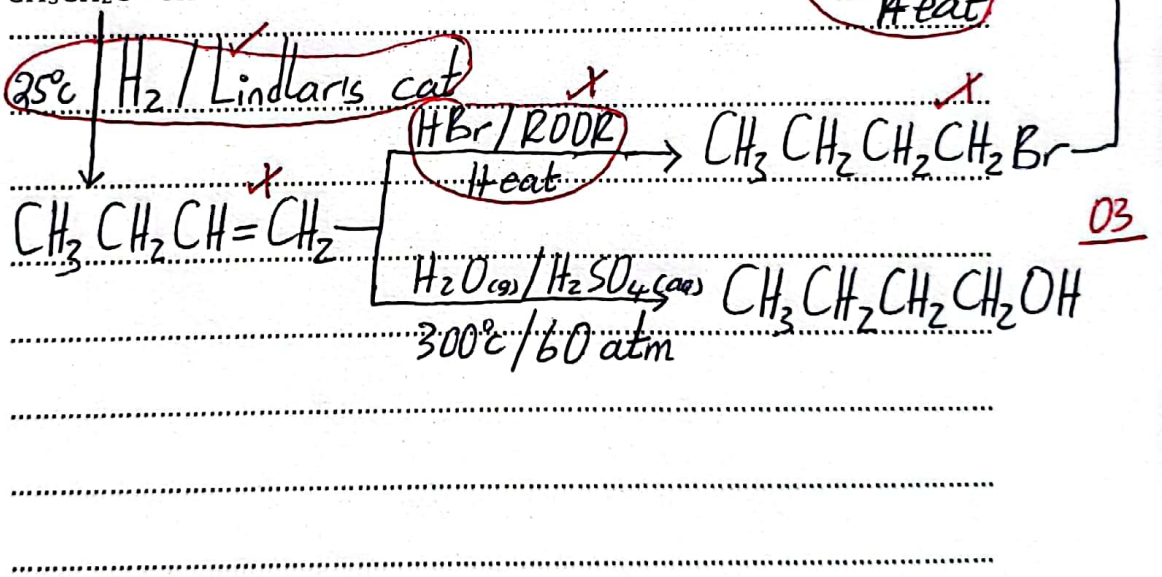
- Determination of solubility of solutes. ✓
- Determination of equilibrium constants. ✓
- solvent extraction. ✓ - purification of organic cpds. ✓
- Ion exchange / Chromatography ✓
- Determining the formula of a complex / Co-ordination number of the central metal ion in a complex. ✓ 02

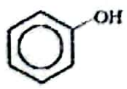
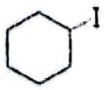
(d) State three limitations of distribution law. (03 marks)

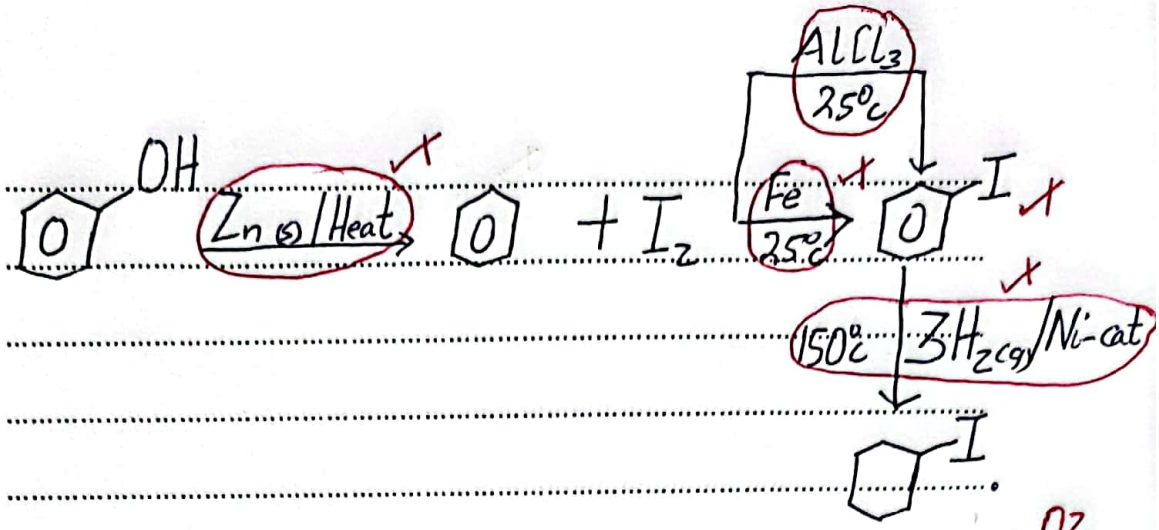
- The solute and solvents should not reacts with @ other. ✓
- The solute shidn't dissociates or associates in any of the solvents. ✓
- The solvents must be immiscible and shidn't reacts with @ others. ✓
- The solutions of the solute in the solvents must be dilute. ✓
- The solute must remains in the same molecular state ✓
- The tempᵉ must remains constant since change in tempᵉ alters the solubility of solute in the solvents. ✓ 03

