S.6

Portable

MARKING GUIDE P525/1 MIDTERM

1. Observation; Purple solution turns colourless ✓✓

(i) $(5e + MnO_{4(aq)}^- + 8H_{(aq)}^+ \rightarrow Mn_{(aq)}^{2+} + 4H_2O_{(l)})2$

$(SO_{2(g)} + 2H_2O_{(l)} \rightarrow SO_{4(aq)}^{2-} + 4H_{(aq)}^+ + 2e)5$ (02✓)

$2MnO_{4(aq)}^- + 5SO_{2(g)} + 2H_2O_{(l)} \rightarrow 2Mn_{(aq)}^{2+} + 5SO_{4(aq)}^{2-} + 4H_{(aq)}^+$ ✓✓

Observation: Green solution ✓ forms a purple solution ✓ and a brown solid ✓

(ii) $(MnO_{4(aq)}^{2-} \rightarrow MnO_{4(aq)} + e)2$

$4H_{(aq)}^+ + MnO_{4(aq)}^{2-} + 2e \rightarrow MnO_{2(s)} + 2H_2O_{(l)}$

$3MnO_{4(aq)}^{2-} + 4H_{(aq)}^+ \rightarrow 2MnO_{4(aq)}^- + MnO_{2(s)} + 2H_2O_{(l)}$ ✓✓

or

$3MnO_{4(aq)}^{2-} + 2CO_{2(g)} \rightarrow 2MnO_{4(aq)}^- + MnO_{2(s)} + 2CO_{3(aq)}^{2-}$ (02✓)

or

$3MnO_{4(aq)}^{2-} + 4CO_{2(g)} + 2H_2O_{(l)} \rightarrow 2MnO_{4(aq)}^- + MnO_{2(s)} + 4HCO_{3(aq)}^-$

2. (a) (i) Regions

A – solid phase ✓

B – liquid phase ✓

C – Gaseous phase ✓

Point O – Triple point ✓ reject Tripple

Point Y – Critical point ✓

Curves

OX – Fusion curve. ✓

OR – Sublimation curve ✓

OY – Vapourisation curve ✓

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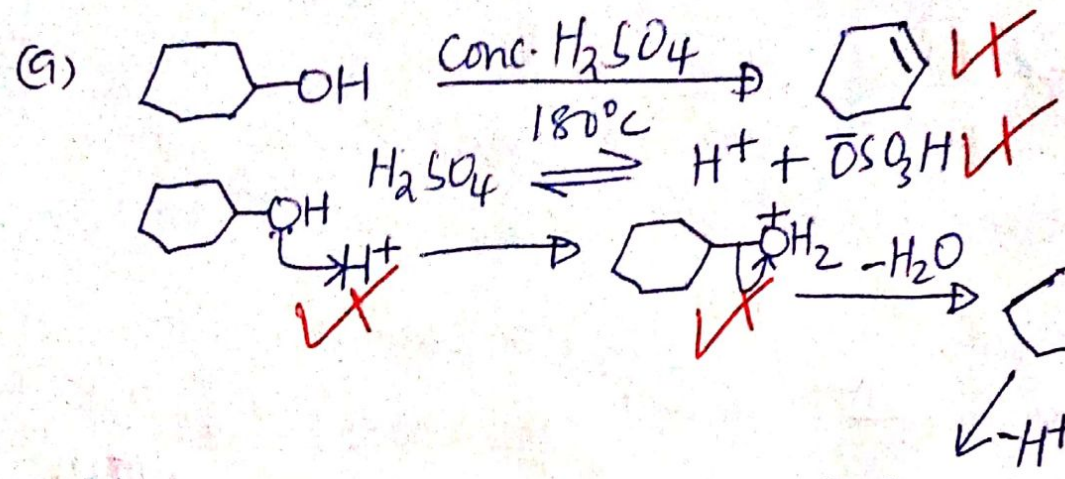
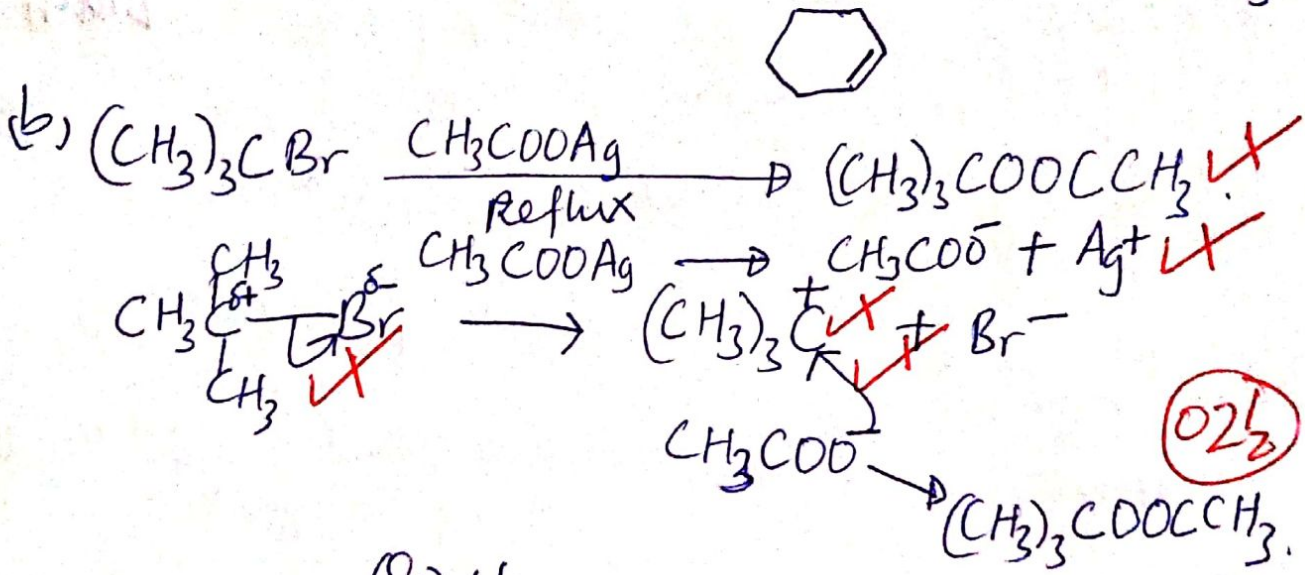
Qn 3

