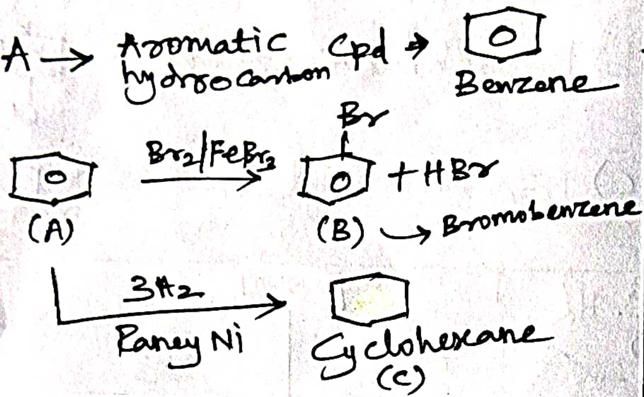
 ① (+1)

+1 Public
Organic Chemistry Problems

① Aromatic hydrocarbon cpd (A) $\xrightarrow{Br_2}$ B [Mar-2019]
(A) $\xrightarrow{Raney\ Ni}$ C   A, B, C = ?

A → Aromatic hydrocarbon cpd → Benzene



(A) $\xrightarrow{Br_2/FeBr_3}$ (B) + HBr, (B) → Bromobenzene
(A) $\xrightarrow[Raney\ Ni]{3H_2}$ Cyclohexane (C)

② $R-C\equiv N \xrightarrow{H_2O/H^+}$ (A) $\xrightarrow{H_2O/H^+}$ B [Mar-19]

$R-CN \xrightarrow{H_2O/H^+} RCONH_2$ Amide (A) $\xrightarrow{H_2O/H^+} RCOOH$ (B) Carboxylic acid.

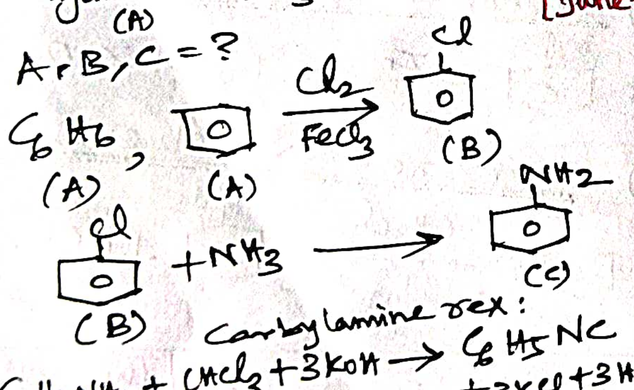
③ C_2H_6O (A) $\xrightarrow[Conc\ H_2SO_4]{\Delta}$ B $\xrightarrow[cold\ alk.KMnO_4]{dilute}$ C [June-19]

A, B, C = ?

C_2H_5OH (A) $\xrightarrow[Conc\ H_2SO_4]{\Delta} CH_2=CH_2$ (B) $\xrightarrow{Bayer\ reagent}$ $CH_2(OH)-CH_2(OH)$ (C)

④ Aromatic hydrocarbon (A) $\xrightarrow[FeCl_3]{Cl_2}$ B $\xrightarrow{NH_3}$ C $\xrightarrow{Carbyl\text{-}amine\ rex}$ [June-19]

A, B, C = ?

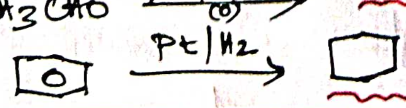


C_6H_6 (A); (A) $\xrightarrow[FeCl_3]{Cl_2}$ (B); (B) + NH_3 → (C)

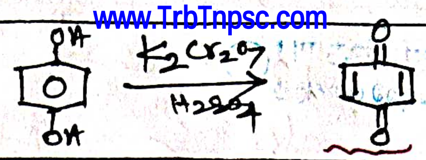
Carbylamine rex:
$C_6H_5NH_2$ (C) + $CHCl_3 + 3KOH \rightarrow C_6H_5NC + 3KCl + 3H_2O$

⑤ A) $CH_2=CH_2 \xrightarrow[Peroxide\ HBr]{Benzoyl} CH_3CH_2Br$ [Sep-20]

B) $CH_3CHO \xrightarrow[(O)]{Acid\ dichromate} CH_3COOH$

C) 

$\xrightarrow{Pt/H_2}$

d) 

$\xrightarrow[H_2SO_4]{K_2Cr_2O_7}$

6. [Sep-21] a) $CH_3CH=CH_2 + H_2 \xrightarrow{Pt} CH_3CH_2CH_3$

b) $CH_3MgCl + H_2O \rightarrow CH_4 + Mg(OH)Cl$

7. Simplest alkene (A) + HBr → B [SEP-21] [May-22]

B + NH_3 → C, A, B, C = ?

Simplest alkene is $CH_2=CH_2$

$CH_2=CH_2$ (A) + HBr → CH_3CH_2Br (B)

CH_3CH_2Br (B) + NH_3 → $CH_3CH_2NH_2$ (C)

Ans:
A → $CH_2=CH_2$ → Ethylene
B → CH_3CH_2Br → Bromo ethane
C → $CH_3CH_2NH_2$ → Ethylamine

8. [May-22]
(i) $C_6H_5Cl + 2NH_3 \xrightarrow[50\,atm,\ -NH_4Cl]{250°C} C_6H_5NH_2$

(ii) $C_6H_5Cl + C_6H_5Cl + 2Na \xrightarrow[\Delta]{Ether} C_6H_5-C_6H_5$
↳ Fittig reaction.

9. C_2H_4 (A) + Cl_2 → B; A + HBr → C [July-22]

A, B, C = ?

A → $CH_2=CH_2$ → Ethene

$CH_2=CH_2$ (A) $\xrightarrow{Cl_2}$ $CH_2(Cl)-CH_2(Cl)$ (B)

$CH_2=CH_2$ (A) $\xrightarrow{HBr}$ CH_3CH_2Br (C)

Ans:
A → $CH_2=CH_2$ → Ethene
B → $CH_2(Cl)-CH_2(Cl)$ → 1,2-dichloro ethane
C → CH_3CH_2Br → Bromo ethane

* Alkane → ...

10. C_2H_5Cl (A) $\xrightarrow{\text{aqueous KOH}}$ B [Mar-23]

C_2H_5Cl (A) $\xrightarrow{\text{alc. KOH}}$ C A,B,C=?