11. Write equations to show how the following compounds can be synthesized and in each case, indicate the conditions for the reaction.

a) $CH_3CH_2C{\equiv}CH$ to $CH_3CH_2CH_2CH_2OH$



b)  to  (02 marks)



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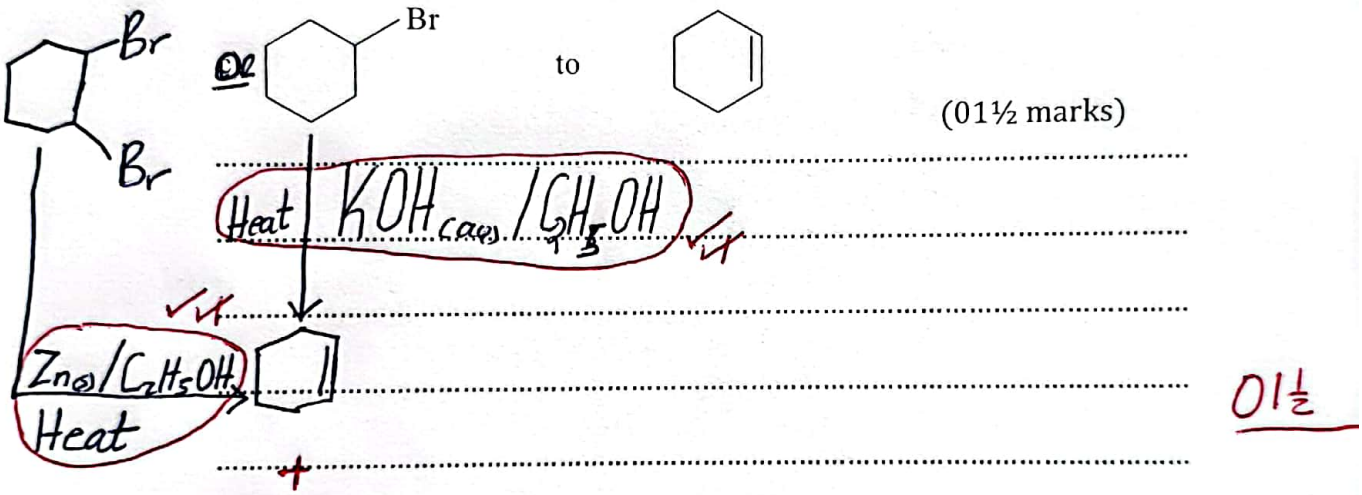
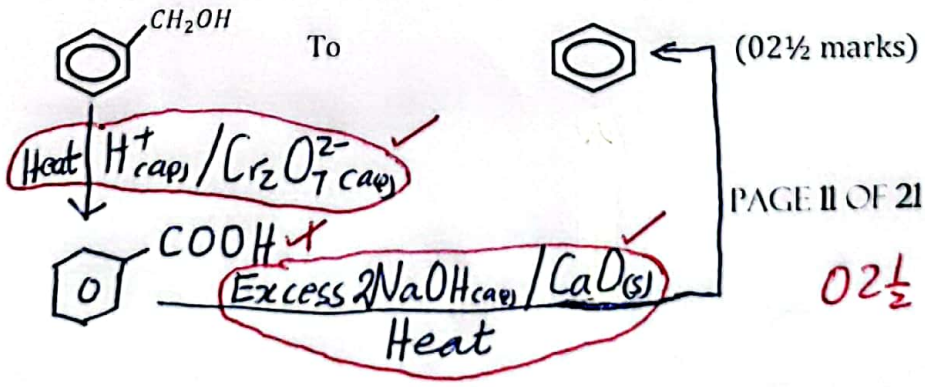


