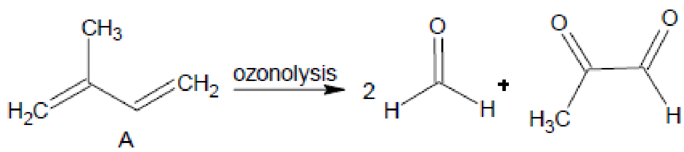
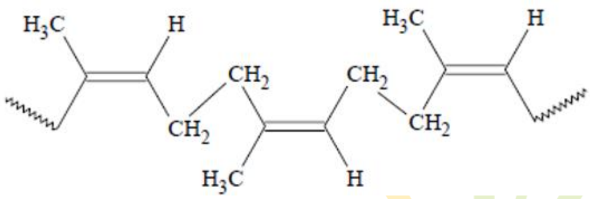
JEE MAIN - 2005

CHEMISTRY

Q.1. Sol.

(a) 

(b) 

"all cis" form of polymer of A

Q.2. Sol.

(a) $^{235}U_{92} + {}_0n^1 \rightarrow {}^{137}A_{52} + {}^{97}B_{40} + 2{}_0n^1$

(b) $^{82}Se_{34} \rightarrow 2{}_{-1}e^0 + {}^{82}Kr_{36}$

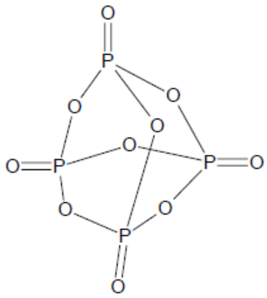
Q.3. Sol.

a) $6CaO + P_4O_{10} \rightarrow 2Ca_3(PO_4)_2$

Moles of $P_4O_{10} = \frac{852}{284} = 3$

Moles of $CaO = 3 \times 6 = 18$

Wt. of $CaO = 18 \times 56 = 1008$ gm.

(b) 

Q.4. Sol.

In FCC, interstitial sites will be octahedral voids & tetrahedral voids.

For octahedral voids For tetrahedral voids

$$\frac{r_1}{r_2} = 0.414 \qquad \frac{r_1}{r_2} = 0.225$$

Where $r_1 =$ radius of atom in interstitial sites

$r_2 =$ radius of atom arranged in FCC.

i.e. $4r_2 = \sqrt{2}a$,

For maximum diameter of atom in interstitial site, octahedral voids will be considered.

$$\text{Diameter } = 2r_1 = 2(0.414r_2) = 2\times0.414\times\frac{400}{2\sqrt{2}} = 117.1\text{pm}$$

Q.5. Sol.

$P_{N_2} = 0.001$ atm, $T = 298$ K, $V = 2.46$ cm^2

By ideal gas, $PV = nRT$

$$n_{N_2} = \frac{PV}{RT} = \frac{0.001\times2.46\times10^{-3}}{0.0821\times298} = 1.0\times10^{-7}$$

Now molecules of $N_2 = 6.023 \times 10^{23} \times 1 \times 10^{-7} = 6.023 \times 10^{16}$

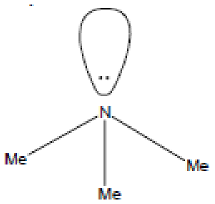
Now total surface sites available $= 6.023 \times 10^{14} \times 1000 = 6.023 \times 10^{17}$

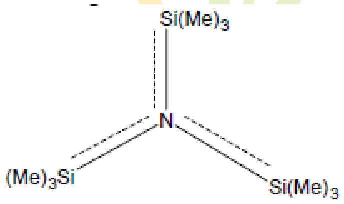
$\therefore$ Surface site used to adsorb $N_2 = \frac{20}{100} \times 6.023 \times 10^{17} = 12.04 \times 10^{16}$

$\therefore$ Sites occupied per molecule of $N_2 = \frac{12.04 \times 10^{16}}{6.02 \times 10^{16}} = 2$

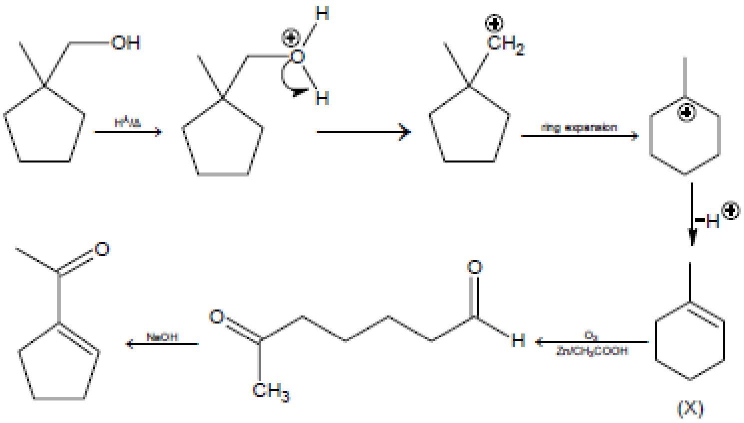
Q.6. Sol.

