JEE Advanced 2020

Chemistry Paper - 1_Solutions

1.(C) $V_{M.P} : V_{avg} : V_{RMS} = \sqrt{\frac{2RT}{M^o}} : \sqrt{\frac{8RT}{\pi M^o}} : \sqrt{\frac{3RT}{M^o}}$

$$= \sqrt{2} : \sqrt{\frac{8}{\pi}} : \sqrt{3}$$

$$= 1 : 1.128 : 1.224$$

2.(B) Pb_3O_4 is a mixed oxide of PbO_2 and PbO, it will not produce $O_2(g)$ on hydrolysis. KO_2 is a superoxide thus its hydrolysis will produce $O_2(g)$

$$2KO_2 + 2H_2O \rightarrow 2KOH + H_2O_2 + O_2(g)\uparrow$$

Na_2O_2 and Li_2O_2 are peroxides and their hydrolysis do not give $O_2(g)$.

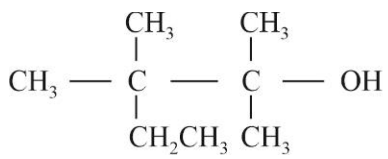
3.(A) $\underset{\text{(Nitrate salts)}}{Ag^{+} + Pb^{+2}} \longrightarrow \underset{\longleftarrow \text{white ppt} \longrightarrow}{AgCl + PbCl_2}$

$$AgCl + PbCl_2 \xrightarrow[\text{(Dissolves } PbCl_2\text{)}]{\Delta,\ \text{(Hot water)}} \underset{\text{[Residue P]}}{AgCl_{(s)}} + \underset{\text{[solution Q]}}{PbCl_{2(aq)}}$$

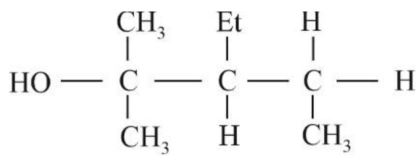
$AgCl_{(s)}$ is soluble in aq. NH_3 and excess $Na_2S_2O_3$ due to formation of complexes $Ag(NH_3)_2^+$ and $[Ag(S_2O_3)_2]^{-3}$ respectively.

$$\underset{\text{(Hot solution Q)}}{PbCl_2} \xrightarrow{KI} \underset{\text{(yellow ppt.)}}{PbI_2}$$

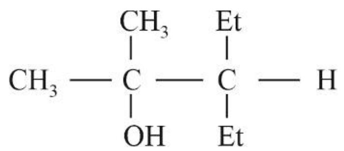
4.(C) Structure of (P) :

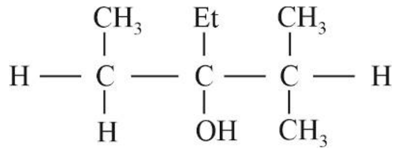


Structure of (Q) :

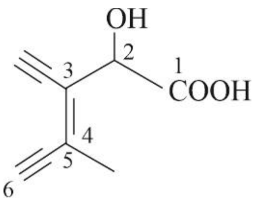


Structure of (R) :

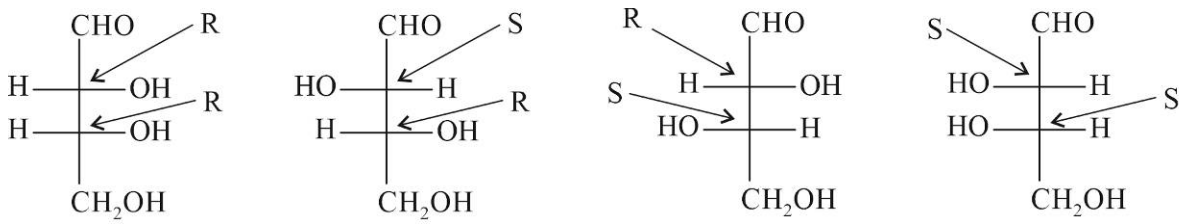


Structure of (S) : 

Hence (Q) and (R) are identical molecules.

5.(D)  is 3-ethynyl-2-hydroxy-4-methyl hex-3-en-5-ynoic acid.