(01½ marks)

01½

c)



(02½ marks)

02½

12. (a) Define the term **Azeotrope**. (01 mark)

Is a liquid mixture of miscible components that have fixed composition which on heating at a constant pressure boils at constant temperature giving off vapour with the same composition as liquid mixture ✓ 01

b) (i) State **three reasons** why **Azeotrope** is a **mixture** and **NOT** a **compound**. (01½ marks)

- It's composition varies with pressure and temperature. ✓
- It's components can be separated by physical means. ✓
- Azeotrope can't be represented by simple molecular formula. ✓
- Azeotrope is heterogenous. ✓

01½

(ii) Name **two methods** for separating **Azeotropic mixtures** in to **pure** components. (01 mark)

- Solvent extraction ✓ - Absorption/chromatography ✓
- Fractional distillation in presence of [O] as a third component. ✓
- Chemical means in addition of quick lime. ✓

01

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(To be fastened together with other answers to paper)

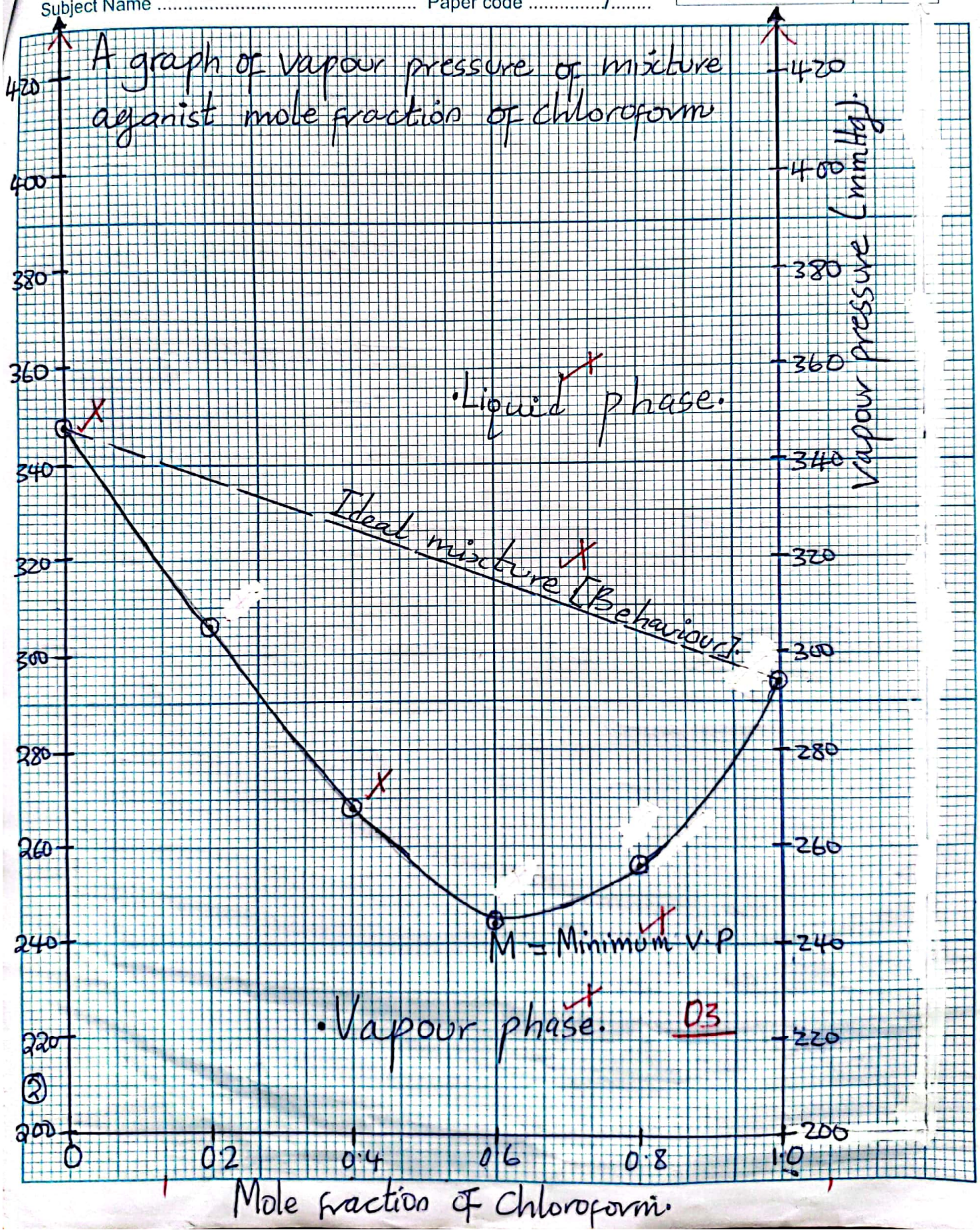
UACE

Candidate's Name .....

Signature .....

Subject Name ..... Paper code ...../.....

Random No.					
Personal Number					



03

(2)

c) The total vapour pressures of a mixture of propanone and trichloromethane.And the mole fraction of trichloromethane at constant temperature are given in the table below.

Mole fraction of $HCCl_3$	0.0	0.2	0.4	0.6	0.8	1.0
Total vapour pressure of the mixture (mmHg)	347	305	267	244	256	293

