



CHEMISTRY PAPER 1

(THEORY)

ANSWER KEY

SECTION A - 14 MARKS

Question 1

(A) [4×1]

- (i) Methyl alcohol, Cannizzaro
- (ii) One, 96,500
- (iii) Unpaired, d-d
- (iv) Salicylic acid, Kolbe's

(B) [7×1]

- (i) (b) $\text{Urea} > \text{KCl} > \text{MgCl}_2 > \text{AlCl}_3$
- (ii) (c) three
- (iii) (d) $\text{CoCl}_3 \cdot 3\text{NH}_3$
- (iv) (b) $k[\text{A}]^1[\text{B}]^0$
- (v) (a) $\text{C}_2\text{H}_5\text{NC} \xrightarrow{\text{LiAlH}_4}$ _____
- (vi) (a) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion.
- (vii) (c) Assertion is true and Reason is false.

(C) [3×1]

- (i) The boiling point of 2-methyl propan-2-ol is much lower than that of butan-1-ol. This is due to the fact that with branching the surface area decreases. Consequently, boiling point also decreases.
- (ii) The greater acidic character of phenol as compared to alcohols can be explained on the basis of resonance. The oxygen attracts the electron pair of O-H bond strongly towards itself, weakens the O-H bond and therefore facilitates the release of H^+ more easily.
- (iii) A 0.2% of phenol acts as an antiseptic, whereas its 1% solution is used as a disinfectant.

SECTION B – 20 MARKS

Question 2

[2]

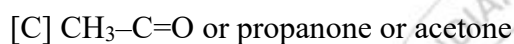
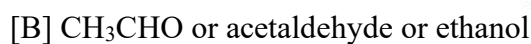
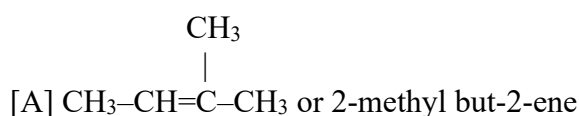
Increasing order of reducing power of metals is $\text{Ag} < \text{Cu} < \text{Fe} < \text{Mg} < \text{Li}$

$$\text{Reducing power} = \frac{1}{\text{Reduction potential}}$$

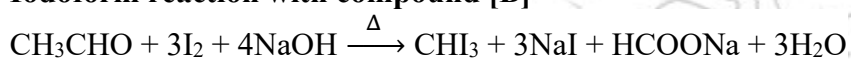
i.e., as the reduction potential (value of metal) decreases, reducing power of metal increases.

Question 3

[2]

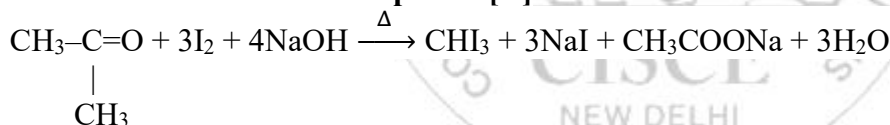


Iodoform reaction with compound [B]



Or

Iodoform reaction with compound [C]



Question 4

[2]

(i) For the coordination complex ion $[\text{Cr}(\text{NH}_3)_6]^{3+}$

(a) Type of hybridisation; d^2sp^3

(b) Magnetic behaviour; paramagnetic

Reason: There are three unpaired electrons.

OR

(ii) (a) $t_{2g}^3 e_g^2$

(b) If the value of CFSE (Δ_0) is more, ligand is strong. (i.e. low spin complex)

Question 5**[2]**

Given: $t_{1/2} = 12$ days, $t = 48$ days

$$\text{Number of half lives} = \frac{\text{Total time}}{\text{Half life period}} = \frac{48}{12} = 4$$

Amount left after 4 half lives

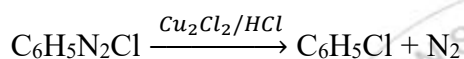
$$A = A_0 \times \left(\frac{1}{2}\right)^4$$

$$A = A_0 \times \frac{1}{16}$$

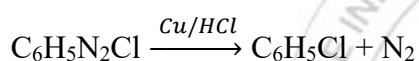
i.e. ; $\frac{1}{16}$ of the initial amount

Question 6**[2]**

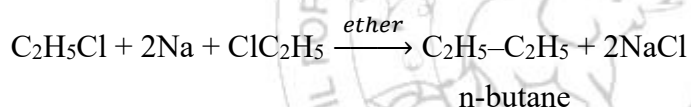
- (i) Aniline to chlorobenzene



or



- (ii) Chloroethane to n-butane

**Question 7****[2]**

- (i) Cobalt has d^7 electrons in the outer shell and therefore, has three unpaired electrons. Therefore, it will be attracted in a magnetic field.