A → CH_3CH_2Cl

CH_3CH_2Cl (A) $\xrightarrow{\text{aqueous KOH}}$ CH_3CH_2OH (B)

CH_3CH_2Cl (A) $\xrightarrow{\text{alc KOH}}$ $CH_2=CH_2$ (C)

Ans:
A → CH_3CH_2Cl → Chloroethane
B → CH_3CH_2OH → Ethanol
C → $CH_2=CH_2$ → Ethene.

11. CH_3CH_2OH $\xrightarrow[430-440K]{\text{Conc. } H_2SO_4}$ A [Jun-23]

A $\xrightarrow[\text{Benzoyl peroxide}]{HBr}$ B A,B=?

CH_3CH_2OH $\xrightarrow{\text{Conc. } H_2SO_4}$ $CH_2=CH_2$ (A)

$CH_2=CH_2$ (A) $\xrightarrow[\text{Benzoyl Peroxide}]{HBr}$ CH_3CH_2Br (B)

Ans: A → $CH_2=CH_2$ → Ethene
B → CH_3CH_2Br → Bromoethane

12. (i) $CaC_2 \xrightarrow{2H_2O} CH\equiv CH + Ca(OH)_2$ [Jun-23]
Ethyne

(ii) DDT: [Jun-23]

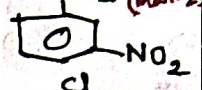
$CCl_3CH=O$ + chlorobenzene + chlorobenzene
Chloral

↓ Conc. H_2SO_4

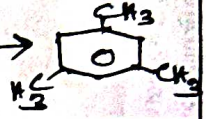
CCl_2CH(C$_6$H$_4$Cl)(C$_6$H$_4$Cl) + H_2O
DDT.
(p,p'-dichlorodiphenyl trichloro ethane)

13. Which is the suitable method for detection of N_2 Present in food and fertilizers? Kjeldhal method [Mar-19]

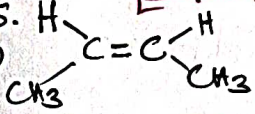
14. Give Structural formula [Mar-19] [Mar-23]

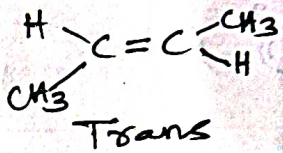
a) m-dinitrobenzene → 

b) p-dichlorobenzene → 

c) 1,3,5-Trimethyl benzene → 

15. [Sep-20] [Mar-19]

a) 
cis

b) 
Trans

16. IUPAC Names: [Mar-19]

a) $CH_3-\overset{2}{C}H(\overset{1}{C}H_3)-\overset{3}{C}H_2-\overset{4}{C}H_3$ → 2-methyl butane

b) $CH_3-\overset{2}{C}(\overset{1}{C}H_3)(CH_3)-\overset{3}{C}H_3$ → 2,2-dimethyl Propane

17. Conversions: [Mar-19]

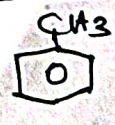
a) Acetylene → Benzene: [Sep-21]

$CH\equiv CH$ $\xrightarrow[\text{Iron tube}]{\text{Red Hot}}$ 
873K Benzene

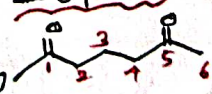
b) Phenol → Benzene:

 $\xrightarrow{Zn}$  + ZnO

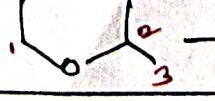
c) Benzene → Toluene:

 $\xrightarrow[\text{Anhydrous } AlCl_3]{CH_3Cl}$  + HCl.

18. IUPAC:- [Jun-2019]

x)  → 5-oxohexanoic acid

y) $CH_3-\overset{2}{C}\equiv\overset{3}{C}-\overset{4}{C}H(Cl)-\overset{5}{C}H_3$ → 4-chloro Pent-2-yne

z)  → 2-ethoxy Propane.

* o-dichloro benzene, p-dichloro benzene which has higher melting point? explain. [Jun-19]
the p-isomer is more symmetrical than other 2 isomers so it has more Closely packed arrangement of molecules in its Crystal lattice.

* Geometrical isomerism of 2-butene → (3) $CH_3-CH=CH-CH_3$ → Trans, cis (Sep-20)

19. a) IUPAC:- [Sep-21]

1) 3-methylpentane ⇒ $CH_3-CH_2-\underset{CH_3}{CH}-CH_2CH_3$

2) 2-methyl propan-2-ol ⇒ $CH_3-\underset{CH_3}{\overset{CH_3}{C}}-OH$

3) Propanone ⇒ CH_3COCH_3

20. Ethyl chloride → Ethane:- [May-22]

$CH_3CH_2Cl \xrightarrow[[H]]{In/HCl} CH_3-CH_3$

21. Ethylene $\xrightarrow[\text{alkaline } KMnO_4]{\text{cold dilute}}$? [May-22]

$CH_2=CH_2 \xrightarrow[\text{reagent}]{\text{Bayer's}} \underset{OH}{CH_2}-\underset{OH}{CH_2}$ Ethan-1,2-diol.

22. IUPAC: [May-22] [Jun-23]

(i) $CH_3-\underset{CH_3}{\overset{3}{CH}}-\underset{Br}{\overset{2}{CH}}-\overset{1}{CH_3}$ → 2-bromo-3-methyl butane

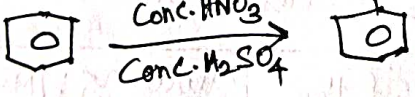
(ii) CH_3-O-CH_3 → Methoxymethane

(iii) $CH_3-\underset{OH}{\overset{2}{CH}}-CHO$ → 2-hydroxy butanal

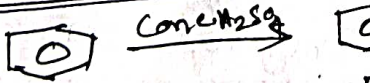
(iv) $CH_2=CH-CH=CH_2$ → buta-1,3-diene

(v) $CH_3-C\equiv C-\underset{Cl}{CH}-CH_3$ → 4-Chloro Pent-2-yne

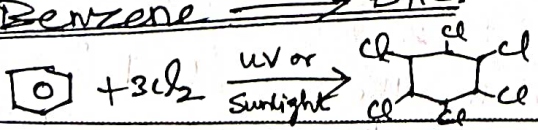
23 (i) Benzene → Nitrobenzene: [May-22]