$\mathrm{N(Me)_3}$ & $\mathrm{N(SiMe_3)_3}$ are not is isostructural. $\mathrm{N(Me)_3}$ is trigonal pyramidal while $\mathrm{N(SiMe_3)_3}$ is trigonal planar due to back bonding.





Q.7. Sol.



Q.8. Sol.

In structure (P) both the rings are present in acetyl form therefore it will not hydrolyse in Sol. that why Fehling Sol. cannot react with this.

In structure (Q) one ring present in the form of hemiacetal. This will hydrolyse in Sol. and it can reduce Fehling Sol..

Q.9. Sol.

a) Reactions used in developing the photographic film

$$2AgBr + \underset{\substack{\text{Hydroquinone} \\ \text{(developer)}}}{C_6H_4(OH)_2} \rightarrow \underset{\left(\substack{\text{black silver} \\ \text{particles}}\right)}{2Ag} + 2HBr + \underset{\text{quinone}}{C_6H_4O_2}$$

$$\underset{\left(\substack{\text{sensitive,} \\ \text{unexposed} \\ \text{emulsion}}\right)}{AgBr} + \underset{\text{Hypo solution}}{2Na_2S_2O_3} \rightarrow Na_3\left[Ag\left(S_2O_3\right)_2\right] + NaBr$$

b) $Na_2S_2O_3 + H^+ \rightarrow 2Na^+ + H_2SO_3 + \underset{\text{colloidal sulphur}}{S\downarrow}$

Q.10. Sol.

$$Fe^{3+} \underset{\text{(excess)}}{SCN^-} \xrightarrow{\text{aqueous}} \underset{(A)\text{(blood red)}}{\left[Fe(SCN)(H_2O)_5\right]^{2+}}$$

$$\underset{(A)\text{(blood red)}}{\left[Fe(SCN)(H_2O)_5\right]^{2+}} + \underset{\text{(excess)}}{6F^-} \rightarrow \underset{(B)\text{(colourless)}}{[FeF_6]^{3-}} + SCN^- + 5H_2O$$

a) Pentaaquathiocyanato iron (III) ion

hexafluro ferrate (III)

b) Magnetic moment $= \sqrt{n(n+2)} = \sqrt{35} = 5.92\,\text{B.M.}$, where $n =$ number of unpaired electrons

Q.11. Sol.

$$2X_{(g)} \rightarrow 3Y_{(g)} + 2Z_{(g)}$$

a) By the given data, we can observed that $t_{1/2}$ of the X is constant i.e. 100 min. therefore order of reaction is one.

b) Rate constant $= \dfrac{0.693}{t_{1/2}}$

$$= \frac{0.693}{100} = 6.93 \times 10^{-3}\ \text{min}^{-1}$$

c) Time taken for 75% completion of reaction $= 2t_{1/2}$

d)

	$2X \rightarrow$	$3Y +$	$2Z$
Initial pressureAt any time	800	0	0
At any time	$800 - x$	$3/2x$	x

Given $800 - x = 700\,\text{mm}$

$x = 100\,\text{mm}$

Total pressure $= 700 + 150 + 100 = 950$ mm

Q.12. Sol.