Zinc has completely filled d^{10} configuration and therefore, will not be attracted by the magnetic field.

- (ii) In Zn, Cd and Hg, all the electrons in d-subshell are paired. Hence, the metallic bonds present in them are weak. Therefore, they have low melting and boiling points.

Question 8**[2]**

$$E_{\text{cell}} = E^{\circ}_{\text{cell}} - \frac{0.059}{n} \log \frac{[\text{Mg}^{2+}_{(\text{aq})}]}{[\text{Cu}^{2+}_{(\text{aq})}]} \text{ (Nernst Equation)}$$

$$\begin{aligned} E^{\circ}_{\text{cell}} &= E^{\circ}_{\text{cathode}} - E^{\circ}_{\text{anode}} \\ &= 0.337\text{V} - (-2.373\text{ V}) \end{aligned}$$

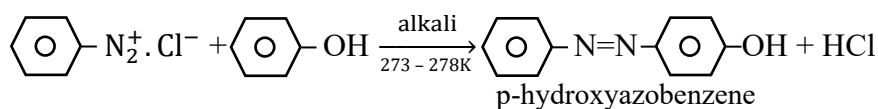
$$E^{\circ}_{\text{cell}} = +2.71\text{ V}$$

$$\begin{aligned} E_{\text{cell}} &= 2.71 - \frac{0.059}{2} \log \frac{1 \times 10^{-3}}{1 \times 10^{-4}} \text{ or} \\ &= 2.71 - 0.0295 \log 10 \text{ or} \\ &= 2.71 - 0.0295 \times 1 \end{aligned}$$

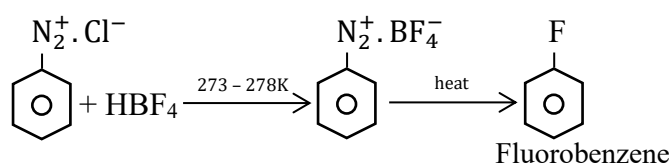
$$E_{\text{cell}} = 2.6805\text{ V}$$

Question 9**[2]**

(i) (a) Coupling reaction

*(or any other correct example)*

(b) Balz-Schiemann reaction

*(or any other correct example)***OR**

- (ii) [A] $\text{C}_2\text{H}_5\text{CONH}_2$
[B] $\text{C}_2\text{H}_5\text{NH}_2$
[C] $\text{C}_2\text{H}_5\text{N}\equiv\text{C}$
[D] $\text{C}_6\text{H}_5\text{SO}_2\text{N}(\text{C}_2\text{H}_5)_2$

Question 10**[2]**Given: $T_1 = 295\text{K}$, $T_2 = 305\text{K}$

$$\log \frac{k_2}{k_1} = 2$$

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left[\frac{1}{T_1} - \frac{1}{T_2} \right] \text{ or}$$

$$\log 2 = \frac{E_a}{2.303 \times 8.314} \left[\frac{1}{295} - \frac{1}{305} \right] \text{ or}$$

$$0.3010 = \frac{E_a}{19.147} \times \frac{10}{295 \times 305} \text{ or}$$

$$E_a = \frac{0.3010 \times 19.147 \times 295 \times 305}{10}$$

$$= 151854.8 \text{ J K}^{-1} \text{ mol}^{-1} \text{ or}$$

$$E_a = 151.854 \text{ kJ mol}^{-1}$$

Question 11**[2]**Given: $\Delta T_b = 0.032 \text{ K}$, $w = 0.45\text{g}$, $W = 500\text{g}$ $K_b = 0.52 \text{ K kg mol}^{-1}$, $\text{NaCl} \longrightarrow \text{Na}^+ + \text{Cl}^-$, $i = 2$

$$M_{(\text{obs})} = \frac{i \times 1000 \times K_b \times w}{\Delta T_b \times W}$$

$$M_{(\text{obs})} = \frac{2 \times 1000 \times 0.52 \times 0.45}{0.032 \times 500}$$