(ii) Benzene → Benzene Sulphonic acid:



(iii) Benzene → BHC:-



24. Kolbe's electrolytic method: [Jun-22]

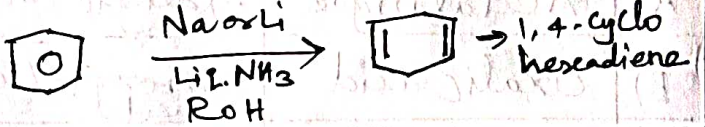
CH_2COOK / CH_2COOK (Potassium Succinate) $\xrightarrow{\text{Electrolysis}}$ $CH_2=CH_2$ (ethene) $+ 2CO_2 + 2KOH + H_2$

25. Haloalkanes from alcohol: [Jun-22]

(i) $CH_3CH_2OH \xrightarrow{SOCl_2} CH_3CH_2Cl + SO_2 + HCl$

(ii) $CH_3CH_2OH \xrightarrow{PCl_5} CH_3CH_2Cl + P(OH)_3 + HCl$

26. Birch reduction: [Jun-22]



27. (i) Non-benzonoid aromatic compound: [Jun-22]
example: azulene, Tropolone

(ii) Aromatic heterocyclic compound
ex: Furan, Pyridine, Pyrroll.

(iii) Carbocyclic Compound:
ex: Cyclopropane, Cyclobutane.

28. (i) $CH_3MgI \longrightarrow CH_3CHO$ [Jun-22] [Mar-23]

$H-\underset{\underset{O}{\|}}{C}-OC_2H_5 + CH_3MgI \rightarrow H-\underset{CH_3}{\overset{OMgI}{C}}-OC_2H_5 \xrightarrow{H_2O/H^+} CH_3CHO + Mg\overset{I}{\underset{OC_2H_5}{}}$

(ii) $CH_3MgI \longrightarrow$ Acetone:

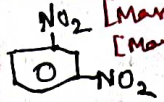
$CH_3COCl + CH_3MgI \rightarrow CH_3-\underset{Cl}{\overset{CH_3}{C}}-OMgI \xrightarrow{H_2O/H^+} \underset{CH_3}{\overset{CH_3}{>}}C=O + CH_3MgI$

* The bond length between all the 4 C atoms in same in 1,3-Butadiene Explain with reason. [J-19]
1,3-butadiene is a conjugated molecule with 4 overlapping p-orbital on adjacent atoms and a delocalised electron over 4 atoms. This shortens the bond length of

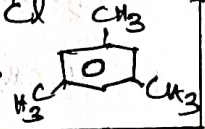
(iii) $CH_3MgI \longrightarrow$ Methane:

$CH_3MgI + HOH \longrightarrow CH_4 + Mg\begin{matrix}I\\OH\end{matrix}$

29. IUPAC: [Structural formula]

(i) m-dinitro benzene →  [Mar-23] [Mar-19]

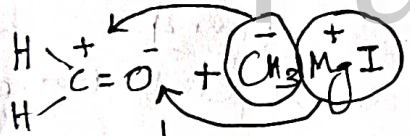
(ii) p-dichloro benzene → 

(iii) 1,3,5-trimethyl benzene → 

30. [Mar-23]

	Compound	Functional group
A)	Acetaldehyde	Aldehyde (-CHO)
B)	Oxalic acid	Carboxylic acid (-COOH)
C)	Dimethyl ether	Ether (-O-)
D)	Methylamine	Amine ($-NH_2$)

31. A) $CH_3MgI \longrightarrow$ Ethyl alcohol:- (Mar-23)



$CH_3CH_2O\{MgI, H, OH \xrightarrow{H^+} CH_3CH_2OH + Mg\begin{matrix}I\\OH\end{matrix}$

B) $CH_3MgI \longrightarrow$ Ethyl methyl ether: (Mar-23)

$CH_3OCH_2Cl + CH_3MgI \longrightarrow CH_3OCH_2CH_3 + Mg\begin{matrix}I\\Cl\end{matrix}$

+1 Public Physical Chemistry

Sums:

1. Both C_2H_2 and CO_2 have the same structure. Explain why. [Mar-19]

* C_2H_2 and CO_2 has SP hybridisation linear structure. The linear structure of ethyne and that of CO_2 is explained on the basis of hybridisation. Ethyne molecule is formed when both the Carbon atoms undergo SP hybridisation and have 2 unhybridised orbitals (2py and 2pz).

2. Calculate the entropy change during the melting of one mole of ice into H_2O at 0°C. enthalpy of fusion of ice is 6008 J/mol. [Sep-20] [Mar-19] [Mar-23]

Ans: Given:

$\Delta H_{fusion} = 6008\ J/mol$, $T_{fusion} = 0°C = 273K$

$$\Delta S_{fusion} = \frac{\Delta H_{fusion}}{T_{fusion}} = \frac{6008\ J/mol}{273\ K}$$

$$\Delta S_{fusion} = 22.007\ J\,K^{-1}mol^{-1}$$

3. Write the balanced chemical equation for the $K_C = \frac{[CaO]_{(s)}[CO_2]_{(g)}}{[CaCO_3]_{(s)}}$ [Mar-19]

Ans:

$$CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$$

4. NH_3 and Hcl do not obey Henry's law Why? [Mar-19]

Ans: NH_3 and Hcl reacts with solvent H_2O.

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

5. Structure of the following: [Mar-19] [Sep-20]

A) NH_3 → Pyramidal

B) BF_3 → Trigonal Planar

6. $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ [Mar-19]

Calculate the standard entropy change for the above reaction, given the standard entropies of $CO_{2(g)}$, $C_{(s)}$, $O_{2(g)}$ are

are 213.6, 5.740 and 205 JK^{-1} respectively.