(i) Plot a graph of total vapour pressure of the mixture against the mole fractions of trichloromethane. (03 marks)

(ii) Use the graph you have drawn to determine the composition of the Azeotrope. (01 mark)

Composition of Azeotrope = Minimum vapour pressure on the graph ≈ 242 mmHg. 01

d) State how the mixture in (c) deviates from **Raoult's law**. Give a **reason** for your answer. (01½ marks)

Negative deviation; Propanone and chloroform when mixed interact via strong intermolecular hydrogen bonds. The individual molecules of propanone and chloroform are held by weak Van der Waals forces of attraction. 02

13. In an experiment it was found that **35.0g** of pure alkene reacted with **100.0g** of bromine gas.

(a) (i) Calculate the **molecular mass** of the alkene. (01½ marks)

$C_nH_{2n} + Br_2 \xrightarrow[25^oC]{CCl_4} C_nH_{2n}Br_2$.

35g of alkene reacts with 100g ✓ of Bromine molecules.

? " " " " 2(80)g " " "

$\therefore \left[\frac{160 \times 35}{100}\right]$ ✓ g of alkene.

Molecular mass of alkene = 56g. ✓ 01½

(ii) Determine the **molecular formula** of the alkene. (01½ marks)

[Empirical formula] = Molar mass $\Leftrightarrow C_nH_{2n} = 56$

$12n(1) + 2n(1) = 56$ ✓ $\Leftrightarrow 14n = 56 \Leftrightarrow n = 4$. ✓

$\therefore$

Molecular formula of the alkene = C_4H_8 ✓ 01½

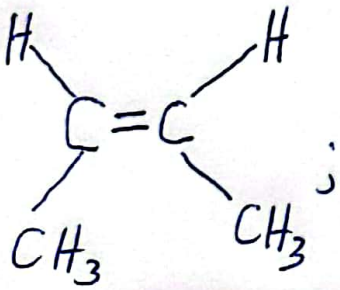
(b) Write the **IUPAC names** of all the possible isomers and **structural** formulae of the alkene. (05 marks)

$CH_3CH_2CH=CH_2$; But-1-ene or 1-butene ✓

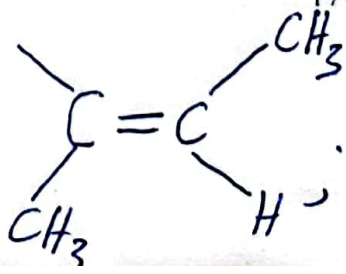
$CH_3CH=CHCH_3$; But-2-ene or 2-butene. ✓