6.(C) Fischer projection formula of the compound (P), (Q), (R) and (S) are



(P) **(Q)** **(R)** **(S)**

$\therefore$ P is identical to given D-Erythrose, (Q) and (R) are diastereomers to the given D- Erythrose and (S) is enantiomer to given D- Erythrose

7.(ABC) For Vander waal’s gas equation

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

For one mole of Vander Waal’s gas

$$\left(P+\frac{a}{v^2}\right)(V-b)=RT$$

$$\left(P+\frac{a}{V^2}\right)=\frac{RT}{V-b}$$

$$\boxed{P=\frac{RT}{V-b}-\frac{a}{V^2}}$$

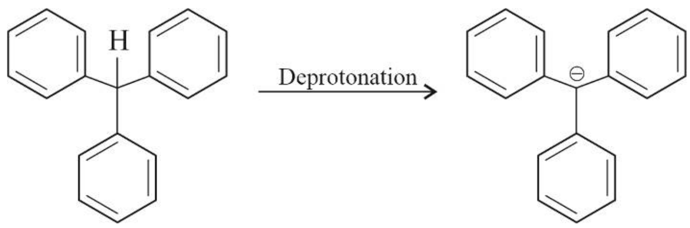
For Reversible isothermal and reversible adiabatic process, work done is

$$w=-\int P\,dv$$

$$w=-\int\left(\frac{RT}{V-b}-\frac{a}{V^2}\right)dv$$

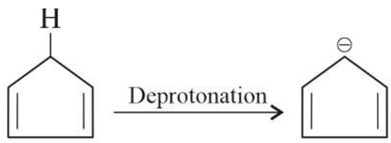
8.(ABC)

(A)



This negative charge is stabilized by conjugation in three phenyl rings

(B)



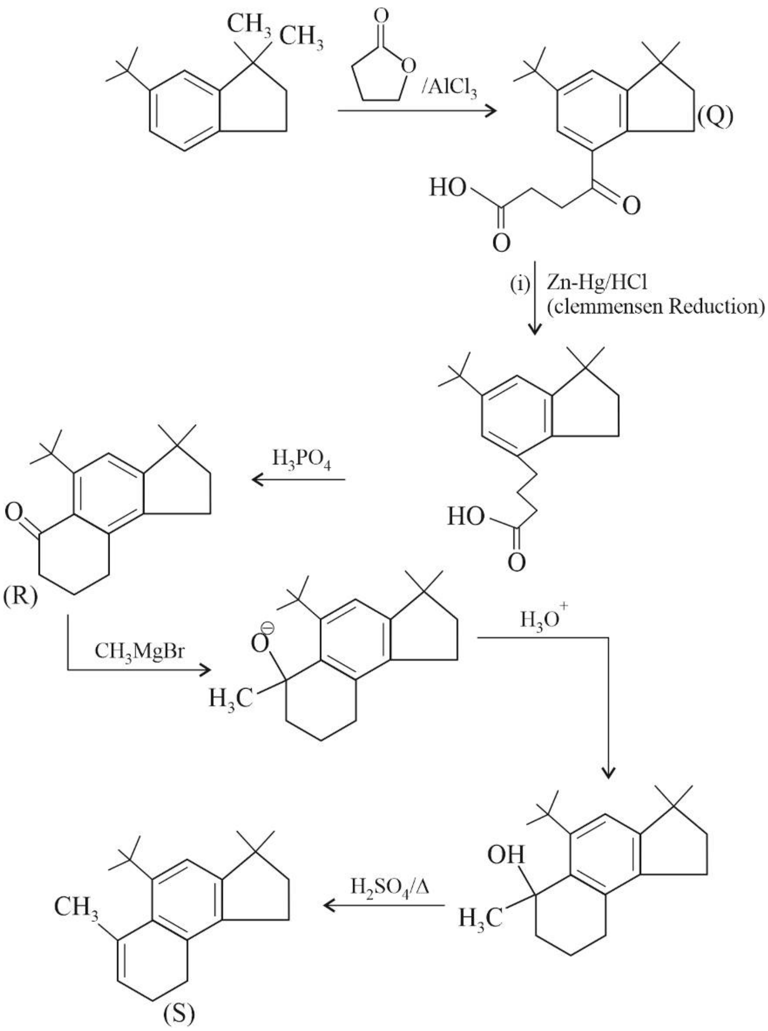
It is Aromatic

[Cyclopentadienyl anion]

(C) Electron with drawing groups increases the acidity of molecule

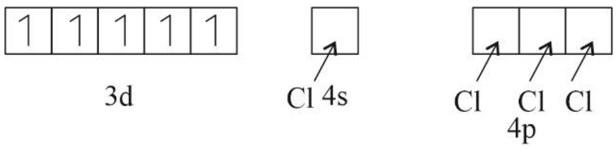
(D) Acidity order $\rightarrow$ IV > I > V > II > III