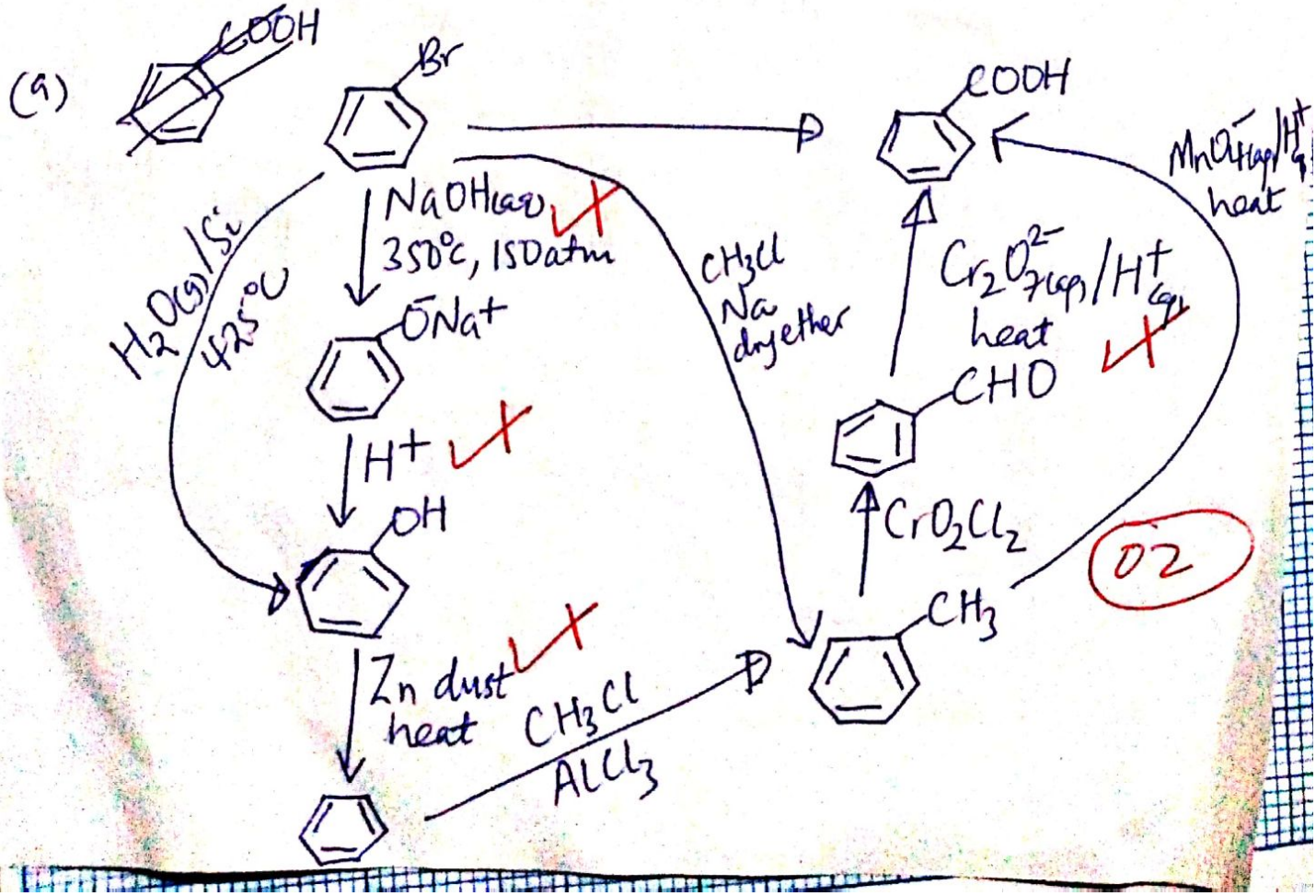
(a) 