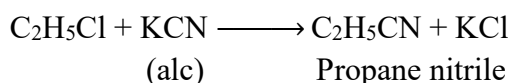
$$M_{(\text{obs})} = 29.25 \text{ g mol}^{-1}$$

SECTION C – 21 MARKS

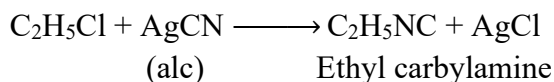
Question 12

[3]

Rehan's Reaction:



Ananya's Reaction:



Question 13

[3]

- (i) Given; $t = 5$ minutes, $a = 0.6$ moles litre⁻¹

$$(a - x) = 0.2 \text{ moles litre}^{-1}$$

$$\begin{aligned} K &= \frac{2.303}{t} \log_{10} \frac{a}{(a-x)} \\ &= \frac{2.303}{5} \log_{10} \frac{0.6}{(0.2)} \\ &= \frac{2.303}{5} \log 3 \\ &= \frac{2.303}{5} \times 0.477 \\ K &= 0.2197 \text{ min}^{-1} \end{aligned}$$

- (ii) The overall order of the following reactions are as follows:

(a) Rate = $k[\text{A}]^{1/2}[\text{B}]^{3/2}$

$$\text{overall order of reaction} = \frac{1}{2} + \frac{3}{2} = 2$$

(b) Rate = $k[\text{A}]^{3/2}[\text{B}]^{-1}$

$$\text{overall order of reaction} = \frac{3}{2} - 1 = \frac{1}{2}$$

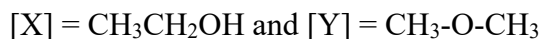
(c) Rate = $k[\text{A}]^1[\text{B}]^2$

$$\text{overall order of reaction} = 1 + 2 = 3$$

Question 14

[3]

- (i) (a) Functional isomers



- (b) Compound [Y] will have lower boiling point as it is an ether which cannot form associated molecules by intermolecular hydrogen bond.

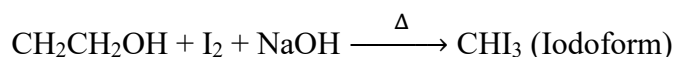
- (ii)



Methanol does not have $\text{CH}_3\text{-CH-}$ group and therefore, does not give iodoform test

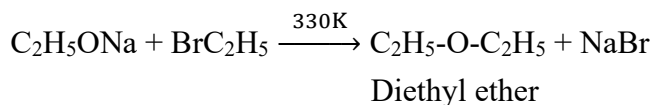


Ethanol contains $\text{CH}_3\text{-CH-}$ group give iodoform test

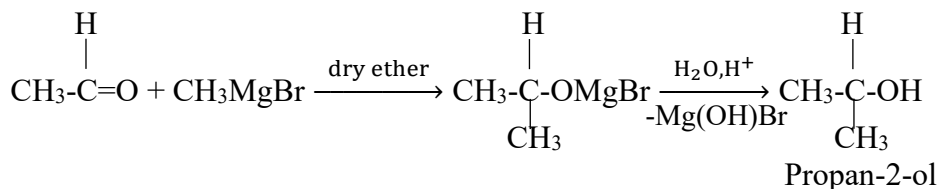


OR

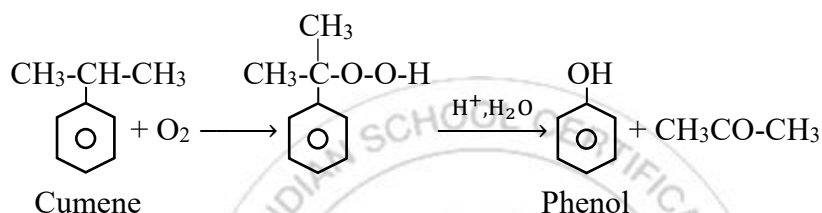
- (iii) (a) Diethyl ether from sodium ethoxide



- (b) Propan-2-ol from Grignard's reagent



- (c) Phenol from Cumene

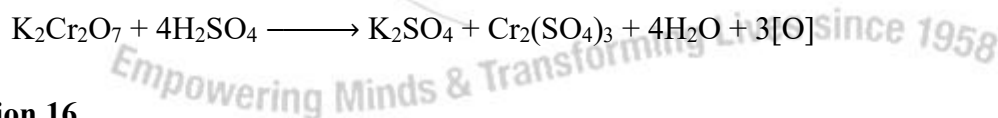


Question 15

[3]

- (i) $2\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 + 5\text{H}_2\text{S} \longrightarrow \text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 8\text{H}_2\text{O} + 5\text{S}$
- (ii) Atoms of transition metal can easily take place in the crystal lattice of another metal in the molten state and are miscible with each other and thus form alloys.
- (iii) Potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) acts as a powerful oxidising agent in acidic medium. In the presence of dilute sulphuric acid, $\text{K}_2\text{Cr}_2\text{O}_7$ liberates nascent oxygen and therefore, acts as an oxidising agent.