Ans:

$\Delta S^\circ_r = \Sigma S^\circ_{Products} - \Sigma S^\circ_{reactants}$

$\Delta S^\circ_r = \{S^\circ_{CO_2}\} - \{S^\circ_C + S^\circ_{O_2}\}$

$\Delta S^\circ_r = 213.6 - \{5.74 + 205\}$

$\Delta S^\circ_r = 213.6 - 210.74 \Rightarrow 2.86\ JK^{-1}$

7. Calculate the formal charge on C & O for the following structure [June-19]

$\ddot{O} = C = \ddot{O}$

Formal charge on C $\Rightarrow N_v - \left[N_l + \frac{N_b}{2}\right]$

$\rightarrow 4 - [0 + 8/2] \rightarrow 0$

Formal charge on O $\Rightarrow N_v - \left[N_l + \frac{N_b}{2}\right]$

$\rightarrow 6 - [4 + 4/2]$

$\Rightarrow 0$ [for both oxygens]

8. What is the mass of glucose ($C_6H_{12}O_6$) in it one litre solution which is isotonic with 6 gl^{-1} of urea (NH_2CONH_2)? [June-19]

Osmotic pressure of urea solution $(\pi) = CRT$

$\pi_1 = \frac{W_2}{M_2 V} RT = \frac{6}{60 \times 1} \times RT$

Osmotic Pressure of glucose solution

$\pi_2 = \frac{W_2}{180 \times 1} \times RT$

for isotonic solution $= \pi_1 = \pi_2$

$\frac{6}{60} RT = \frac{W_2}{180} RT$; $W_2 = \frac{6}{60} \times 180$

$W_2 = 18g$

9. Calculate the mole fraction of methanol and H_2O when 0.5 mole of methanol is mixed with 1.5 moles of H_2O. [Sep-20]

Mole fraction of ethanol $\Rightarrow$ $\frac{\text{No. of moles of ethanol}}{\text{Total no of moles of ethanol} + H_2O}$

$= \frac{0.5}{1.5+0.5} = \frac{0.5}{2.0} = 0.25$

Mole fraction of H_2O $= \frac{\text{No of moles of } H_2O}{\text{Total no of moles of ethanol \& } H_2O}$

$= \frac{1.5}{1.5+0.5} = \frac{1.5}{2.0} = 0.75$

10. Shapes of molecules by VSEPR theory: [Sep-21] [Jun-22]

a) $BeCl_2$ → Linear
b) NH_3 → Pyramidal
c) H_2O → Bent (V-shaped)
d) BF_3 → Trigonal planar
e) BrF_3 → T-shaped
f) PCl_5 → Trigonal bipyramidal
g) SF_6 → Octahedral
h) IF_7 → Pentagonal bipyramidal

11. Hybridisation of CH_4 $\Rightarrow$ SP^3 [Sep-21]

12. Inside a certain automobile engine the volume of air in a cylinder is 0.375 dm^3 when the pressure is 1.05 atm. When the gas is compressed to a volume of 0.125 dm^3 at the same temperature, what is the pressure of the compressed air? [Sep-21]

$V_1 = 0.375\ dm^3$ $V_2 = 0.125\ dm^3$

$P_1 = 1.05$ atm $P_2 = ?$ $T \Rightarrow$ Constant

$P_1V_1 = P_2V_2$

$P_2 = \frac{P_1V_1}{V_2} = \frac{1.05 \times 0.375}{0.125} = 3.15$ atm

13. Write a balanced chemical equation for $K_c = \frac{[NH_3]^4 [O_2]^5}{[NO]^4 [H_2O]^6}$ [May-22]

Ans: $4NO + 6H_2O \rightleftharpoons 4NH_3 + 5O_2$

14. Write the formula to calculate the molar mass of a solute from relative lowering of vapour pressure values.

Ans:

$$M_B = \frac{W_B \times M_A}{W_A} \times \frac{p^\circ - p}{p^\circ}$$

21. A sample of gas at 15°C at 1 atm has a volume of 2.58 dm³ when the temperature is raised to 38°C at 1 atm does the volume of the gas increase? If So calculate the final volume. (6) [June-23]

15. The equilibrium Concentrations of NH_3, N_2, H_2 are 1.8×10^{-2}M, 1.2×10^{-2}M and 3×10^{-2}M respectively. Calculate the equilibrium constant for the formation of NH_3 from N_2 and H_2. [May-22]

Given:-

$[NH_3] = 1.8\times10^{-2}$M $[N_2] = 1.2\times10^{-2}$M

$[H_2] = 3\times10^{-2}$M, K_c = ?

Ans: $N_2 + 3H_2 \rightleftharpoons 2NH_3$

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$K_c = \frac{(1.8\times10^{-2})^2}{1.2\times10^{-2}\times(3\times10^{-2})^3}$$

$K_c = 1\times10^3\ L^2\ mol^{-2}$

16. 50g of tab H_2O Contains 20 mg of dissolved solids. what is the TDS Value in ppm? [July-22]

Ans:

$$\text{TDS Value (ppm)} = \frac{\text{Mass of the dissolved solids}}{\text{Mass of } H_2O}\times10^6$$

$$\text{TDS Value (ppm)} = \frac{20\times10^{-3}\text{ g}}{50\text{ g}}\times10^6$$

$= 400$ ppm

17. If an automobile engine burns Petrol at a temperature of 1089K and if the surrounding temperature is 294K, Calculate its maximum Possible efficiency. [July-22]

$$\%\ \text{Efficiency} = \left[\frac{T_h - T_c}{T_h}\right]\times100$$

Here $T_h = 1089$K, $T_c = 294$K

$$= \left(\frac{1089-294}{1089}\right)\times100 \Rightarrow 73\%$$

18. At particular temperature $K_c = 4\times10^{-2}$ for the reactions

$H_2S \rightleftharpoons H_2 + \frac{1}{2}S_2$

Calculate K_c for each of the following reactions. [July-22]

(i) $2H_2S \rightleftharpoons 2H_2 + S_2$

(ii) $3H_2S \rightleftharpoons 3H_2 + \frac{3}{2}S_2$

Ans:

$K_c = 4\times10^{-2}$ for the reaction

$H_2S \rightleftharpoons H_2 + \frac{1}{2}S_2$

$$K_c = \frac{[H_2][S_2]^{1/2}}{[H_2S]} = 4\times10^{-2}$$

(i) For the reaction,

$2H_2S \rightleftharpoons 2H_2 + S_2$

$$K_c = \frac{[H_2]^2[S_2]}{[H_2S]^2} = (4\times10^{-2})^2 = 16\times10^{-4}$$

(ii) for the reaction,

$3H_2S \rightleftharpoons 3H_2 + \frac{3}{2}S_2$

$$K_c = \frac{[H_2]^3[S_2]^{3/2}}{[H_2S]^3} = (4\times10^{-2})^3 = 64\times10^{-6}$$