03

(b) 

02½

Qn 4

(a) 

02

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(b) $CH_3CH_2COOH \longrightarrow CH_3CH_2NH_2$

$CH_3CH_2COOH \xrightarrow{NH_3,\ heat} CH_3CH_2CONH_2$

$CH_3CH_2COOH \xrightarrow{(NH_4)_2CO_3(s),\ heat} CH_3CH_2CONH_2$

reject if (s) missing

$CH_3CH_2CONH_2 \xrightarrow{Br_2/NaOH,\ warm} CH_3CH_2NH_2$

reject heat or reflux.

01

QN 5

(a) - Substance to be steam distilled should be immiscible with water.
- Substance should have a high relative molecular mass.
- Substance should exert a high vapour pressure near the boiling point of water (should be volatile)

any 2

(b) $P_X = (760 - 734) = 26\ mmHg$.

$P_{H_2O} = 734\ mmHg$. % by mass of X = 100 − 85 = 15.

$\frac{P_X}{P_{H_2O}} = \frac{n_X}{n_{H_2O}}$

$\frac{26}{734} = 15/M_{rX} / 85/18$

−½ if units missing

$M_{rX} = \frac{734 \times 15 \times 18}{26 \times 85}$

$= 89.67\ g$

03

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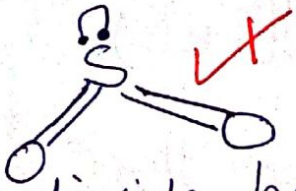
(6) a) (i) $_6C - 1s^2 2s^2 2p^2$ ✓½

(ii) $_{16}S - 1s^2 2s^2 2p^6 3s^2 3p^4$ ✓½

b) $O=C=O$ ✓½

i) Carbon dioxide has two carbon-oxygen double bonds, two bonding pairs ✓½ and no lone pair ✓½ since all the four valence electrons are used for bonding. The two bonding pairs repel each other ✓½ greatly. The molecule has a bond angle of 180° hence a linear shape ✓½ (02½)

ii)



Sulphur dioxide has two bonding pairs ✓½ and one lone pair ✓½. The repulsion between the lone pair and bond pairs is greater ✓½ than the repulsion between the two bonding pairs. The molecule thus attains a bent shape ✓½ (02½)

Q7

(a) $CaC_{2(s)} + 2H_2O_{(l)} \rightarrow HC\equiv CH_{(g)} + Ca(OH)_{2(aq)}$ ✓½

(b) i) CH_2BrCH_2Br ✓ 1,2-dibromoethane ½

Accept CH_2ClCH_2Cl.

ii) $CH_2BrCH_2Br \xrightarrow[\text{heat}]{KOH/CH_3CH_2OH} HC\equiv CH$ ½

mechanism:

$2KOH + 2CH_3CH_2OH \rightarrow 2CH_3CH_2O^-K^+ + 2H_2O_{(l)}$ ½

$2CH_3CH_2O^-K^+ \rightarrow 2CH_3CH_2O^- + 2K^+$ ½

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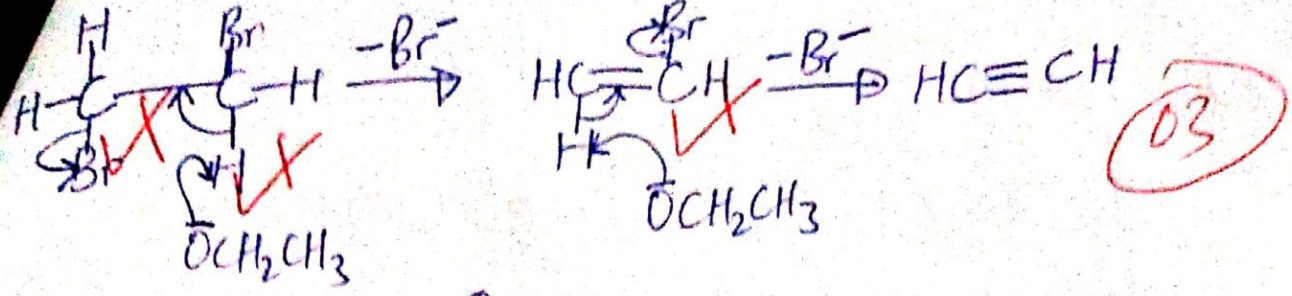