$CH_3-C(CH_3)=CH_2$; 2-methyl-1-propene or ✓

2-methylprop-1-ene. ✓



; Cis-but-2-ene ✓



Trans-but-2-ene ✓

05

(c) Write the equation of reaction between any isomers of the alkene with bromine gas in presence of carbontetrachloride. (01 mark)

$CH_3CH=CHCH_3 \xrightarrow[25^oC]{Br_2/CCl_4} CH_3CH(Br)CH(Br)CH_3$ ✓ 01

14. Beryllium and magnesium are some of the elements in group (II) of the periodic table.

a) Write the equation for the reaction between **water** and the **carbide** of:

(i) Beryllium (01½ marks)

$Be_2C_{(s)} + 4H_2O_{(l)} \longrightarrow 2Be(OH)_{2(aq)} + CH_{4(g)}$ ✓✓

(ii) Magnesium (01½ marks) 03

$Mg_2C_{3(s)} + 4H_2O_{(l)} \longrightarrow 2Mg(OH)_{2(aq)} + CH_3C\equiv CH_{(g)}$ ✓✓

b) A sample of nitrogen gas completely reacted with heated magnesium to form **product Q**. **Product Q** reacted with water and all the ammonia gas produced was absorbed in **50.0cm³** of **0.05M** sulphuric acid. **12.5cm³** of **0.1M** sodium hydroxide solution was required to completely neutralize the remaining acid. Write equation for the reaction between:

(i) Nitrogen gas and Magnesium. (01 mark)

$3Mg_{(s)} + N_{2(g)} \longrightarrow Mg_3N_{2(s)}$ ✓

(ii) **Product Q** and water. (01 mark)

$Mg_3N_{2(s)} + 6H_2O_{(l)} \longrightarrow 3Mg(OH)_{2(s)} + 2NH_{3(g)}$ ✓ 02

c) Calculate the **volume** of nitrogen gas at **s.t.p** that reacted with magnesium. (04 marks)

$2NaOH_{(aq)} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$

Moles of NaOH reacted with excess $H_2SO_4 = \frac{12.5 \times 0.1}{1000}$ ✓

$= 1.25 \times 10^{-3}$ mol

Moles of H_2SO_4 acid reacted $= \frac{1}{2} \times 1.25 \times 10^{-3} \approx 6.25 \times 10^{-4}$ mol ✓

[Since mole ratio is 2 : 1] ✓

Initial moles of $H_2SO_4 = \frac{50 \times 0.05}{1,000} \approx 2.50 \times 10^{-3}$ moles

Moles of H_2SO_4 reacted with $NH_3 = 0.0025 - 0.000625$

$= 0.001875$ moles ✓

Moles of $NH_3 = 2 \times 0.001875 \approx 0.00375$ ✓ moles.

$\Rightarrow$ Moles of $Mg_3N_2 = NH_3 = \frac{1}{2} \times 0.00375 \approx 1.875 \times 10^{-3}$ ✓ moles

Volume $= 22.4 \times 1.875 \times 10^{-3}$ ✓

$= 0.042\ dm^3$ ✓

04

15. **(a)** Write the general outer most electronic configuration of group (IV) elements. (0½ mark)

ns^2np^2.

(b) Explain why carbon show differences from the rest of the group elements. (01½ marks)

- Small atomic radius. ✓
- Lack of vacant d-orbital. ✓
- High electronegativity. ✓
- Doesn't show inert pair effect. ✓

01½

(c) State three differences between the chemistry of carbon and the rest of group (IV) members. (03 marks)

- The halides are stable to hydrolysis. ✓
- Forms gaseous oxides unlike other members. ✓
- Forms stable multiple bonds with itself and other non-metals. ✓
- Form number of hydrocarbon since it catenate. ✓

03

(d) Explain why carbon tetrachloride does not undergo hydrolysis in water whereas silicon (IV) chloride does. (03 marks)

