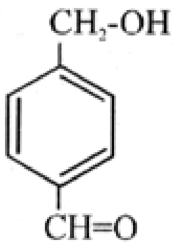
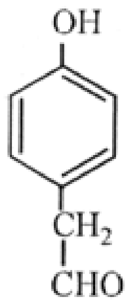
JEE 2002 - SOLUTIONS - CHEMISTRY

(INDIANET GROUP)

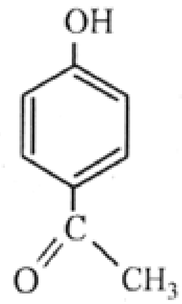
Q1. (A)



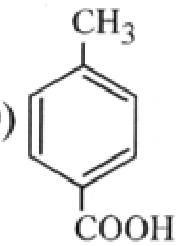
(B)



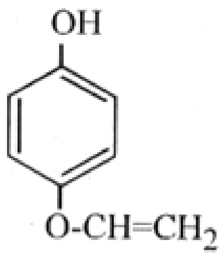
(C)



(D)



(E)



Q2.(i) 500ml of 0.2M CH_3COOH

500 ml of 0.2M HCl

V = 500 + 500 = 1000ml, $\quad M(CH_3COOH) = 0.1$ M; M(HCl) = 0.1M

$$\underset{0.1\,(1-\alpha)}{CH_3COOH} \Leftrightarrow \underset{0.1\,\alpha}{CH_3COO^-} + \underset{0.1\,\alpha}{H^+}$$

$$HCl \longrightarrow H^+ + Cl^-$$

0.1	0	0
0	0.1	0.1

$$\underset{0.1\,(1-\alpha')}{CH_3COOH} \Leftrightarrow \underset{0.1\,\alpha'}{CH_3COO^-} + \underset{(0.1\,\alpha' + 0.1)}{H^+}$$

$$k_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]} = \frac{(0.1\,\alpha' + 0.1)\,0.1\,\alpha'}{0.1(1-\alpha')}$$

$$k_a = 1.75 \times 10^{-5}$$

$$1.75 \times 10^{-5} = \frac{0.1\,\alpha'(0.1\,\alpha' + 0.1)}{0.1(1-\alpha')}$$

$$\alpha' = 1.75 \times 10^{-4} \text{ (approx)}$$

(ii) mol of NaOH = 6/40 = 0.15

molarity of NaOH = 0.15M

HCl	+ $NaOH$	$\longrightarrow$ $NaCl$	+ H_2O
0.1	0.15	0	0
0	0.05	0.1	0.1

CH_3COOH	+ $NaOH$	$\longrightarrow$ CH_3COONa	+ H_2O
0.1	0.05	0	0.1
0.05	0	0.05	0.15