Or



Question 16

[3]

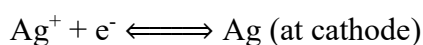
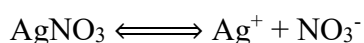
- (i) Sucrose
- (ii) Primary structure
- (iii) (a) Rickets – Vitamin D
(b) Night blindness – Vitamin A

Question 17

[3]

- (i) Cell [X] contains AgNO_3

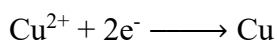
The reaction may be represented as follows



- (a) 1 mole or 108 g of Ag is deposited by 96500 coulombs

$$1.45 \text{ g of Ag is deposited by } \frac{96500 \times 1.45}{108} = 1295.6 \text{ coulombs}$$

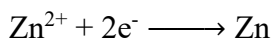
(b) In cell [Y] the electrode reaction is:



2 x 96500 coulombs of current will deposit 63.5 g of Cu

1295.6 coulombs of current will deposit $\frac{63.5 \times 1295.6}{2 \times 96500} = 0.426$ g of Cu

In cell [Z] the electrode reaction is:



2 x 96500 coulombs of current will deposit 65.3 g of Zn

1295.6 coulombs of current will deposit $\frac{65.3 \times 1295.6}{2 \times 96500} = 0.438$ g of Zn

OR

(ii) Given; $\Lambda_m^0(\text{NaI}) = 126.9 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$

$$\Lambda_m^0(\text{CH}_3\text{COONa}) = 91.0 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

$$\Lambda_m^0(\text{CH}_3\text{COO})_2\text{Mg} = 126.9 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

The molar conductivity at infinite dilution for MgI_2 may be calculated as:

$$\Lambda_m^0(\text{MgI}_2) = \Lambda_m^0(\text{CH}_3\text{COO})_2\text{Mg} + 2\Lambda_m^0(\text{NaI}) - 2\Lambda_m^0(\text{CH}_3\text{COONa})$$

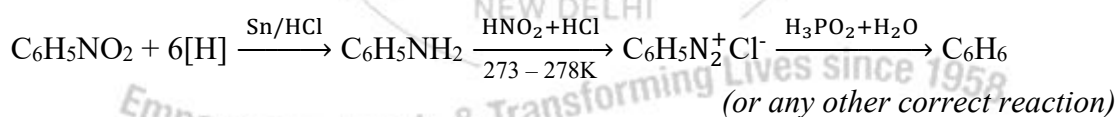
$$= 187.8 + 2(126.9) - 2(91.0)$$

$$= 259.6 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

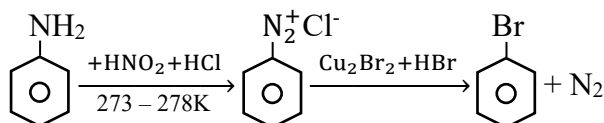
Question 18

[3]

(i) Nitrobenzene to benzene

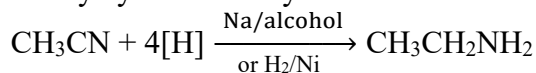


(ii) Aniline to bromobenzene



(or any other correct reaction)

(iii) Methylcyanide to ethylamine



SECTION D – 15 MARKS

Question 19

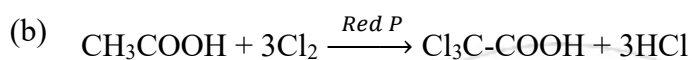
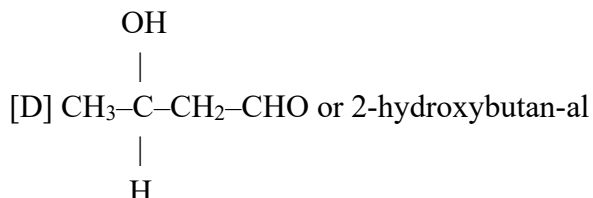
[5]