Carbon tetrachloride doesn't hydrolyse in water due to it's inert ✗ pair effect. Since it lacks ✗ vacant d-orbital to accept ✗ electrons from oxygen atom in water. ✗

Silicon (IV) chloride undergo hydrolysis in water due to the presence of empty ✗ d-orbital that accomodate lone ✗ pairs of electrons from oxygen atom in water. ✗

03

(e) Write the equation for the reaction between silicon (IV) chloride and water. (01 mark)

$SiCl_{4(l)} + 2H_2O_{(l)} \longrightarrow SiO_{2(s)} + 4HCl_{(g)}$ ✓

$SiCl_{4(l)} + 4H_2O_{(l)} \longrightarrow SiO_2.2H_2O_{(s)} + 4HCl_{(g)}$ ✓

OR

$SiCl_{4(l)} + 4H_2O_{(l)} \longrightarrow Si(OH)_{4(s)} + 4HCl_{(g)}$ ✓

$SiCl_{4(l)} + 3H_2O_{(l)} \longrightarrow H_2SiO_{3(s)} + 4HCl_{(g)}$ ✓ 01.

16. (a) Define the term **osmotic pressure.** (01 mark)

Osmotic pressure is a pressure that must be applied to a solution to balance the tendency of solvent to flow from the solvent side to the solution side across a semi-permeable membrane. ✓ 01

(b) Explain why determination of molar mass of polymer, osmotic pressure is preferred than boiling point elevation method. (02 marks)

Polymers have very high ✓ relative molecular masses causing very small ✓ temperature change hence difficult to measure using Thermometer since colligative property is inversely ✓ proportional to the molar mass Molar mass will be higher ✓ than true value. 02

(c) The Osmotic pressure of various concentrations of solute X in methylbenzene at 25°C are given in the table below.

Concentration (g/dm^3)	1.0	2.0	3.0	4.0	5.0	6.0
Osmotic pressure (Nm^{-2})	23	37	53	75	92	109

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(To be fastened together with other answers to paper)

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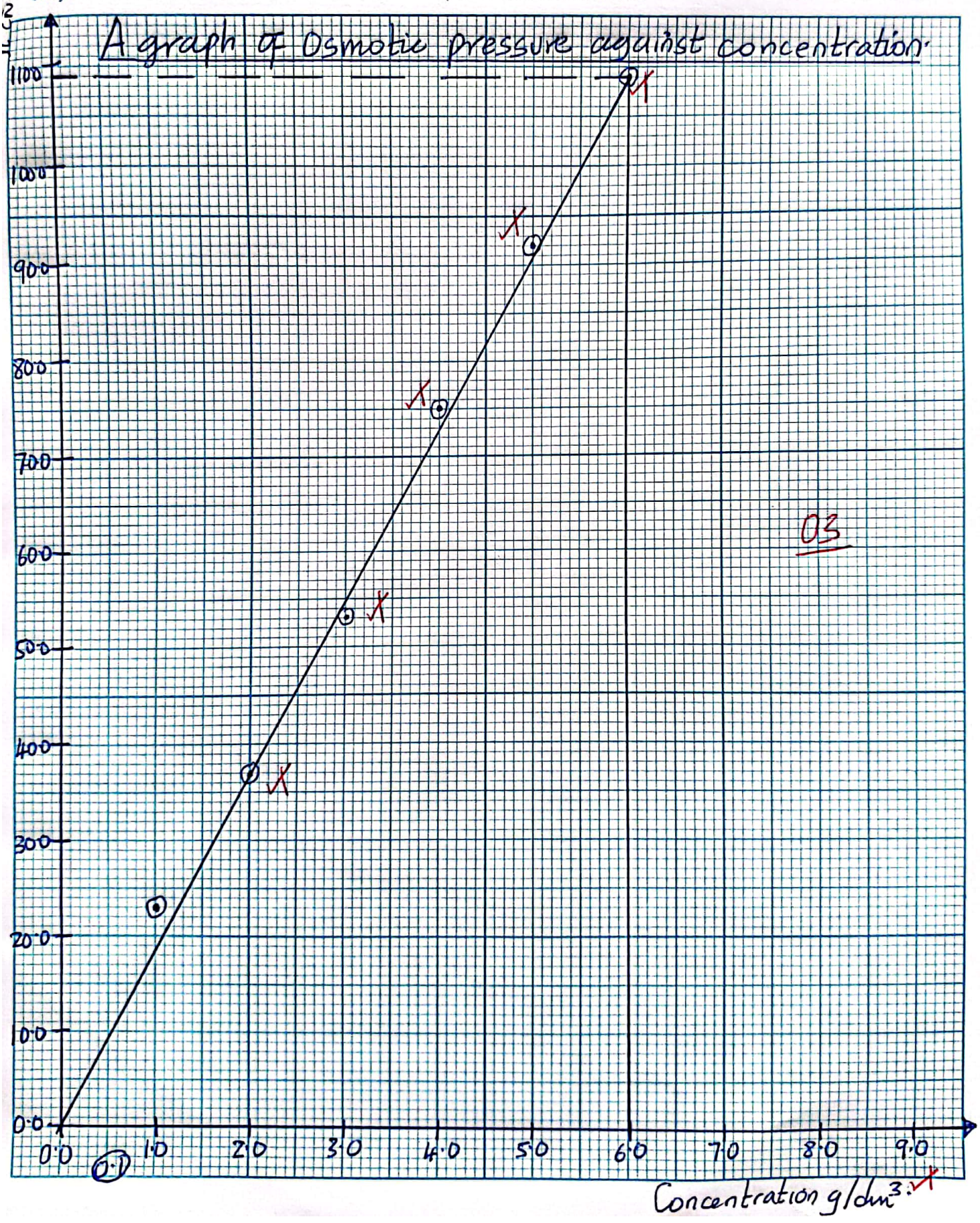