19. Lewis Structure: [Mar-23]

(i) HNO_3 : Valence e⁻s : 1+5+18 = 24e

(ii) Water: H_2O 

Valence e⁻s : 2+6 = 8

20. Write K_p and K_c for the reaction:

$2CO_{(g)} \rightleftharpoons CO_{2(g)} + C_{(s)}$ [June-23]

$$K_c = \frac{[CO_2]}{[CO]^2}\ ;\ K_p = \frac{P_{CO_2}}{P_{CO}^2}$$

Ans:- Given: $T_1 = 15°C = 288K$ $T_2 = 38°C = 311K$ $V_1 = 2.58\ dm^3$ V_2 = ? $P_2 = 1$ atm

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}\ ;\ V_2 = \left(\frac{V_1}{T_1}\right)T_2 = \frac{2.58\ dm^3}{288K}\times311K \Rightarrow V_2 = 2.78\ dm^3$$

Volume increased from 2.58 dm³ to 2.78 dm³

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+1 Public Inorganic Chemistry Sums:

1. Calculate the equivalent mass of H_2SO_4 [March-2019]

H_2SO_4 basicity = 2 eq mol^{-1}

Molar mass of H_2SO_4 → (2×1) + (1×32) + (4×16) → 98 g/mol

Gram equivalent mass of H_2SO_4 = $\frac{98}{2}$ = 49 g eq^{-1}

2. Explain why $Ca(OH)_2$ is used in White washing? [Mar-19]

In White wash due to its disinfectant nature.

3. Calculate the oxidation number of oxygen in H_2O_2 [Mar-19]

$\overset{-1}{H_2O_2}$

$2(+1) + 2x = 0$

$2 + 2x = 0$; $2x = -2$; $x = -1$

4. Complete the following equation: [Mar-19]

$Na_2O_2 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O_2$

5. Among the alkaline earth metals BeO is insoluble in H_2O but other oxides are soluble. Why? [Mar-19]

BeO is covalent in nature, while other alkaline earth metal oxides are ionic in nature.

6. A compound having the empirical formula C_6H_6O has the Vapour density 47. Find its molecular formula

Empirical formula → C_6H_6O

Empirical mass = [(6×12) + (6×1) + (1×16)] = 94

$n = \frac{\text{Molar mass}}{\text{Empirical mass}} = \frac{2 \times \text{Vapour density}}{94} = \frac{2 \times 47}{94} = \frac{94}{94} = 1$

Molecular formula = n × Empirical formula = $1 \times C_6H_6O = C_6H_6O$

7. Calculate the orbital angular momentum for d & f orbital. [June-19]

Angular momentum = $\sqrt{l(l+1)}\,\frac{h}{2\pi}$

For d-orbital, $l = 2$ = $\sqrt{2(2+1)}\ h/2\pi$

= $\sqrt{6}\ h/2\pi$

For F-orbital $l = 3$ = $\sqrt{3(3+1)}\ h/2\pi$

= $\sqrt{12}\ h/2\pi$

= $2\sqrt{3}\ h/2\pi = \frac{\sqrt{3}h}{\pi}$

8. Ionisation potential of N is greater than that of O Explain [June-19]

$_7N \rightarrow 1s^2 2s^2 2p^3$ (2p: ↑ ↑ ↑)

$_8O \rightarrow 1s^2 2s^2 2p^4$ (2p: ↑↓ ↑ ↑)

Nitrogen has half filled and more stable configuration due to symmetry. But oxygen is partially filled so N > O.

9. Among the alkalimetal halides which is covalent? Explain. [June-19]

Among the alkalimetal halides LiI shows covalent character, as it is the smallest cation that exerts high polarising power on the iodide anion. Additionally the iodide ion being the largest can be polarised to a greater extent of Li^+ ion.

10. What are the n, l values for 3Px and $4dx^2-y^2$ e$^-$. [June-19]

3Px	n = 3	l = 1
$4dx^2-y^2$	n = 4	l = 2

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11. Why H_2O_2 is stored in Plastic bottles? Give reason. [June-19]

H_2O_2 is not stored in glass Container because it dissolves the alkali metals from the glass, which Catalyzes the disproportionation reaction.

$H_2O_2 \longrightarrow H_2O + \frac{1}{2}O_2$

12. Calculate the uncertainty in the position of an e^-, if the uncertainty in it Velocity is $5.7 \times 10^5 ms^{-1}$ [June-19]

Given: $\Delta V = 5.7 \times 10^5 ms^{-1}$ $\Delta x = ?$

$$\frac{h}{4\pi} = \frac{6.626 \times 10^{-34} Js}{4 \times 3.14} = 5.28 \times 10^{-35}$$

$m = 9.1 \times 10^{-31} kg$

$\Delta x \cdot \Delta P \geq h/4\pi$; $\Delta x \cdot m\Delta V \geq \frac{h}{4\pi}$

$$\Delta x \geq \frac{h}{4\pi} \times \frac{1}{m\Delta V}$$

$$\geq \frac{5.28 \times 10^{-35}}{9.1 \times 10^{-31} \times 5.7 \times 10^5}$$

$\Delta x \geq 1.017 \times 10^{-10} m$

13. Basicity of ortho-Phosphoric acid: [Sep-20]

H_3PO_4 (ortho Phosphoric acid) Basicity → 3 eq/mol

14. In degenerate orbitals why do the completely filled and half filled Configurations are more stable than the Partially filled Configurations? [Sep-20]

Reason:

(i) Symmetrical distribution of e^- in orbital

(ii) Exchange energy

15. Calculate the empirical formula and molecular formula of a Compound Containing 76.6% C, 6.38% of H, and rest oxygen. Its Vapour density is 47. [July-22] [Sep-20]

O ⇒ 100 − 76.6 = 17.02%

Element	%	Atomic Mass	Relative no of moles	simple ratio moles	simplest whole no ratio.
C	76.6	12	$\frac{76.6}{12} = 6.38$	$\frac{6.38}{1.06} = 6$	6
H	6.38	1	$\frac{6.38}{1} = 6.38$	$\frac{6.38}{1.06} = 6$	6
O	17.02	16	$\frac{17.02}{16} = 1.06$	$\frac{1.06}{1.06} = 1$	1