- (i) (a) Identify the compounds A, B, C and D

[A] $\text{Cl}_3\text{C}-\text{COOH}$ or trichloroacetic acid

[B] CH_3COOH or acetic acid

[C] CH_3CHO or acetaldehyde



[B]

Hell-Volhard-Zelinsky (HVZ) reaction

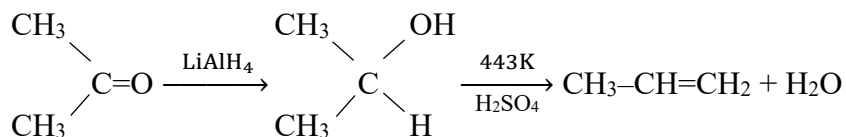
- (c) Compound [C] acetaldehyde gives Tollen's reagent test (silver mirror), Fehling's solution test (Red ppt of Cu_2O), Schiff's reagent test (pink colour), whereas acetone does not response to these tests. *(or any other correct test)*
- (d) Compound [A] i.e. trichloroacetic acid will be more acidic due to the electron withdrawing tendency of Cl atoms (-I effect). It stabilises the carboxylate anion by dispersing the negative charge and therefore, strengthening the acid. Compound [B] i.e. acetic acid is less acidic due to the absence of -I effect.

OR

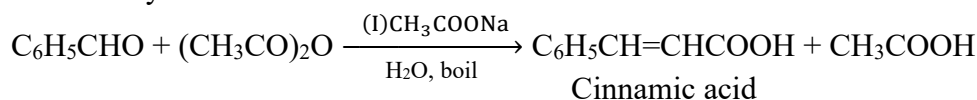
- (ii) (a) [A] CH_3CHO
[B] $\text{CH}_3\text{CHOHCH}_3$
[C] CH_3COCH_3

- (b) [A] CH_3CHO
[B] CH_3COOH
[C] CH_3COCl

- (iii) (a) Acetone to Propene



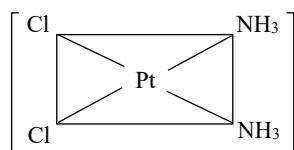
- (b) Benzaldehyde to cinnamic acid



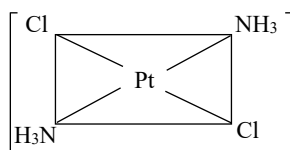
Question 20

[5]

- (i) (a) diamminedichloridoplatinum (II)



cis-diamminedichlorido
platinum(II)

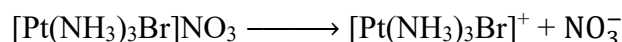


trans- diamminedichlorido
platinum(II)

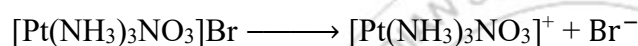
Geometrical isomerism

- (b) Square planar geometry

- (ii) Ionisation isomers

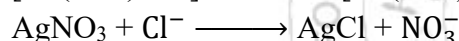
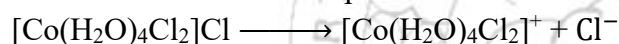


Aqueous solution of this isomer when heated strongly with conc. H_2SO_4 gives brown fumes of NO_2 . It also gives brown ring test with freshly prepared FeSO_4 solution and conc. H_2SO_4 .



Aqueous solution of this isomer when reacts with AgNO_3 solution gives yellow precipitate of AgBr which is sparingly soluble in excess of NH_4OH .

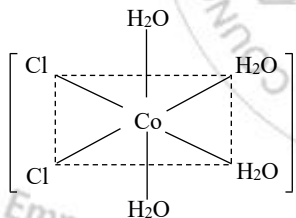
- (iii) Structural formula of compound is



(aq)

ppt

Formula:



IUPAC Name – tetraaquadichlorocobalt(III)chloride

Question 21

[5]