pH = pKa + log salt/Acid

$pH = -\log(1.75 \times 10^{-5}) + \log(0.05 / 0.05)$

pH = 4.76

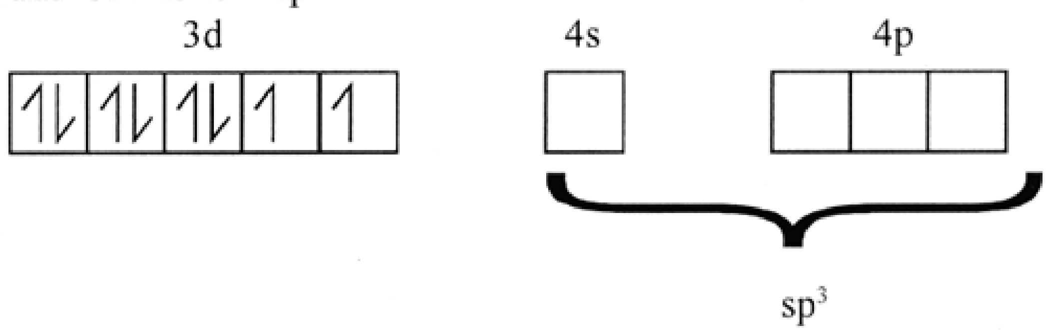
Q3. $[NiCl_4]^{2-}$

$Ni \rightarrow 28 \rightarrow 3d^8, 4s^2$

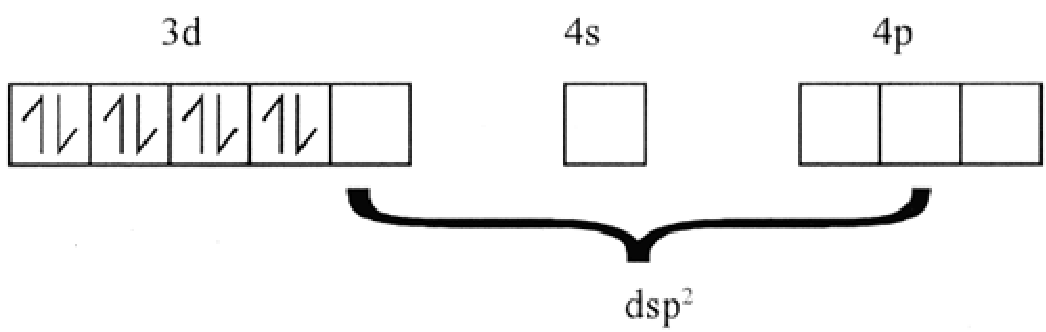
$Ni^{2+} \rightarrow 3d^8$

Cl^- is high spin ligand and CN^- is low spin

$[NiCl_4]^{2-}$



$[Ni(CN)_4]^{2-}$



$[NiCl_4]^{2-}$ is tetrahedral

$[Ni(CN)_4]^2$ is square planer

$\mu = \sqrt{n(n+2)}$ BM where n is no. of unpaired electron

$\mu\ [NiCl_4]^{2-} = \sqrt{2(4)} = \sqrt{8} = 2\sqrt{2}$ BM

$$\mu\ [Ni(CN)_4]^{2} = \sqrt{0(0+2)} = 0 \text{ BM}$$

Q4.(a) $$\frac{r_{vapour}}{r_{O_2}} = \sqrt{\frac{32}{M_{vapour}}} = 1.33$$

$$M_{vapour} = \frac{32}{(1.33)^2} = 18.09 \text{ gm/mol}$$

$$V = \frac{\text{Mass}}{\text{Density}} = \left(\frac{18.09 \text{ x } 10^{-3}}{0.36}\right) m^3 = 50.25 \text{ litre}$$

$$PV = ZnRT$$

$$P = \frac{Z \cdot wt}{V \cdot M} \text{ x } RT$$

$$P \text{ x } M = Z\rho RT$$

$$Z = \frac{18.09 \text{ x } 1}{0.36 \text{ x } 0.0821 \text{ x } 500} = 1.22$$

$Z > 1$ so repulsive force will dominate.

(b) $$KE = \frac{3}{2} kT$$

$$= \frac{3}{2} \text{ x } 1.38 \text{ x } 10^{-23} \text{ x } 1000$$

$$= 2.07 \text{ x } 10^{-20} \text{ Joules.}$$

Q5.