03

QN 8

(a) $5(H_2O_{2(aq)} \rightarrow O_{2(g)} + 2H^+_{(aq)} + 2e)$

$2(MnO_4^-{}_{(aq)} + 8H^+_{(aq)} \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)})$

$2MnO_4^-{}_{(aq)} + 6H^+_{(aq)} + 5H_2O_{2(aq)} \rightarrow 2Mn^{2+}_{(aq)} + 8H_2O_{(l)} + 5O_{2(g)}$

(b) It is a very strong oxidising agent thus easily reduced even by weak reducing agents. It is also never obtained free from manganese(IV) oxide impurity. 03

(c) - Oxalic acid
- Sodium oxalate

9(a)(i) Osmotic pressure of a solution is the pressure which must be applied to the solution to balance the tendency of solvent molecules to flow from the solvent side to the solution side of a semi-permeable membrane.

(ii) ~~When the solute does not react with~~
- The solution should be very dilute
- The solute should not associate or dissociate with the solvent
- The solute should not react with the solvent.
- Temperature must be kept constant.

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(b) $m = 7g$

$V = 100\,cm^3 = 100 \times 10^{-6}\,m^3$

$\pi = 7067.9\,mmHg = \frac{7067.9}{760} \times 101325\,Pa$.

$T = 18°C = (18+273)K$

$\pi V = nRT$

$\pi V = \frac{m}{M_r}RT$

$M_r = \frac{mRT}{\pi V} = \frac{7 \times 8.31 \times (18+273)}{\left(\frac{7067.9}{760} \times 101325\right) \times 100 \times 10^{-6}}$

$= 179.59$ (03)

SECTION B.

10 (a) (i) ns^2np^2

(ii) +2 and +4 (01)

(iii) PbO, PbO_2, Pb_3O_4 (01)

(b) Observation;

The red solid dissolves to form a brown solid and a colourless solution.

Equation;

$$Pb_3O_{4(s)} + 4HNO_{3(aq)} \rightarrow PbO_{2(s)} + 2Pb(NO_3)_{2(aq)} + 2H_2O_{(l)}$$

(c) (i) Observation.

A yellow precipitate is formed.

Equation;

$$Pb^{2+}_{(aq)} + CrO^{2-}_{4(aq)} \longrightarrow PbCrO_{4(s)}$$

(ii) Brown solid dissolves to form bubbles of a greenish-yellow gas and a colourless solution.

$$PbO_{2(s)} + 4HCl_{(aq)} \longrightarrow PbCl_{2(aq)} + Cl_{2(g)} + 2H_2O_{(l)}$$

(02)

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Q5 11

(a)(i) Formula: $Al_2O_3 \cdot 2H_2O$ Name; Bauxite

(ii) Silicon(IV) oxide
Iron(III) oxide
Titanium(IV) oxide

(b) The ore is heated in presence of oxygen to drive off water of crystallisation, to obtain anhydrous aluminium oxide and also convert iron(II) ions to iron(III) oxide

$Al_2O_3 \cdot 2H_2O(s) \rightarrow Al_2O_3(s) + 2H_2O(l)$

The roasted product is crushed into fine powder and digested with hot concentrated sodium hydroxide under pressure to dissolve amphoteric aluminium oxide that forms aluminate ions

$Al_2O_3(s) + 2\bar{O}H(aq) + 3H_2O(l) \rightarrow 2Al(OH)_4^-(aq)$

Silica being acidic dissolves in sodium hydroxide to form sodium silicate.

$SiO_2(s) + 2\bar{O}H(aq) \rightarrow SiO_3^{2-}(aq) + H_2O(l)$

The basic iron(III) oxide and titanium(IV) oxide do not dissolve in the sodium hydroxide hence filtered off, forming a residue. The aluminate and silicate form the filtrate.

The filtrate is cooled, diluted with water, and seeded with freshly precipitated aluminium hydroxide to precipitate aluminium hydroxide

$Al(OH)_4^-(aq) + Al(OH)_3(s) \rightarrow 2Al(OH)_3(s) + \bar{O}H(aq)$

The aluminium hydroxide is then filtered off, washed, dried and heated strongly to form pure anhydrous aluminium oxide.

$2Al(OH)_3(s) \rightarrow Al_2O_3(s) + 3H_2O(l)$

(c)(i) To lower the melting point of aluminium oxide

(ii) ~~$2Al(s) + 3Cl_2(g) \rightarrow 2AlCl_3(s)$~~

$Al_2O_3(s) + 6HCl(g) \rightarrow 2AlCl_3(s) + 3H_2O(l)$

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QN 12

(a) Ca^{2+} and Ba^{2+}

Reagent

Dilute sulphuric acid.