Empirical formula ⇒ C_6H_6O

Empirical mass $C_6H_6O = (6\times12)+(6\times1)+(1\times16)$
$= 94$

$$n = \frac{\text{Molar mass}}{\text{Empirical mass}} = \frac{2 \times \text{Vapour density}}{94} = \frac{2\times47}{94}$$

$n = \frac{94}{94} = 1$, Molecular formula = Empirical formula $\times n$

Molecular formula $= 1 \times C_6H_6O = C_6H_6O$

16. Calculate total no of angular nodes and radial nodes Present in 3d & 4f orbital. [Sep-20]

Orbital	n	l	Radial node (n-l-1)	Angular (l) node	Total no of nodes
3d	3	2	0	2	2
4f	4	3	0	3	3

17. Explain why the electron affinity of Be & N is almost zero. [Sep-20]

$_4Be \rightarrow 1s^2 2s^2$ (2s: ↑↓)

$_7N \rightarrow 1s^2 2s^2 2p^3$ (2p: ↑ ↑ ↑) Half filled,

These elements having fully filled s & half filled p orbital in their valence shell. Fully filled and Half filled orbitals are most stable due to symmetry. Therefore these elements would be having least tendency to accept e^-. So the e- affinities of Be, N are almost 0.

18. Empirical formula for the following:- [Sep-21]

a) Fructose ($C_6H_{12}O_6$) ⇒ CH_2O

b) Caffeine ($C_8H_{10}N_4O_2$) ⇒ $C_4H_5N_2O$

19. Calculate the maximum number of e⁻s that can be accommodated in L shell. [May-22]

Formula: $2n^2$ L shell is n=2

$2(2)^2 = 8$

20. Calculate the oxidation number of underlined elements: [May-22]

(i) $\overset{+4}{\underline{C}}O_2 \rightarrow x + 2(-2) = 0$

$x - 4 = 0$

$x = +4$

(ii) $H_2\overset{+6}{\underline{S}}O_4 \rightarrow 2(+1) + x + 4(-2) = 0$

$2 + x - 8 = 0$

$x - 6 = 0$

$x = +6$

21. How many orbitals are possible for n=4? [May-22]

n=4 l = 0, 1, 2, 3 → s, p, d, f → 1 + 3 + 5 + 7 ⇒ 16 orbitals.

22. Write the electronic configuration and orbital diagram for nitrogen? [May-22]

$_7N \rightarrow 1s^2 2s^2 2p^3$ (1s: ↑↓, 2s: ↑↓, 2p: ↑ ↑ ↑)

23. Give an example for ionic hydride and covalent hydride [July-22]

Ionic Hydride → LiH, CaH_2

Covalent Hydride → CH_4, C_2H_6, B_2H_6, NH_3, H_2O

24. Compare the Ionisation energy of Be & B [July-22]

$_4Be \rightarrow 1s^2 2s^2$ (2s: ↑↓)

$_5B \rightarrow 1s^2 2s^2 2p^1$ (2p: ↑ _ _)

Be having fullyfilled s orbital. fullyfilled orbitals are more stable due to symmetry. Therefore Be due to symmetry. Therefore Be more Ionisation energy than Partially filled B.

25. e⁻ configuration of Mn^{+2}, Cr^{3+} [July-22]

$Mn^{+2} \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^0$

$Cr^{3+} \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^0$

26. Balancing equation by oxidation Number method: [March-23]

(i) $KMnO_4 + Na_2SO_3 \rightarrow MnO_2 + Na_2SO_4 + KOH$

$Mn^{+7} + 3e^- \rightarrow Mn^{+4}$ (3e⁻)

$S^{+4} \rightarrow S^{+6} + 2e^-$ (2e⁻)

$2KMnO_4 + 3Na_2SO_3 \rightarrow MnO_2 + Na_2SO_4 + KOH$

$2KMnO_4 + 3Na_2SO_3 \rightarrow 2MnO_2 + 3Na_2SO_4 + KOH$

$2KMnO_4 + 3Na_2SO_3 + H_2O \rightarrow 2MnO_2 + 3Na_2SO_4 + 2KOH$

(ii) $Cu + HNO_3 \rightarrow Cu(NO_3)_2 + NO_2 + H_2O$

$Cu^0 \rightarrow Cu^{+2} + 2e^-$ (2e⁻)

$N^{+5} + 1e^- \rightarrow N^{+4}$ (1e⁻)

$Cu + 2HNO_3 \rightarrow Cu(NO_3)_2 + NO_2 + H_2O$

$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

27. Compound on analysis gave Na = 14.31%, S = 9.97% H = 6.22% O = 69.5%. Calculate Molecular formula of the compound. If all the Hydrogen in the compound is present in combination with O_2 as H_2O of Crystallisation [Molecular mass of the compound is 322] [March-23]

Element	%	Molar Mass	Relative no of atoms	Simple ratio
Na	14.31	23	$\frac{14.31}{23} = 0.62$	$\frac{0.62}{0.31} = 2$
S	9.97	32	$\frac{9.97}{32} = 0.31$	$\frac{0.31}{0.31} = 1$
H	6.22	1	$\frac{6.22}{1} = 6.22$	$\frac{6.22}{0.31} = 20$
O	69.5	16	$\frac{69.5}{16} = 4.34$	$\frac{4.34}{0.31} = 14$

∴ Empirical formula → $Na_2SH_{20}O_{14}$

$n = \frac{\text{Molar Mass}}{\text{Empirical mass}} = \frac{322}{322} = 1$

Empirical mass → (2×23) + (1×32) + (20×1) + (14×16) = 322

Swartz reaction: [Sep-21]

$$CH_3CH_2Br + AgF \xrightarrow{\Delta} CH_3CH_2F + AgBr$$

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Molecular formula } = n × Empirical formula
= 1 × $Na_2SH_{20}O_{14}$

Ans ⇒ $Na_2SH_{20}O_{14}$

Since all the hydrogen in the Compound Present as H_2O.