(i) $Al_4C_3 + 6H_2O \rightarrow 4Al(OH)_3 + 3CH_4$

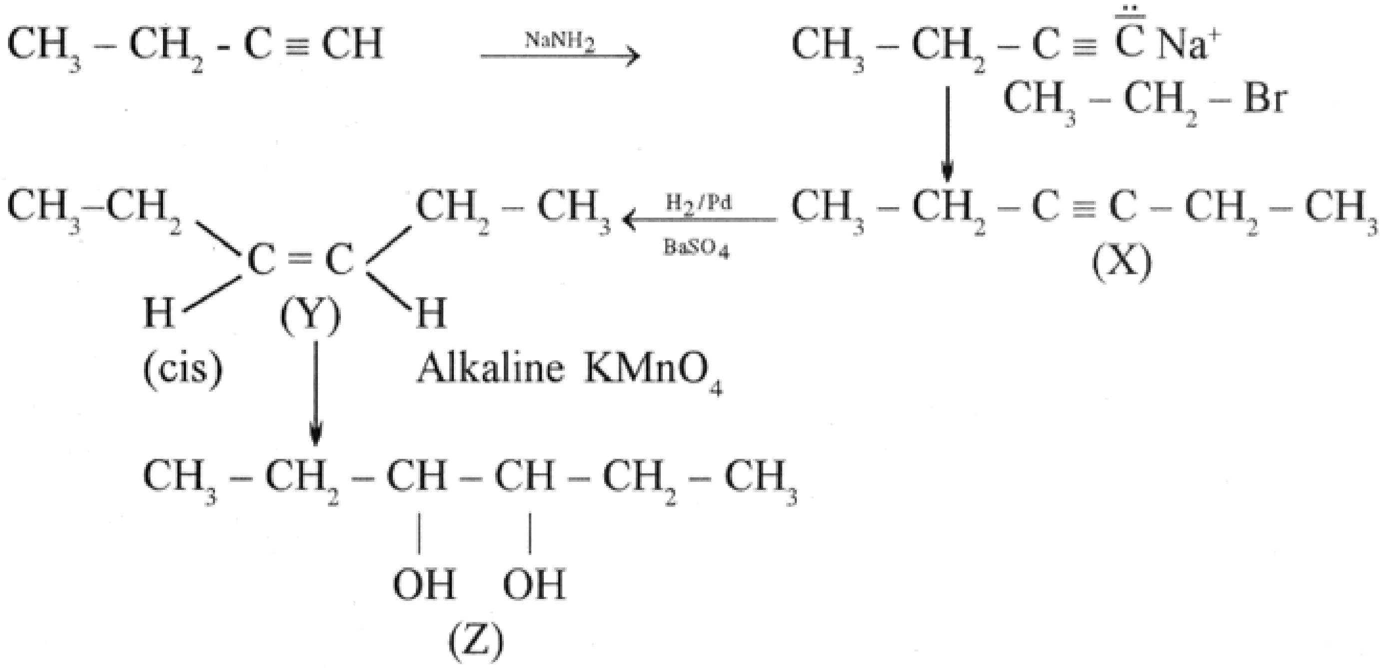
(ii) $CaCN_2 + 5H_2O \rightarrow CaCO_3 + 2NH_4OH$

(iii) $BF_3 + 3H_2O \rightarrow B(OH)_3 + 3HF$

(iv) $NCl_3 + 4H_2O \rightarrow NH_4OH + 3HOCl$

(v) $3XeF_4 + 6H_2O \rightarrow 2Xe + XeO_3 + 12\ HF + \frac{3}{2}\ O_2$

Q6.

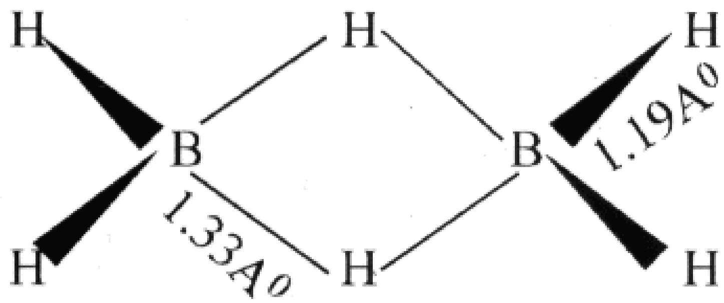


Compound Z consist of plane of symmetry. So it is optically inactive.(Meso)

Q7. $Na_2B_4O_7 \cdot 10H_2O + 2HCl \longrightarrow 2NaCl + 4H_3BO_3 + 5H_2O$
Borax

$H_3BO_3 \xrightarrow[\text{Red Heat}]{\Delta} B_2O_3 + H_2O$
o-Boric acid — Boric anhydride

$B_2O_3 + Mg \longrightarrow B + MgO$
Boron



$B_2H_6 + HCl \longrightarrow B_2H_5Cl + H_2$

Q8.