a) $mvr = \dfrac{nh}{2\pi}$ $\quad r = a_0 = 0.529 Å$

$$v = \frac{nh}{2\pi mr} = 2.18 \times 10^{6}\ \text{m/sec}\,(n = 1)$$

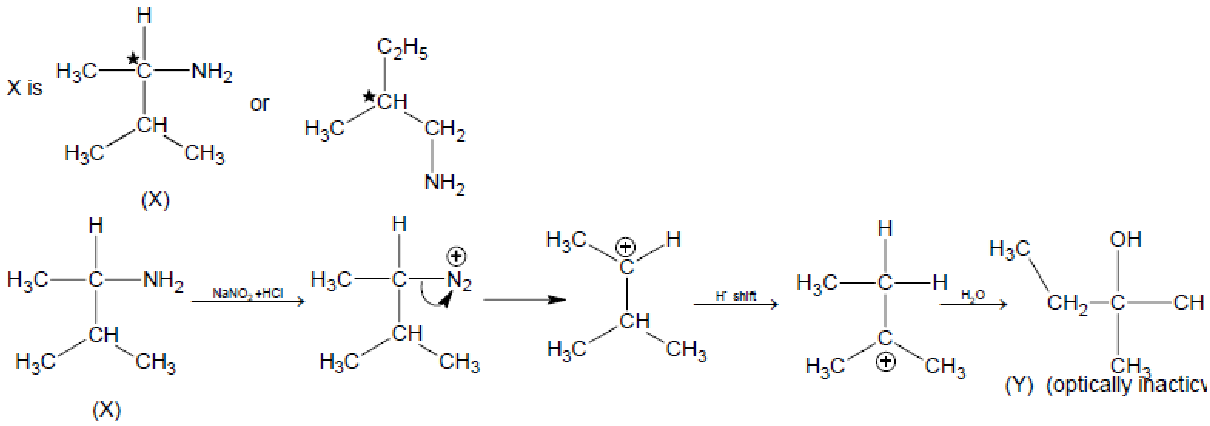
b) $\lambda = \dfrac{h}{mv} = \dfrac{6.63 \times 10^{-34}}{9.1 \times 10^{-31} \times 2.15 \times 10^{6}} = 0.33 \times 10^{-9} m = 3.3 Å$

c) For 2 valve of $\ell = 1$

Orbital angular momentum $= \sqrt{\ell(\ell+1)}\dfrac{h}{2\pi}$

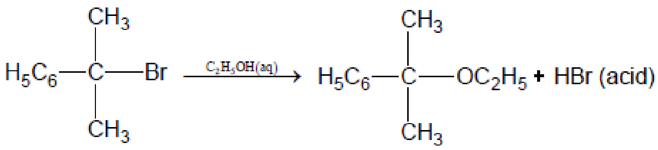
$$= \sqrt{2}\frac{h}{2\pi}$$

Q.13. Sol.

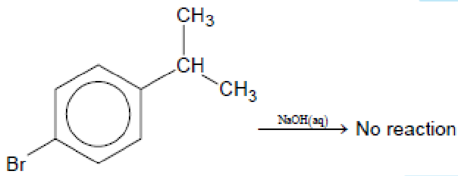


Q.14. Sol.

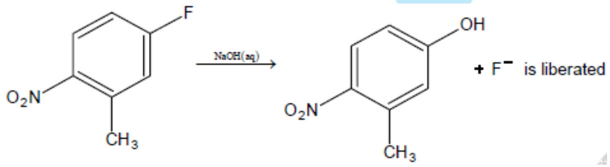
(a) (i)



(ii)

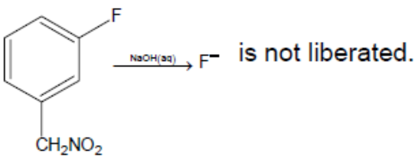


(b) (i)



This is a bimolecular reaction. Rate of this reaction is being enhanced by presence of electron withdrawing groups at ortho and para positions.

(ii)



Bimolecular mechanism is not possible is this case.

(c) (i) Due to presence of lone pair on nitrogen atom NO group is electron donating and ortho, para directing.

(ii) NO_2 group is electron withdrawing and meta directing.

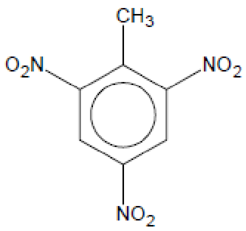
(d) Due to reduction of central ring, three four membered antiaromatic rings become stable while on reduction of terminal ring only one antiaromatic ring can be stabilized.

Q.15. Sol.

(A) H_2SO_4

(B) Br_2

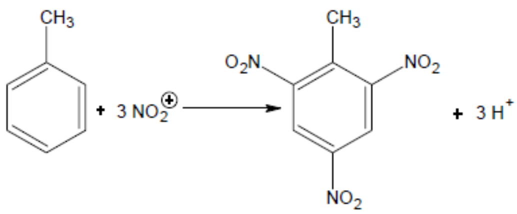
(C) $NO_2^{\oplus}$

(D) 

Reactions involved are:

$$\underset{(A)}{2H_2SO_4} + 2NaBr + MnO_2 \rightarrow \underset{(B)(\text{Brown fumes})}{Br_2} + Na_2SO_4 + MnSO_4 + 2H_2O$$

$$\underset{(A)}{2H_2SO_4} + HNO_3 \rightarrow HSO_4^- + \underset{(C)}{NO_2^{\oplus}} + H_2O$$



(D) (Explosive)

Q.16. Sol.