∴ Molecular formula is $Na_2SO_4 \cdot 10H_2O$

28. Second Ionisation Potential is always higher than 1st Ionisation Potential → Explain. [June-23]

* The minimum amount of energy required to remove an e⁻ from a unipositive cation is called second Ionisation energy.

$$M^+ + I.E_2 \longrightarrow M^{2+} + 1e^-$$

* The total no of e-s are less in the cation than the neutral atom and nuclear charge remains the same.
* Therefore the effective nuclear Charge of the Cation is higher. Thus the second ionisation energies always higher than first ionisation energy

29. Calculate the effective nuclear Charge on 4s e⁻ and 3d e⁻ in Scandium. [June-23]

4s e⁻ in Sc:

$_{21}Sc \rightarrow \underbrace{1s^2\ 2s^2 2p^6}_{\text{Inner}}\ \underbrace{3s^2 3p^6\ 3d^1}_{(n-1)}\ \underbrace{4s^2}_{n}$

Inner = 1, (n-1) = 0.85, n = 0.35

$Z_{eff} = Z - S$
$= 21 - \{(1\times0.35) + (9\times0.85) + (10\times1)\}$
$= 21 - 18 \Rightarrow 3$

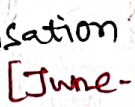
3d e⁻ in Sc:

$_{21}Sc \rightarrow \underbrace{1s^2\ 2s^2 2p^6}_{\text{Inner}}\ \underbrace{3s^2 3p^6}_{(n-1)}\ \underbrace{3d^1}_{n}\ 4s^2$

Inner = 1, (n-1) = 1, n = 0.35

$Z_{eff} = Z - S$
$= 21 - \{(0\times0.35) + (18\times1)\}$
$= 21 - 18 \Rightarrow 3$

30. Acetylene $\xrightarrow{O_3}$? [June-19]

$CH{\equiv}CH \xrightarrow{O_3}$  $\xrightarrow{H_2O}$  $\xrightarrow{H_2O_2}$ $2HCOOH$

31. **Polymerisation of Acetylene:** [June-19] [Sep-20]

Two types.

(i) Linear Polymerisation:

$2CH{\equiv}CH \xrightarrow{CuCl_2|NH_4Cl}$ $CH_2{=}CH{-}C{\equiv}CH$

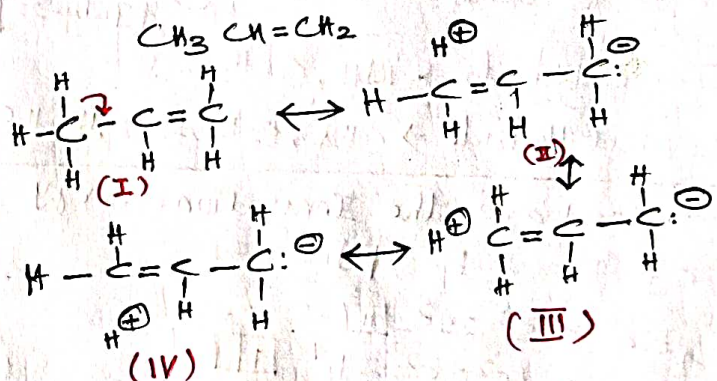
Vinyl acetylene

(ii) Cyclic Polymerisation:

$3CH{\equiv}CH \xrightarrow[\text{Iron tube}]{\text{Red hot}}_{873K}$ Benzene

32. **No bond Resonance structures of Propene:** [Sep-20]

$CH_3CH{=}CH_2$



(I) (II) (III) (IV)

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+1 Chemistry Public Sums:-

+1 March & July 2024:-

Public Problems:-

Inorganic Chemistry:-

1. Write the balanced equation for the action of Heat on Calcium Carbonate. [Mar-24]

Ans:-

$$CaCO_3 \rightleftharpoons CaO + CO_2$$

2. What are the n & l values for $3p_x$ and $4d_{x^2-y^2}$ electron? [Mar-24]

Ans:-

Orbital	n	l
$3p_x$	3	1
$4d_{x^2-y^2}$	4	2

3. An organic Compound Present in Vinegar has 40 % Carbon 6.6 % of hydrogen and 53.4 % oxygen. Find the the empirical formula of the Compound. [Mar-24]

Ans:

S.No	Element	%	Atomic Mass	Relative No of moles	Simplest ratio	Simplest ratio in whole no.
1.	C	40	12	$\frac{40}{12}=3.3$	$\frac{3.3}{3.3}=1$	1
2.	H	6.6	1	$\frac{6.6}{1}=6.6$	$\frac{6.6}{3.3}=2$	2
3.	O	53.4	16	$\frac{53.4}{16}=3.3$	$\frac{3.3}{3.3}=1$	1

The empirical formula is ⇒ CH_2O

4. Give the General electronic Configuration of Lanthanides and Actinides. [Mar-24]

Ans:- Lanthanides ⇒ $[Xe]\ 4f^{1-14}\ 5d^{0-1}\ 6s^2$

Actinides ⇒ $[Rn]\ 5f^{0-14}\ 6d^{0-2}\ 7s^2$

5. How many orbitals are possible for n=4? [July-24]

Ans:

n=4 $\quad l = 0, 1, 2, 3$ (s, p, d, f)

$1 + 3 + 5 + 7 = 16$

Total 16 orbitals are possible

6. What is Water gas shift reaction? [July-24]

Ans:

$$\underset{\text{Water gas}}{CO + H_2O} \xrightarrow[400^\circ C]{Fe/Cu} CO_2 + H_2$$

7. What is the empirical formula of the following?

(i) Fructose ($C_6H_{12}O_6$) found in Honey

(ii) Caffeine ($C_8H_{10}N_4O_2$) a substance found in tea and coffee [July-24]

Ans:

Compound	Molecular formula	Empirical formula
Fructose	$C_6H_{12}O_6$	CH_2O
Caffeine	$C_8H_{10}N_4O_2$	$C_4H_5N_2O$

8. How is plaster of paris Prepared? [July-24]

Ans:

$$\underset{\text{Gypsum}}{2CaSO_4 \cdot 2H_2O_{(s)}} \xrightarrow{393K} 2CaSO_4 \cdot \tfrac{1}{2}H_2O + 3H_2O$$

Physical Chemistry:-

1. Write the hybridisation present in the following Compounds: [Mar-24]

Ans:

S.No	Molecule	Hybridisation
a)	BF_3	sp^2
b)	CH_4	sp^3
c)	PCl_5	sp^3d
d)	SF_6	sp^3d^2

2. Calculate the molality of the solution containing 90 g of glucose dissolved in 2 kg of H_2O. [Mar-24]

Ans:-

$$\text{Molality (m)} = \frac{\text{Number of moles of solute}}{\text{Mass of the solvent (in kg)}}$$

$$= \frac{\left(\frac{90}{180}\right)}{2} = \frac{0.5}{2} = \boxed{0.25\ m}$$

3. Give the mathematical expression that relates gas Volume and moles. [July-24]

Ans:

$$V \propto n \text{ (or) } \frac{V_1}{n_1} = \frac{V_2}{n_2}$$

4. Define: Gibbs free energy [July-24]

Ans:

$$G = H - TS \text{ (or) } \Delta G = \Delta H - T\Delta S$$

5. Write the Vander Waals equation for real gases and explain the terms involved. [July-24]

Ans:

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

P → Pressure, V → Volume, R → gas constant, n → no of moles, T → Temperature, a, b → Vander Waals Constant.