9.(BD)



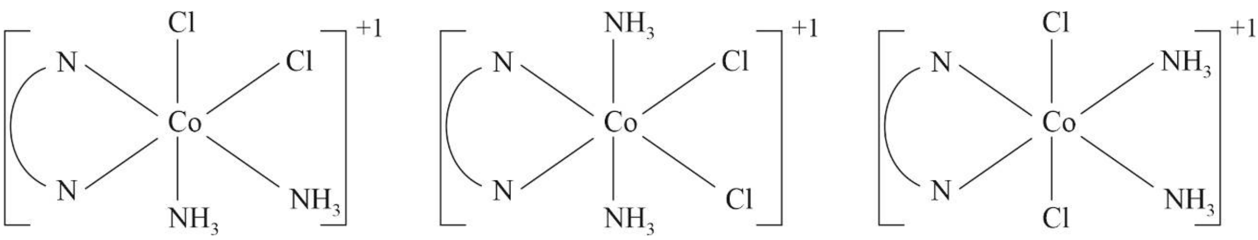
10.(AC)

(A) In $[FeCl_4]^-$ oxidation state of Fe is +3. Electronic configuration of $Fe^{+3} = 3d^5 4S^o$



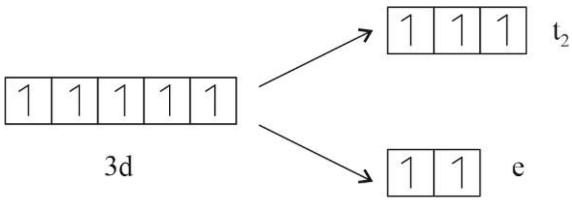
So hybridization is sp^3

(B) $[Co(en)(NH_3)_2Cl_2]^+$



(C) Fe is in +3 oxidation state in $[FeCl_4]$

$Fe^{+3} = d^5$ configuration



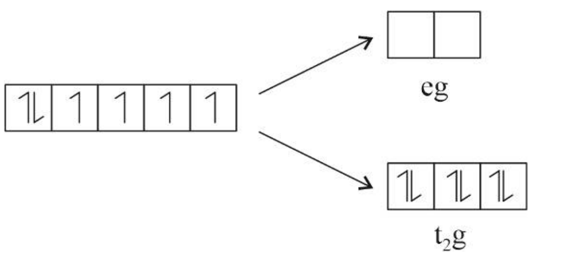
Spin only magnetic moment $= \sqrt{n(n+2)}$

$= \sqrt{5(5+2)}$

$= \sqrt{35}$

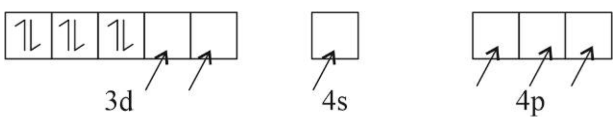
Co is in +3 oxidation state in $[Co(en)(NH_3)_2Cl_2]^+$ & en & NH_3 act as strong field ligand here

$\therefore$ $Co^{+3} = d^6$ configuration



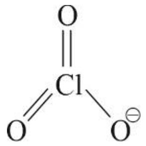
Spin only magnetic moment $= \sqrt{0(0+2)} = 0$

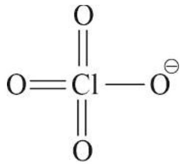
(D) $Co^{+3} \rightarrow 3d^6, 4s^0$ & as en & NH_3 are strong field ligands, they will cause pairing of e^-

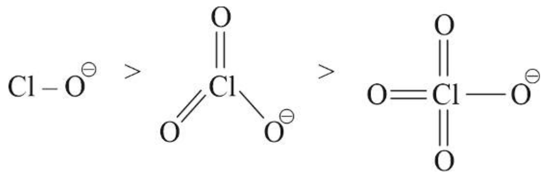


Hybridisation is d^2sp^3

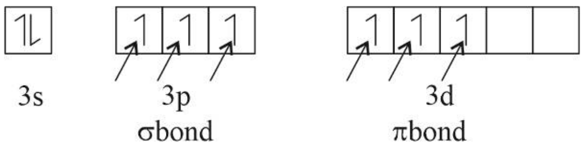
11.(ABD) $Cl-O^- \rightarrow$ hypochlorite ion

 $\rightarrow$ chlorate ion

 $\rightarrow$ perchlorate ion

(A) Basicity order = 

(B) ClO_3^- (chlorate), Cl has one lone pair.