$M = Ti$

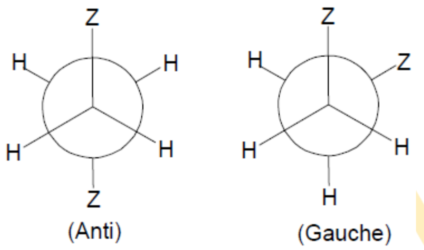
$A = \left[Ti\left(H_2O\right)_6\right]^{3+}$

$B = TiO_2$

$Ti(+IV)$ ion contains no d-electrons, while $d-d$ transition of single electron of $Ti(+III)$ will cause colour change.

Q.17. Sol.17.

a)



Mole fraction of anti form $= 0.82$

Mole fraction of Gauche form $= 0.18$

$\mu_{ob.} = 1$

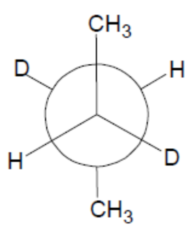
$1 = \mu_{(anti)} \times 0.82 + \mu_{(Gauce)} \times 0.18$

$\mu_{(anti)} = 0$

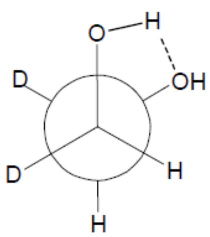
$\therefore 1 = \mu_{(Gauche)} \times 0.18$

$\mu_{(Gauche)} = \frac{1}{0.18} = 5.55\,D$

b) i)



ii)



Q.18. Sol. Cell reactions are

$$Ag + \frac{1}{2}Cl_2 \rightarrow AgCl \quad \ldots(i)$$

$$Ag \rightarrow \frac{1}{2}Ag^+ \rightarrow e^- \quad \ldots(ii)$$

$$\frac{1}{2}Cl_2 + e \rightarrow Cl^- \quad \ldots(iii)$$

$$\overline{Ag^+ + Cl^- \rightarrow AgCl \ldots (i - ii - iii)}$$

hence cell representation is $|Ag|Ag^+|AgCl||Cl^-|Cl_2, Pt$

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s); \quad \sum \Delta G_P^0 - \sum \Delta G_R^0$$

i) $\Delta G° = -109 - (-129 + 77)$

$$= -109 + 129 - 77$$

$$= 20 - 77 = -57 = -1 \times F \times E°$$

$$-57 = -1 \times 96500 \times E°$$

$$\Rightarrow E° = \frac{57000}{96500} = 0.59\,\text{Volts}$$

ii) $-57 = -2.303\,RT \log K_0$

$$\log K_0 = \frac{57 \times 1000}{2.303 \times 8.314 \times 298}$$

$$\log K_0 = 9.98 \approx 10$$

$$K_0 = 10^{10}$$

$$\therefore K_{sp} = 1/K_0$$

$$\therefore K_{sp} = 10^{-10}$$

$$\therefore \log K_{sp} = -10$$

iii) $10\,AgCl((s) \rightleftharpoons \underset{S}{Ag^+(aq)} + \underset{S}{Cl^-(aq)}$

$$10^{-10} = S^2$$

$$\therefore S = 10^{-5}\ m/L$$

b) When $\frac{65.39\times10^{-2}}{65.39}=10^{-3}$ moles of Zn has been added,

$$2Ag^{+}+2e\rightarrow2Ag;\quad E^{0}=0.80\,V$$
$$Zn\rightarrow Zn^{2}+2e;\quad E^{0}=0.77\,V$$
$$\overline{2Ag^{+}_{(aq)}Zn_{(s)}\rightarrow Zn^{2+}_{(aq)}+2Ag_{(s)};\quad E^{0}=1.57\,V}$$
$$10^{-6}\,\text{mole}\,10^{-3}\,\text{moles}$$
$$\log_{10}K(eq)=52.8$$

Therefore, this reaction will move in forward direction completely. Hence moles of Ag formed will be 10^{-6}

At equilibrium, $(E_{cell}=0)$

$$E^{0}_{Cell}=\frac{+0.0591}{2}\log_{10}\frac{[Zn^{2+}]}{[Ag^{+}]^{2}}$$
$$\therefore\frac{1.56\times2}{0.0591}=\log\frac{[Zn^{+2}]}{[Ag^{+2}]^{2}}=52.8$$