6. An engine operating between 127°C and 47°C takes some specified amount of heat from a high temperature reservoir. Assuming that there are no frictional losses, Calculate the Percentage efficiency of the engine [July-24]

Ans:

$T_h \rightarrow 127°C = 127 + 273 = 400\ K$

$T_c = 47°C = 47 + 273 = 320\ K$

% efficiency $\eta = ?$

$$\eta = \left[\frac{T_h - T_c}{T_h}\right] \times 100$$

$$\eta = \left[\frac{400 - 320}{400}\right] \times 100$$

$$\eta = \left[\frac{80}{400}\right] \times 100$$

$$\eta = 20\%$$

7. What is dipole moment? [July-24]

Ans:

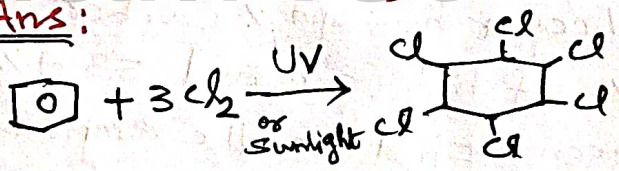
Dipole moment $\mu = q \times 2d$

$q \rightarrow$ charge, $d \rightarrow$ distance between two charges.

Organic Chemistry

1. How will you convert Benzene to BHC? [Mar-24]

Ans:



Benzene — BHC

2. $CH_2 = CH_2 + Br_2 \rightarrow A$

A $\xrightarrow{\text{alc. KOH}}$ B $\xrightarrow{NaNH_2}$ C

Find A, B, C [Mar-24]

Ans:

$$CH_2 = CH_2 + Br_2 \rightarrow \underset{\underset{Br}{|}}{CH_2} - \underset{\underset{Br}{|}}{CH_2} \quad (A)$$

$$\underset{\underset{Br}{|}}{CH_2} - \underset{\underset{Br}{|}}{CH_2} \xrightarrow{\text{alc. KOH}} CH_2 = \underset{\underset{Br}{|}}{CH} \quad (B)$$

$$CH_2 = CH - Br \xrightarrow[-NaBr, NH_3]{NaNH_2} CH \equiv CH \quad (C)$$

Ans:

A → $\underset{\underset{Br}{|}}{CH_2} - \underset{\underset{Br}{|}}{CH_2}$ → 1,2-dibromo ethane

B → $CH_2 = CH - Br$ → Bromo ethene

C → $CH \equiv CH$ → Acetylene

3. Give the IUPAC name for the following :- [MAR-24]

Ans:-

(i) $\overset{3}{C}H_3\overset{2}{C}H_2\overset{1}{C}OOH$

Propanoic acid

(ii) $\overset{5}{C}H_3-\overset{4}{C}H_2-\overset{3}{\underset{\underset{O}{\|}}{C}}-\overset{2}{C}H_2-\overset{1}{C}H_3$

3-Pentanone (or) Pentan-3-one

(iii) $CH_3CH_2CH_2-\overset{\overset{CH_3}{|}}{N}-CH_3$

N,N-dimethyl Propan-1-amine

4. How will you Prepare Benzene from the following: [Mar-24]

A) Acetylene B) Phenol

Ans: (A) Acetylene ⟶ Benzene:-

$3\,CH\equiv CH \xrightarrow[\text{tube } 873K]{\text{Red Hot Fe}}$ 

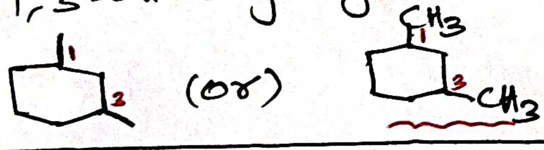
(B) Phenol ⟶ Benzene:-

$C_6H_5OH + Zn \longrightarrow C_6H_6 + ZnO$

5. Give the structure for the following compounds: [July-24]

Ans:-

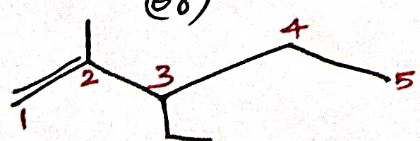
(i) 1,3-dimethyl cyclohexane



(ii) 3-ethyl-2-methyl-1-pentene

$\overset{5}{C}H_3\overset{4}{C}H_2\overset{3}{\overset{CH_2CH_3}{C}}H-\overset{2}{\underset{CH_3}{C}}=\overset{1}{C}H_2$

(or)



6. Complete the following Reactions:- [July-24]

Ans:-

(i) $C_6H_5Cl + Mg \xrightarrow{THF} C_6H_5MgCl$

(ii) $CCl_4 + H_2O \xrightarrow{\Delta} COCl_2 + 2HCl$

7. What happens when acetyl chloride is treated with excess of CH_3MgI? [July-24]

Ans:

$CH_3COCl + CH_3MgI$

Acetylchloride

↓

$CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{OMgI}{|}}{C}}-Cl$

↓ H^+/H_2O

$CH_3COCH_3 + Mg\begin{smallmatrix} I \\ Cl \end{smallmatrix}$

acetone

8. Which is considered to be earth's protective umberella? Why? [July-24]

Ans: O_3 (ozone) acts as an umberella or shield for harmful UV radiations. It protects us from harmful effect such as skin cancer.

9. How will you distinguish 1-butyne and 2-butyne? [July-24]

Ans:

(i) 1-butyne react with tollen's reagent due to presence of acidic hydrogen.

(ii) 2-butyne not react with Tollens reagent due to the absence of acidic hydrogen.

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