Ca^{2+} Potassium chromate(VI) and dilute ethanoic acid

Ca^{2+} - Yellow precipitate soluble in ethanoic acid

Ba^{2+} - Yellow precipitate insoluble in ethanoic acid

or

Ammonium oxalate solution and dilute ethanoic acid.

Ca^{2+} - White precipitate insoluble in ethanoic acid.

Ba^{2+} - white precipitate soluble in ethanoic acid.

(b) Sn^{2+} and Sn^{4+}

Acidified potassium manganate(VII) solution

Sn^{2+} — Purple solution turns colourless

Sn^{4+} - No observable change.

or

Acidified potassium dichromate(VI) solution

Sn^{2+} - orange solution turns green

Sn^{4+} - No observable change.

or

Iron(III) chloride solution.

Sn^{2+} - Brown solution turns green

Sn^{4+} - No observable change.

etc

(c) $\begin{matrix} COO^- \\ COO^- \end{matrix}$ And CH_3COO^-

Acidified potassium manganate(VII) solution and heat.

$C_2O_4^{2-}$ — Bubbles of a colourless gas and purple solution turns colourless.

CH_3COO^- - No observable change.

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or Ethanol and concentrated sulphuric acid and heat

$C_2O_4^{2-}$ – No observable change.

CH_3COO^- – Sweet fruity smell.

or Iron(III) chloride solution and heat.

$C_2O_4^{2-}$ – No observable change.

CH_3COO^- – Brown precipitate on heating

Q No 13.

(a) (i) % by mass of H = 100 − 90 = 10

Elements	C	H	Empirical formula is C_3H_4.
moles	$\frac{90}{12}$	$\frac{10}{1}$	
simplest ratio	$\frac{7.5}{7.5}$:	$\frac{10}{7.5}$	
	(1 :	1.333)3	
	3 :	4	

(03)

(i) 1 cm^3 at stp contains 1.785×10^{-3} g of Q.

22400 cm^3 contain $\frac{22400 \times 1.785 \times 10^{-3}}{1}$.

molar mass of Q is 39.984 ≈ 40g.

$(C_3H_4)n = 40$

$(36+4)n = 40$

$n = 1$

molecular formula is C_3H_4 (03)

(b) Q is $CH_3C{\equiv}CH$ or Propyne.

(c) $CH_3CH_2COOH \xrightarrow[\text{dry ether}]{LiAlH_4} CH_3CH_2CH_2OH \xrightarrow[180°C]{conc.H_2SO_4} CH_3C(H)=CH_2$

$CH_3C(H)=CH_2 \xrightarrow{Br_2/CCl_4} CH_3CHBrCH_2Br$

$CH_3CHBrCH_2Br \xrightarrow[\text{heat}]{KOH/CH_3CH_2OH} CH_3C{\equiv}CH$ (03)

$HC{\equiv}CNa \xrightarrow{CH_3Br} CH_3C{\equiv}CH$.

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Q.N 14

(a) (i) $AlCl_3$ ✓+
$SiCl_4$ ✓+
PCl_5 ✓+

(ii) Cleaned red hot ✓+ aluminium reacts with steam ✓+

$2Al_{(s)} + 3H_2O_{(g)} \rightarrow Al_2O_{3(s)} + 3H_{2(g)}$ ✓

Red hot silicon ✓+ reacts with steam ✓+

$Si_{(s)} + 2H_2O_{(g)} \rightarrow SiO_{2(s)} + 2H_{2(g)}$ ✓

Phosphorus does not react ✓+ with water.

(b) (i) Bubbles of a colourless ✓+ gas and a white precipitate ✓+

(ii) ~~$AlCl_{3(aq)} + 3H_2O_{(l)} \rightarrow Al(OH)_{3(s)} + 3HCl_{(aq)}$~~

~~$(HCl_{(aq)} + NaHCO_{3(aq)} \rightarrow NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}) \times 3$~~

$AlCl_{3(aq)} + 3NaHCO_{3(aq)} \rightarrow Al(OH)_{3(s)} + 3NaCl_{(aq)} + 3CO_{2(g)}$ ✓

or

~~$Al(H_2O)^{3+}_{6(aq)} + 3H_2O_{(l)} \rightarrow Al(H_2O)_3(OH)_{3(s)} + 3H_3O^+_{(aq)}$~~

~~$3(H_3O^+_{(aq)} + HCO^-_{3(aq)} \rightarrow CO_{2(g)} + 2H_2O_{(l)})$~~

$Al(H_2O)^{3+}_{6(aq)} + 3HCO^-_{3(aq)} \rightarrow Al(H_2O)_3(OH)_{3(s)} + 3CO_{2(g)} + 3H_2O_{(l)}$

or

~~$Al^{3+}_{(aq)} + 3H_2O_{(l)} \rightarrow Al(OH)_{3(s)} + 3H^+_{(aq)}$~~

~~$3(H^+_{(aq)} + HCO^-_{3(aq)} \rightarrow (O_{2(g)} + H_2O_{(l)})$~~

$Al^{3+}_{(aq)} + 3HCO^-_{3(aq)} \rightarrow Al(OH)_{3(s)} + 3CO_{2(g)}$.