$$ {}^{64}_{29}Cu \xrightarrow[\text{path-I } \lambda_1]{\beta\text{-emission}} {}_{30}Zn^{64} + {}_{-1}e^{0} \quad (38\%)$$

$$ {}^{64}_{29}Cu \xrightarrow[\text{path-II } \lambda_2]{\beta^{+}\text{-emission}} {}_{28}Ni^{64} + {}_{+1}e^{0} \quad (19\%)$$

$$ {}^{64}_{29}Cu \xrightarrow[\text{capture } \lambda_3]{\text{k-electron}} {}_{28}Ni^{64} \quad (43\%)$$

$$n + {}_{-1}e^{0} + \overline{\nu} \rightarrow \pi$$

$$\lambda_{net} = \lambda_1 + \lambda_2 + \lambda_3$$

$$\text{Fractional yield for path (I)} = \frac{\lambda_1}{\lambda_{net}} \Rightarrow \frac{\frac{0.6931}{(t_{1/2})_1}}{\frac{0.6931}{(t_{1/2})_{net}}} = \frac{(t_{1/2})_{net}}{(t_{1/2})_1}$$

$$\text{Half life for Path I} = \frac{(t_{1/2})_{net}}{\text{fractional yield}} = \frac{12.8}{0.38} = 33.684 \text{ hr}$$

$$\text{Half life for path II} = \frac{12.8}{0.19} = 67.368 \text{ hr}$$

$$\text{Half life for path III} = \frac{12.8}{0.43} = 29.767 \text{ hr}$$

Q9. (X) NH_4Cl (A) CrO_2Cl_2 (B) Na_2CrO_4 (C) $PbCrO_4$

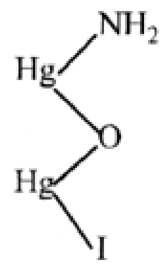
(D) $HgOIHgNH_2$

$$NH_4Cl + K_2Cr_2O_7 + 3H_2SO_4 \longrightarrow K_2SO_4 + (NH_4)_2SO_4 + 2CrO_2Cl_2\uparrow + 3H_2O$$

$$CrO_2Cl_2 + 4NaOH \longrightarrow 2NaCl + Na_2CrO_4 + 2H_2O$$

$$Na_2CrO_4 + (CH_3COO)_2Pb \longrightarrow \underset{\text{yellow}}{PbCrO_4\downarrow} + CH_3COONa$$