Hybridization $\rightarrow sp^3$

Shape $\rightarrow$ pyramidal

$Cl-O^- \rightarrow$ Lienar

$ClO_4^- \rightarrow$ Tetrahedral in shape & no lone pair is present on Cl atom , so doesn't influence by lone pair

(C) $ClO_3^- \longrightarrow ClO_4^- + Cl^-$

$OCl^- \xrightarrow{\text{hot}} ClO_3^- + Cl^-$

(D) $$\overbrace{10ClO^- + SO_3^{2-} \longrightarrow 10Cl^-}^{\text{Reduction}} + SO_4^{2-}$$

$$10ClO^- + \underbrace{SO_3^{2-} \longrightarrow 10Cl^- + SO_4^{2-}}_{\text{Oxidation}}$$

12.(AC)

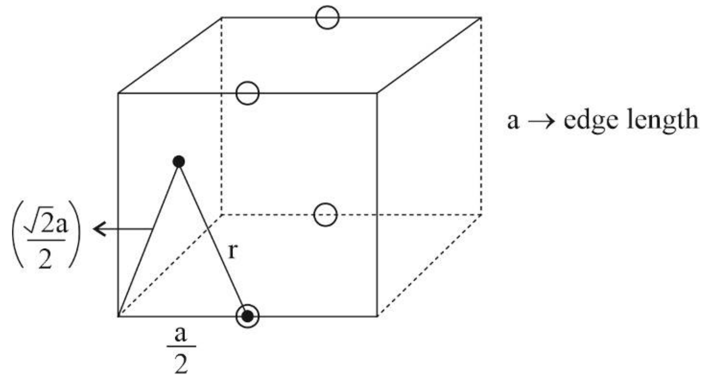
(A) $Z = \left(\frac{1}{2} \times 2\right)_M + \left(\frac{1}{4} \times 4\right)_X$

$= \boxed{MX}$

(B) Coordination number of M = 8

Coordination number of X = 8

(C)



$$r^2 = \left(\frac{\sqrt{2}}{2}a\right)^2 + \left(\frac{a}{2}\right)^2$$

$$r^2 = \frac{2a^2}{4} + \frac{a^2}{4} \Rightarrow r^2 = \frac{3a^2}{4} \Rightarrow r = \frac{\sqrt{3}a}{2}$$

According to question

$$\frac{r}{a} = \frac{\sqrt{3}a}{2} \times \frac{1}{a} \Rightarrow \frac{\sqrt{3}}{2} = 0.866$$

(D) As the coordination number of both cation & anion is 8. So $\frac{r^+}{r^-} = 0.732 - 1$

13.(0.11) 9 ml NaOH required in 3 consequtive experiments.

So, NaOH used = 9 ml

So, Gm Eqt of $H_2C_2O_4$ = Gm Eqt. Of NaOH

$$M \times \frac{Vml}{1000} \times nf = M \times \frac{Vml}{1000} \times nf$$

$$0.1 \times \frac{5}{1000} \times 2 = M \times \frac{9}{1000} \times 1$$

$$M = 0.11$$

14.(0.25) $A \rightleftharpoons B$

$$Kp_1 = \frac{P_B}{P_A} = \frac{10}{1} = 10$$

$$Kp_2 = \frac{P_B}{P_A} = \frac{100}{1} = 100$$

$$\Delta G_1^o = -RT_1 \ell n Kp_1 \quad \ldots\ldots(1)$$

$$\Delta G_2^o = -RT_2 \ell n Kp_2 \quad \ldots\ldots(2)$$

(1) ÷ (2)

$$\frac{\Delta G_1^o}{\Delta G_2^o} = \frac{T_1}{T_2} \frac{\ell n Kp_1}{\ell n Kp_2}$$

$$\frac{\Delta G_1^o}{\Delta G_2^o} = \frac{T_1}{T_2} \times \frac{2.303 \log Kp_1}{2.303 \log Kp_2}$$

$$= \frac{1000}{2000} \times \frac{\log 10}{\log 100}$$

$$\Rightarrow \frac{1000}{2000} \times \frac{1}{2} \Rightarrow \frac{1}{4} = 0.25$$

15.(13.32) $\frac{1}{2}O_2 + 2H^+ + 2e^- \longrightarrow H_2O \quad E^0 = 1.23\,V$ …..(1)

$2H^+ + 2e^- \longrightarrow H_2 \quad E^0 = 0.00V$

So, $H_2 \longrightarrow 2H^+ + 2e^- \quad E^0 = 0.00V$ …..(2)