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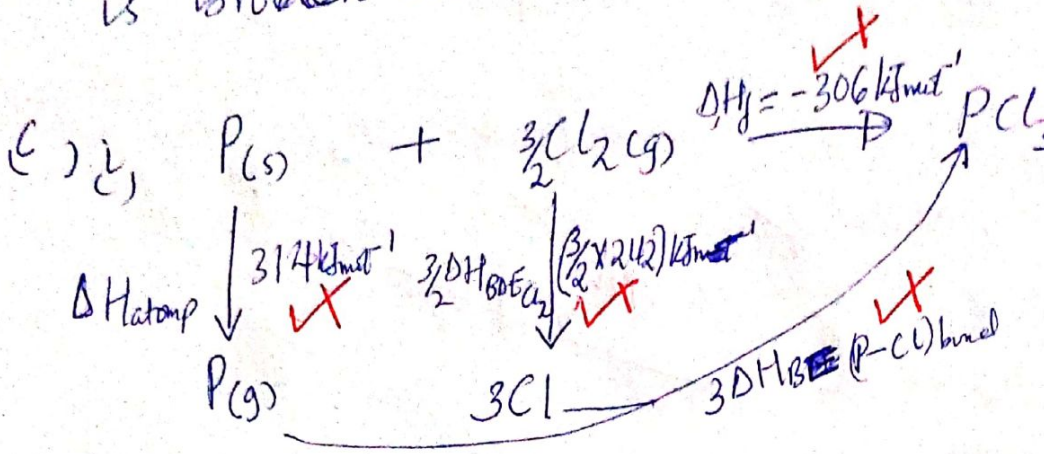
QN 15

(a)(i) This is the enthalpy change that occurs when one mole of a substance is formed from its constituent elements in their standard states and at 25°C and 1 atmosphere. ✓

(ii) Lattice energy is the enthalpy change that occurs when one mole of an ionic compound is broken down into its gaseous ions. ✓

(c) (i)



02

(ii) $\Delta H_{fPCl_3} = \Delta H_{atomp} + \frac{3}{2}\Delta H_{BDE Cl_2} + 3\Delta H_{BE(P-Cl)}$

$3\Delta H_{BE(P-Cl)} = (-306 - 314 - \frac{3}{2}(242))$

$= -983$

$\Delta H_{BE(P-Cl)} = \frac{-983}{3} = -327.67 \text{ kJmol}^{-1}$

02

(d) $C_{(s)} + O_{2(g)} \xrightarrow{-403 \text{ kJmol}^{-1}} CO_{2(g)}$ ——— (i)

$H_{2(g)} + \frac{1}{2}O_{2(g)} \xrightarrow{-285 \text{ kJmol}^{-1}} H_2O_{(g)}$ ——— (ii)

$CH_3CH_{3(g)} + \frac{7}{2}O_{2(g)} \xrightarrow{-1395 \text{ kJmol}^{-1}} 2CO_{2(g)} + 3H_2O_{(l)}$ ——— (iii)