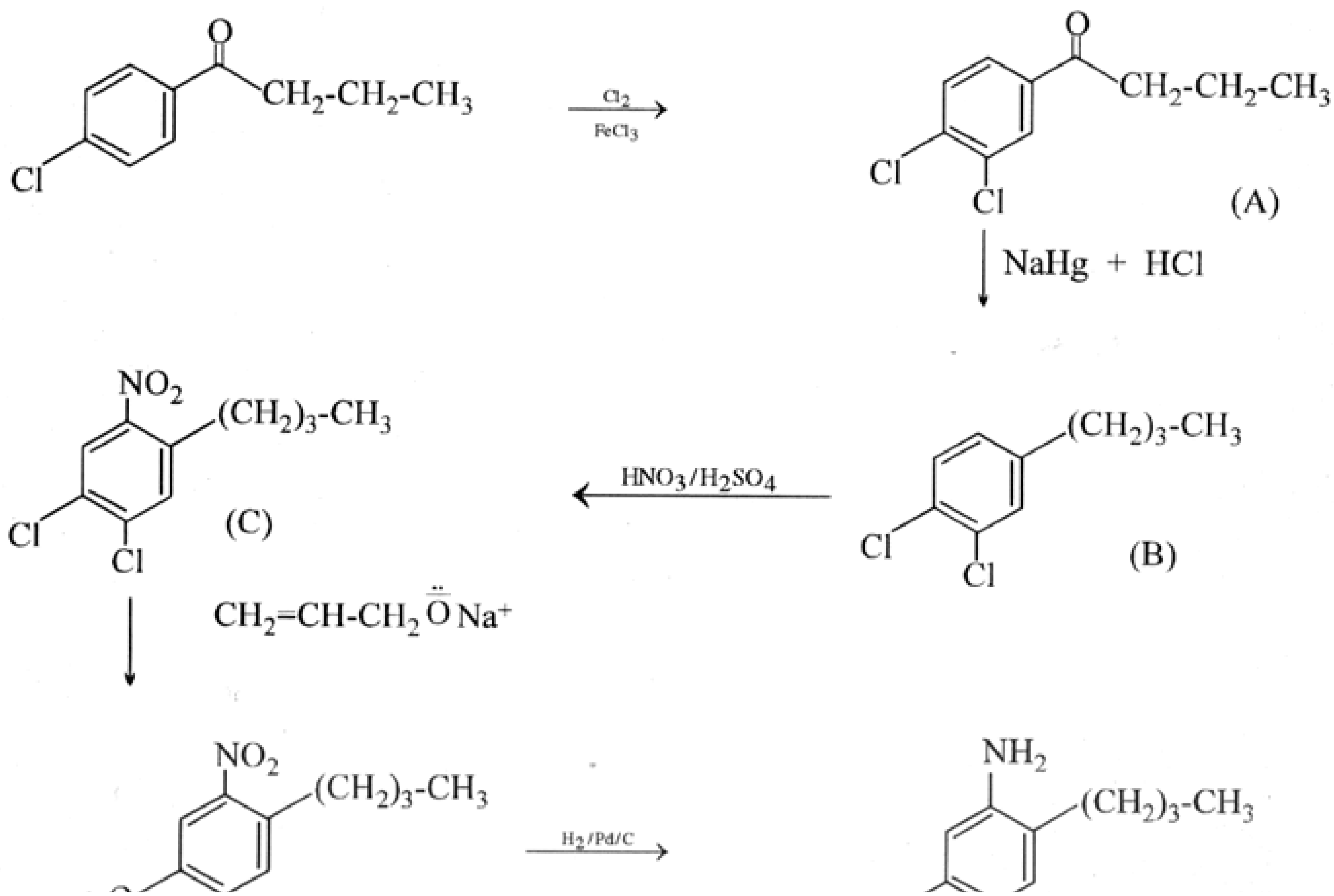
$$\underset{(X)}{NH_4Cl} + 2K_2HgI_4 + KOH \longrightarrow$$

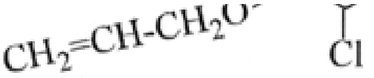


$$+ 7KI + KCl + H_2O$$

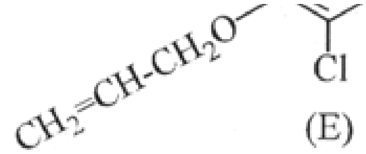
Brown ppt.

Q10.





(D)



(E)

Q11. $CH_3–CH_2–CH_2–CH = CH – CH = CH – (CH_2)_8 – CH_2 – OH$

(Bombykol)

In Bombykol total no. of Double bond is 2

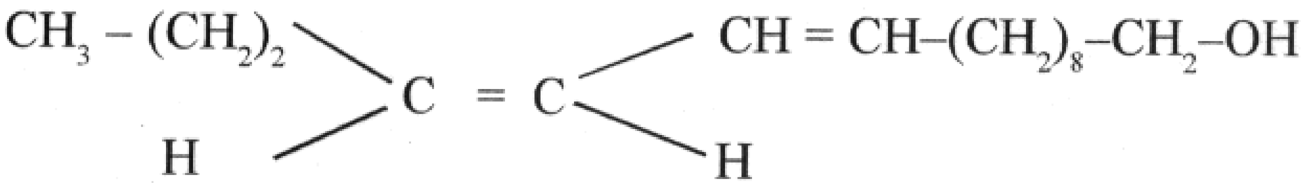
$C_{16}H_{30}O$

$\beta = (16 + 1) – 30/2$

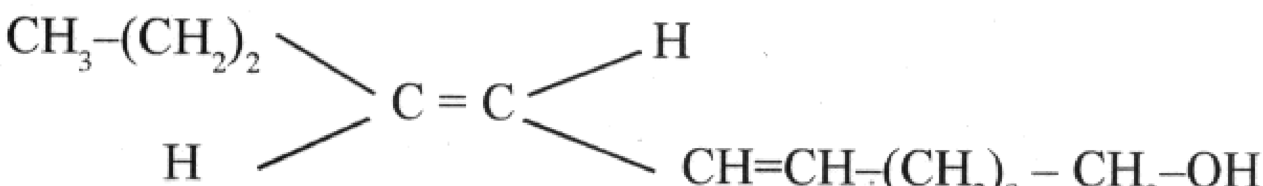
$\beta = 2$ (Degree of unsaturation)