From (1) and (2)

$$H_2 + \frac{1}{2}O_2 \longrightarrow H_2O \quad E^0 = 1.23V$$

$$\Delta G^o = -nfE^o$$

$$= -2 \times 96500 \times 1.23 \times 1 \times 10^{-3} \times \frac{70}{100}$$

$$= -166.173\ J$$

For compression in a thermally insulated container

$$w = nCv\Delta T$$

$$166.173 = 1 \times \frac{3}{2} R \times \Delta T$$

$$166.173 = 1 \times \frac{3}{2} \times 8.314 \times \Delta T$$

$$\Delta T = \frac{166.173 \times 2}{3 \times 8.314}$$

$$\boxed{\Delta T = 13.32}$$

Note : Cv for monoatomic gas $= \frac{3}{2}R$

16.(6.15)

Balanced chemical reaction is $3Al + 3H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 3H_2$

$$n = \frac{5.4}{27} \qquad n = M \times V_L$$

$$n = 0.2 \qquad = 5 \times \frac{50}{1000}$$

$$\frac{n}{S.C} = \frac{0.2}{2} \qquad \frac{n}{S.C} \Rightarrow \frac{0.25}{3}$$ so, it is limiting reagent

$\Rightarrow 0.1$

Hence, moles of H_2 formed $= \frac{0.25}{3} \times 3 \Rightarrow 0.25$

$$V_L = \frac{nRT}{P} = \frac{0.25 \times 0.082 \times 300}{1}$$

$V_L = 6.15$

17.(1.20) ${}^{238}_{92}U \longrightarrow {}^{206}_{82}Pb + 8\alpha + 6\beta$

Initial moles of $U = \frac{68 \times 10^{-6}}{238}$

Moles left after 3 half lines $\Rightarrow \frac{1}{8}\left(\frac{68 \times 10^{-6}}{238}\right)$

So, moles of α particles formed after 3 half lines $= 7\left(\frac{68 \times 10^{-6}}{238}\right)$

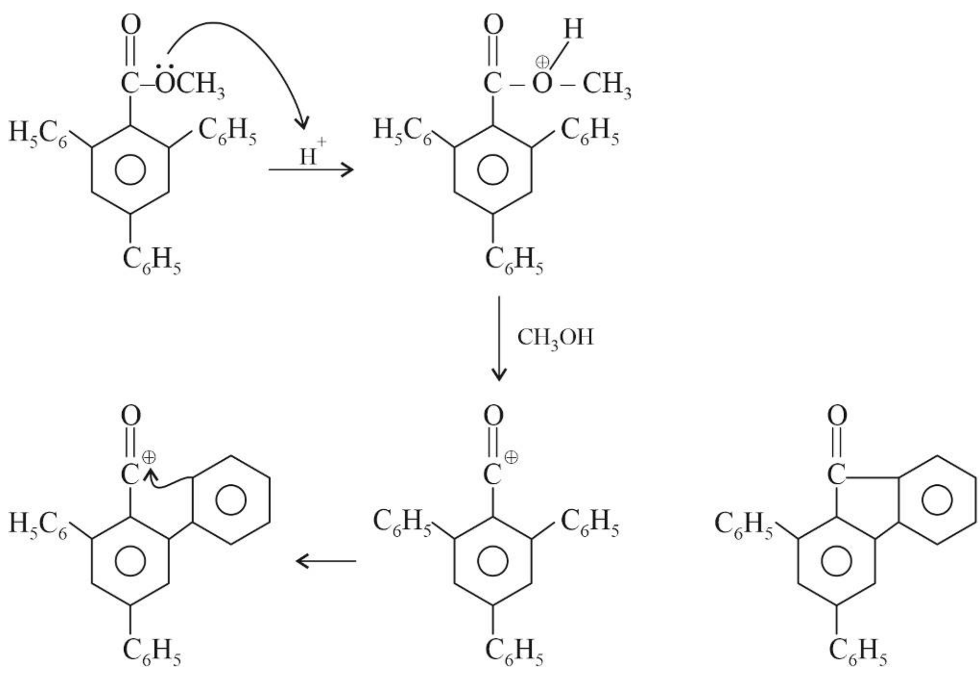
So, number of α particles $= \frac{7 \times 68 \times 10^{-6}}{236} \times 6.023 \times 10^{23}$

$\Rightarrow 12.046 \times 10^{17}$

$= 1.20 \times 10^{18}$

So Z = 1.2

18.(18)



So DOU = 18