$2C_{(s)} + 3H_{2(g)} \xrightarrow{\Delta H_{f C_2H_6}} CH_3CH_{3(g)}$

$\Delta H_{f C_2H_6} = 2(i) + 3(ii) - (iii)$

$= 2(-403) + 3(-285) - (-1395)$

$= -266 \text{ kJmol}^{-1}$

03

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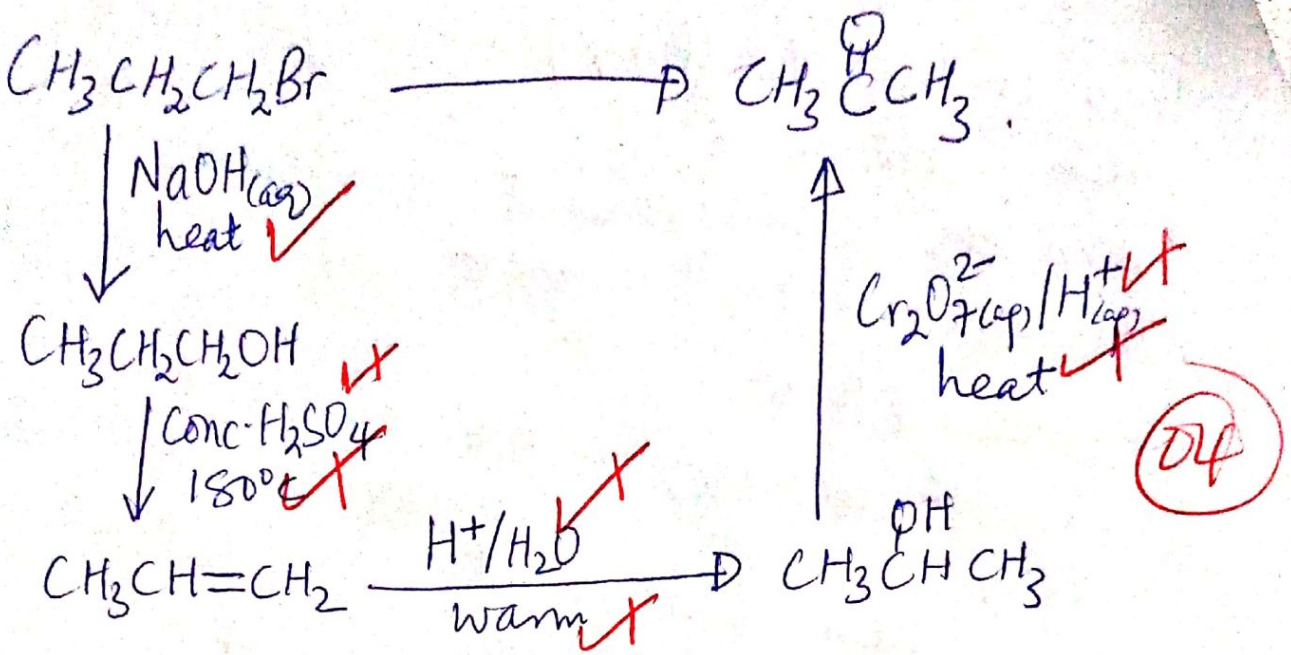
16

(a)



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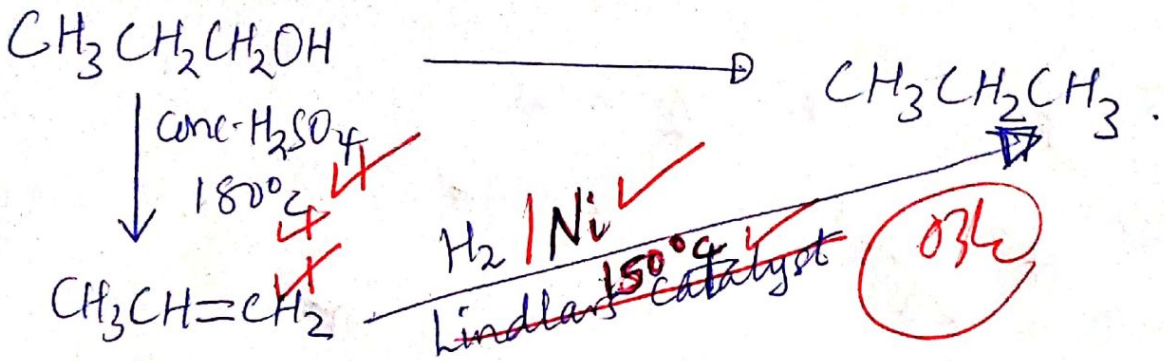
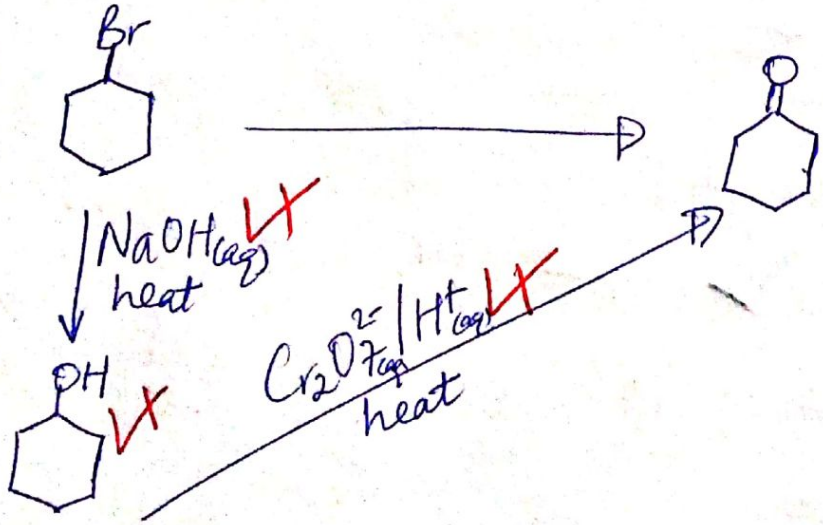
(b)



03

(c)



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Q17

(a) An azeotropic mixture is a mixture of a certain composition which when heated continues to boil at a constant temperature without change in composition of both the mixture and its vapour.