(A) $CH_3 – (CH_2)_{14} – CH_2 – OH$

Total no. of Geometrical Isomer in Bombykol is 4



(Cis)



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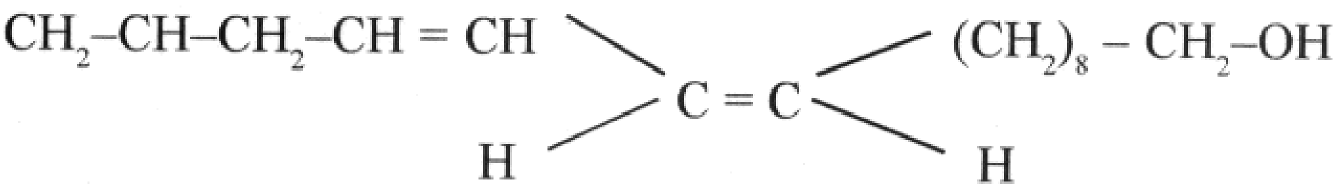

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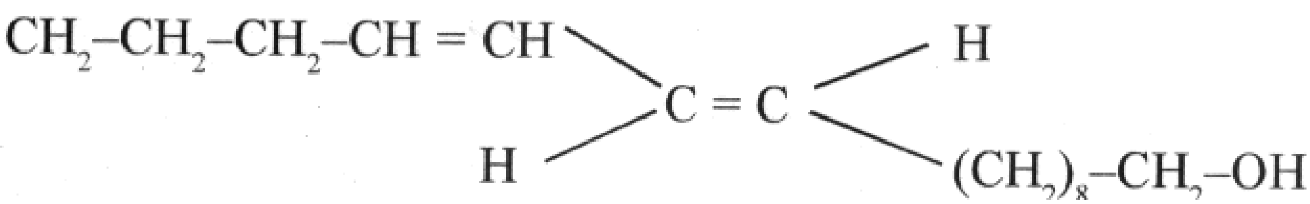
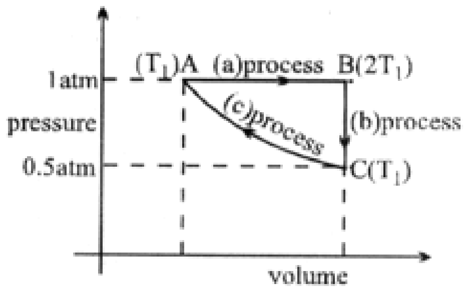


trans

Q12.

(i)



where T_1 & T_2 are temperature when gas is at stage A & B.

(ii) Total work (w) is the area under the curve

$$= 1 \text{ atm } (40 - 20)\text{L} - 2.303 \times 2 \times 0.0821 \times 27 \log\frac{20}{40}$$

$$= 51.076 \text{ lit atm}$$

$$= 5.1723 \times 10^3 \text{ Joule}$$

$\Delta Q = \Delta U + \Delta w$ (First law of thermodynamics)

$\Delta U = 0$ (cyclic process)

$\Delta Q = w = 5.1723 \times 10^3$ Joule

(iii) $\Delta U = 0$

$$\Delta H_{net} = f \times \frac{n}{2} R\Delta T + w_{A\rightarrow B} + f\frac{n}{2} R\,\Delta T + w_{B\rightarrow C} + 0 + 0$$

$$= 20 \times 1 \text{ L atm}$$

$$= 2.025 \times 10^3 \text{ Joule}$$

$\Delta S = 0$ for cyclic process