- (i) (a) Given; $\pi = 3.05 \times 10^{-3}$ atm, $T = 298\text{K}$

$$V = \frac{300}{1000} = 0.3\text{Lit}, w = 1.85 \text{ g}$$

$$\pi = CRT = \frac{w \times R \times T}{m \times V}$$

$$m = \frac{1.85 \times 0.0821 \times 298}{3.05 \times 10^{-3} \times 0.3}$$

$$m = 49466 \text{ g mol}^{-1}$$

- (b) Given; $k_f = 5.12 \text{ K kg mol}^{-1}$, $\Delta T_f = 0.85 \text{ K}$,
 $m = 94 \text{ g mol}^{-1}$, $w = 2.5 \text{ g}$, $W = 120 \text{ g}$
 $n = 2$

$$m_{(\text{observed})} = \frac{1000 \times k_f \times w}{\Delta T_f \times W}$$

$$m_{(\text{obs})} = \frac{1000 \times 5.12 \times 2.5}{0.85 \times 120} \\ = 125.49 \text{ g mol}^{-1}$$

$$(i) = \frac{M_{(\text{normal})}}{M_{(\text{observed})}} = \frac{94}{125.49} = 0.749$$

$$\alpha (\text{degree of association}) = \frac{1-i}{1-\frac{1}{n}} = \frac{1-0.749}{1-\frac{1}{2}} \\ = \frac{0.251}{0.5} = 0.502 \text{ or } 50.2\%$$

- (c) The observed molecular mass of potassium chloride will be half of its theoretical molecular mass. The depression in freezing point is a colligative property which depends upon the number of solute particles present in solution. KCl is a strong electrolyte, it furnishes two ions $\text{KCl} \rightarrow \text{K}^+ + \text{Cl}^-$.

The observed molecular mass of sucrose as determined by depression in freezing point method will be same as the theoretical molecular mass.

OR

- (ii) (a) Osmotic pressure is a colligative property which depends upon the number of solute particles.

Osmotic pressure $\propto$ No. of solute particles

$$(1) \text{ Moles of urea} = \frac{\text{wt. of urea}}{\text{mol. wt. of urea}} = \frac{6}{60} = 0.1 \text{ moles} \\ 1 \text{ mole of urea} = 6.023 \times 10^{23} \times 0.1 = 6.023 \times 10^{22} \text{ particles}$$

$$(2) \text{ Moles of glucose} = \frac{\text{wt. of glucose}}{\text{mol. wt. of glucose}} = \frac{72}{180} = 0.4 \text{ moles} = 6.023 \times 10^{23} \times 0.4 \\ = 24.092 \times 10^{22} \text{ particles}$$

$$(3) \text{ Moles of sodium chloride} = \frac{\text{wt. of NaCl}}{\text{mol. wt. of NaCl}} = \frac{5.85}{58.5} = 0.1 \text{ moles} \\ 1 \text{ mole of NaCl} = 2 \times 6.023 \times 10^{23} \text{ particles, } \text{NaCl} \rightarrow \text{Na}^+ + \text{Cl}^- \\ 0.1 \text{ mole of NaCl} = 2 \times 6.023 \times 10^{23} \times 0.1 = 12.046 \times 10^{22} \text{ particles}$$

Therefore, increasing order of their osmotic pressure is:

Urea < NaCl < glucose

- (b) Given: wt. of $\text{C}_2\text{H}_5\text{OH} = 92 \text{ g}$, wt. of $\text{H}_2\text{O} = 540 \text{ g}$
 mol. wt. of $\text{C}_2\text{H}_5\text{OH} = 46 \text{ g mol}^{-1}$, mol. wt. of $\text{H}_2\text{O} = 18 \text{ g}$

$$\text{No. of moles of } \text{C}_2\text{H}_5\text{OH} (n) = \frac{92}{46} = 2 \text{ moles}$$

$$\text{No. of moles of } \text{H}_2\text{O} (N) = \frac{540}{18} = 30 \text{ moles}$$

$$\text{Mole fraction of } \text{C}_2\text{H}_5\text{OH} = \frac{n}{n+N} = \frac{2}{2+30} = \frac{2}{32}$$

$$X_{(\text{C}_2\text{H}_5\text{OH})} = 0.0625$$

$$\text{Mole fraction of water } (\text{H}_2\text{O}) = \frac{N}{n+N} = \frac{30}{2+30} = \frac{30}{32}$$

$$X_{(\text{H}_2\text{O})} = 0.9375$$

- (c) The mixture of chloroform and acetone is an example of maximum boiling azeotrope. It shows negative deviation from Raoult's Law because of the increase in intermolecular forces of attraction between chloroform and acetone, since they form hydrogen bonds between them.