(b) (i) Check on graph paper.

(ii) Azeotropic mixture is 56% (±1.25) Methanol or has a mole fraction of 0.56 methanol at a temperature of 55°C ±0.5 (44% cyclohexane)

(c) (i) Positive deviation

(ii) Methanol has polar molecules which associate through strong hydrogen bonds. Cyclohexane is non-polar and has vander waals forces of attraction. The forces holding the molecules of the two liquids are different and when the components are mixed, there forces of attraction between them are on average weaker than the forces holding the individual molecules of the two separate components. This increases the escaping tendency of the molecules into vapour phase hence exerting a higher vapour pressure and a low minimum boiling point

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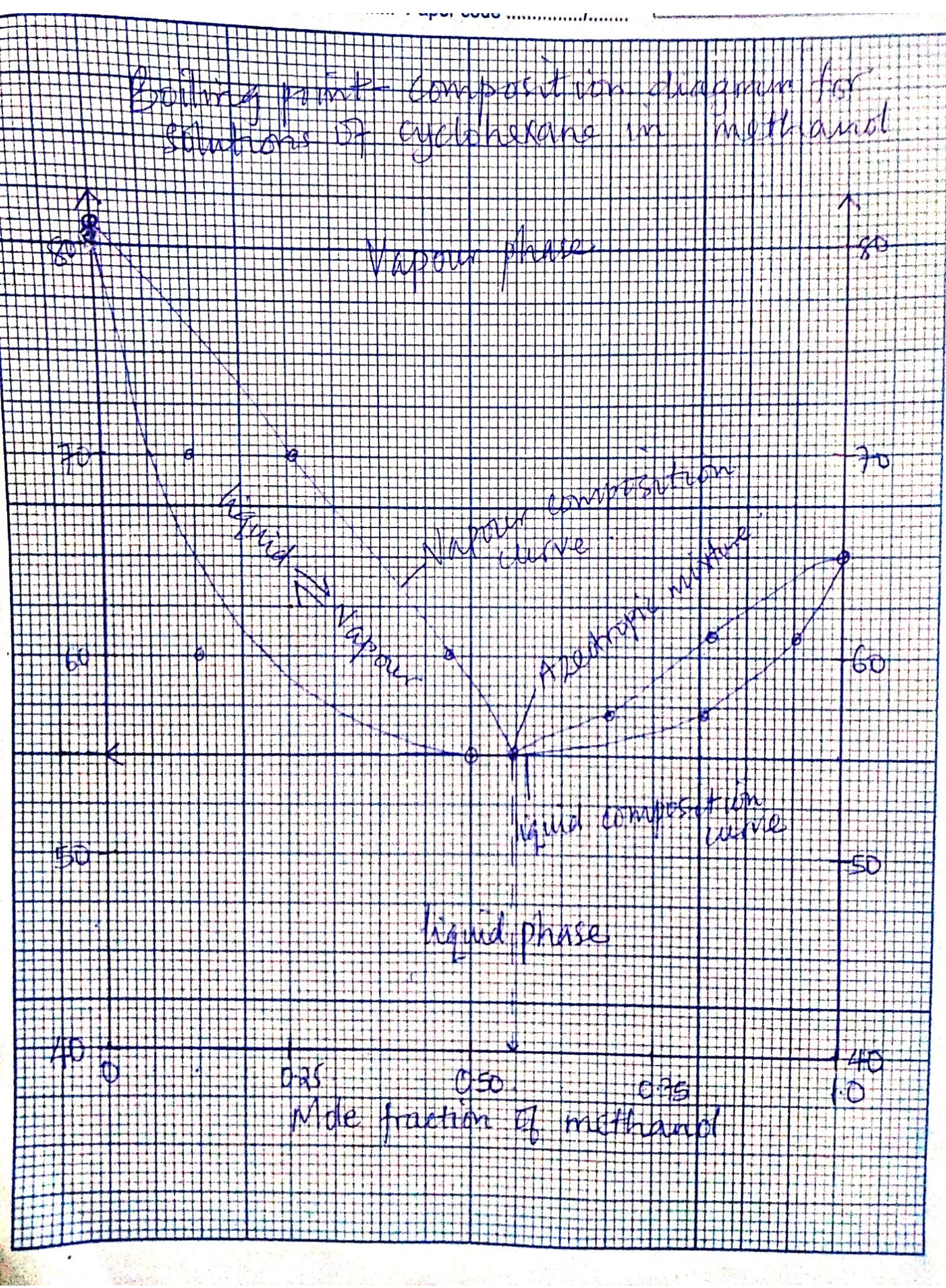

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