03

(i) Plot a graph of **osmotic pressure** against **concentration**.
(03 marks)

(ii) Use the graph to determine the molecular mass of X.[Universal gas constant, R = 8.314J/K/mol]
(03 marks)

$Slope = \frac{Y_2 - Y_1}{X_2 - X_1} \Rightarrow Slope = \frac{114 - 0}{6.3 - 0} \Leftrightarrow Slope = 18.1$

[Values from the graph]

$Slope = \frac{R \times T}{M_r} \Leftrightarrow M_r = \frac{8.314 \times 298}{18.1 \times 10^{-3}}$

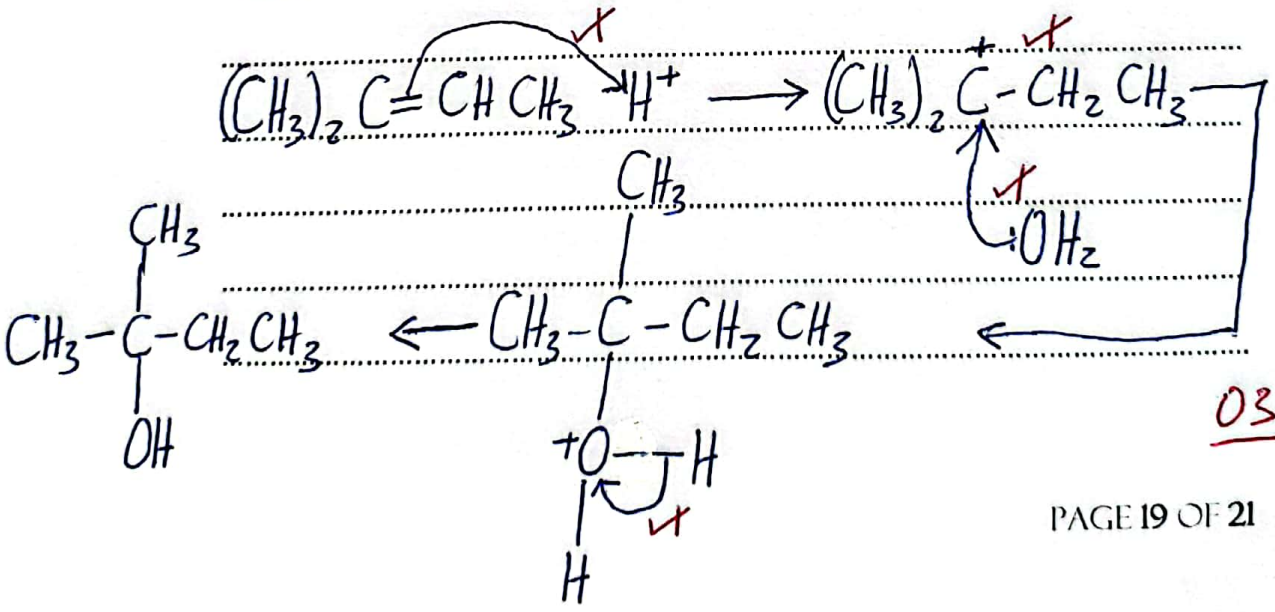
[Since $1\,dm^3 = 10^{-3}\,m^3$]

Molar mass, $M_r = 136,951.3$ 03.

17. Complete the following equations and outline the mechanism for each reaction.
[a (03½ marks), b (02½ marks), c (03 marks)]

(a). $(CH_3)_2C{=}CH\,CH_3 \xrightarrow[\text{Heat}]{H_2O/H^+} CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle OH}{\underset{|}{\overset{|}{C}}}}-CH_2CH_3$

Mech:



03

$$\text{Slope} = \frac{109 - 0}{6.0 - 0} \Leftrightarrow \text{Slope} = 18.2 \cdot \checkmark$$

[Values from the graph]

$$Mr = \frac{8.314 \times 298}{18.2 \times 10^{-3}} \checkmark \Leftrightarrow Mr = 136,130 \cdot \checkmark$$

03

[Since $1\,dm^3 = 10^{-3}\,m^3$]

(b). $(CH_3)_3CBr \xrightarrow[\text{Heat}]{KOH/CH_3CH_2OH} CH_3-\underset{CH_3}{\overset{|}{C}}=CH_2 + HBr$.

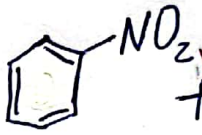
Mech: $C_2H_5OH_{(l)} + KOH_{(aq)} \xrightarrow{Heat} C_2H_5O^-K^+_{(aq)} + H_2O_{(l)}$

$C_2H_5O^-K^+_{(aq)} \longrightarrow C_2H_5O^-_{(aq)} + K^+_{(aq)}$

$(CH_3)_3C-Br \rightleftharpoons (CH_3)_3C^+ + Br^-$

$CH_3-\overset{CH_3}{\overset{|}{C^+}}-CH_2-H \quad \ddot{O}C_2H_5 \longrightarrow CH_3-\underset{CH_3}{\overset{|}{C}}=CH_2 + C_2H_5OH$

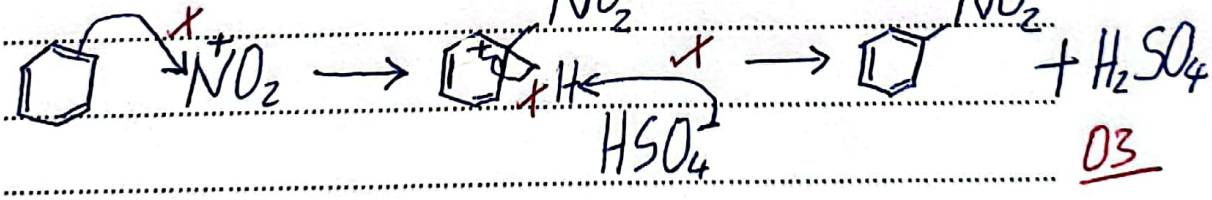
02½

(c).  + $Conc.HNO_{3(aq)} \xrightarrow[60^oC]{Conc.H_2SO_{4(l)}}$  $+ H_2O$.

Mech:

$H-HSO_4 + HO-NO_2 \overset{slow}{\rightleftharpoons} H_2O^+-NO_2 + HSO_4^-$.

$H_2O + NO_2^+$.



03

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