

JEE(Advanced) – 2018 TEST PAPER - 2 WITH SOLUTION

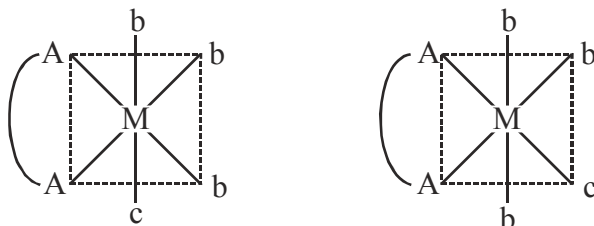
(Exam Date: 20-05-2018)

PART-1 : CHEMISTRY

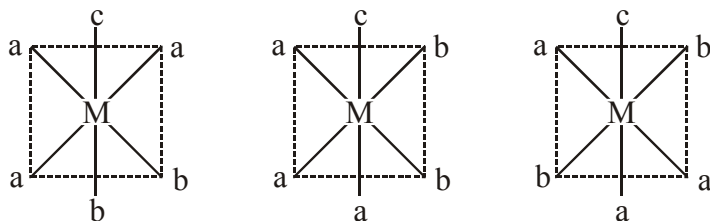
1. The correct option(s) regarding the complex $[\text{Co(en)}(\text{NH}_3)_3(\text{H}_2\text{O})]^{3+}$:-
 (en = $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$) is (are)
 (A) It has two geometrical isomers
 (B) It will have three geometrical isomers if bidentate 'en' is replaced by two cyanide ligands
 (C) It is paramagnetic
 (D) It absorbs light at longer wavelength as compared to $[\text{Co(en)}(\text{NH}_3)_4]^{3+}$

Ans. (A,B,D)

Sol. (A) $[\text{Co(en)}(\text{NH}_3)_3(\text{H}_2\text{O})]^{3+}$ complex is type of $[\text{M}(\text{AA})\text{b}_3\text{c}]$ have two G.I.



(B) If (en) is replaced by two cyanide ligand, complex will be type of $[\text{Ma}_3\text{b}_2\text{c}]$ and have 3 G.I.

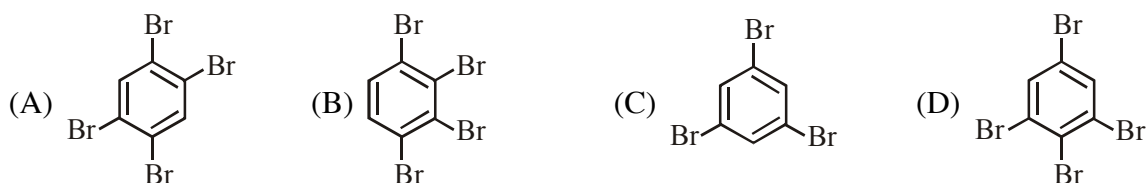
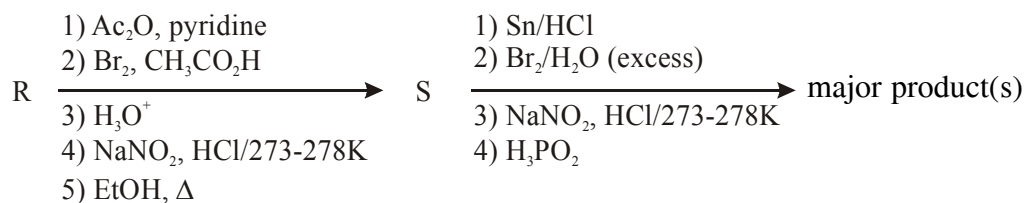


- (C) $[\text{Co(en)}(\text{NH}_3)_3(\text{H}_2\text{O})]^{3+}$ have d^6 configuration (t_{2g}^6) on central metal with SFL therefore it is diamagnetic in nature.
 (D) Complex $[\text{Co(en)}(\text{NH}_3)_3(\text{H}_2\text{O})]^{3+}$ have lesser CFSE (Δ_o) value than $[\text{Co(en)}(\text{NH}_3)_4]^{3+}$ therefore complex $[\text{Co(en)}(\text{NH}_3)_3(\text{H}_2\text{O})]^{3+}$ absorbs longer wavelength for d-d transition.
2. The correct option(s) to distinguish nitrate salts of Mn^{2+} and Cu^{2+} taken separately is (are) :-
 (A) Mn^{2+} shows the characteristic green colour in the flame test
 (B) Only Cu^{2+} shows the formation of precipitate by passing H_2S in acidic medium
 (C) Only Mn^{2+} shows the formation of precipitate by passing H_2S in faintly basic medium
 (D) Cu^{2+}/Cu has higher reduction potential than Mn^{2+}/Mn (measured under similar conditions)

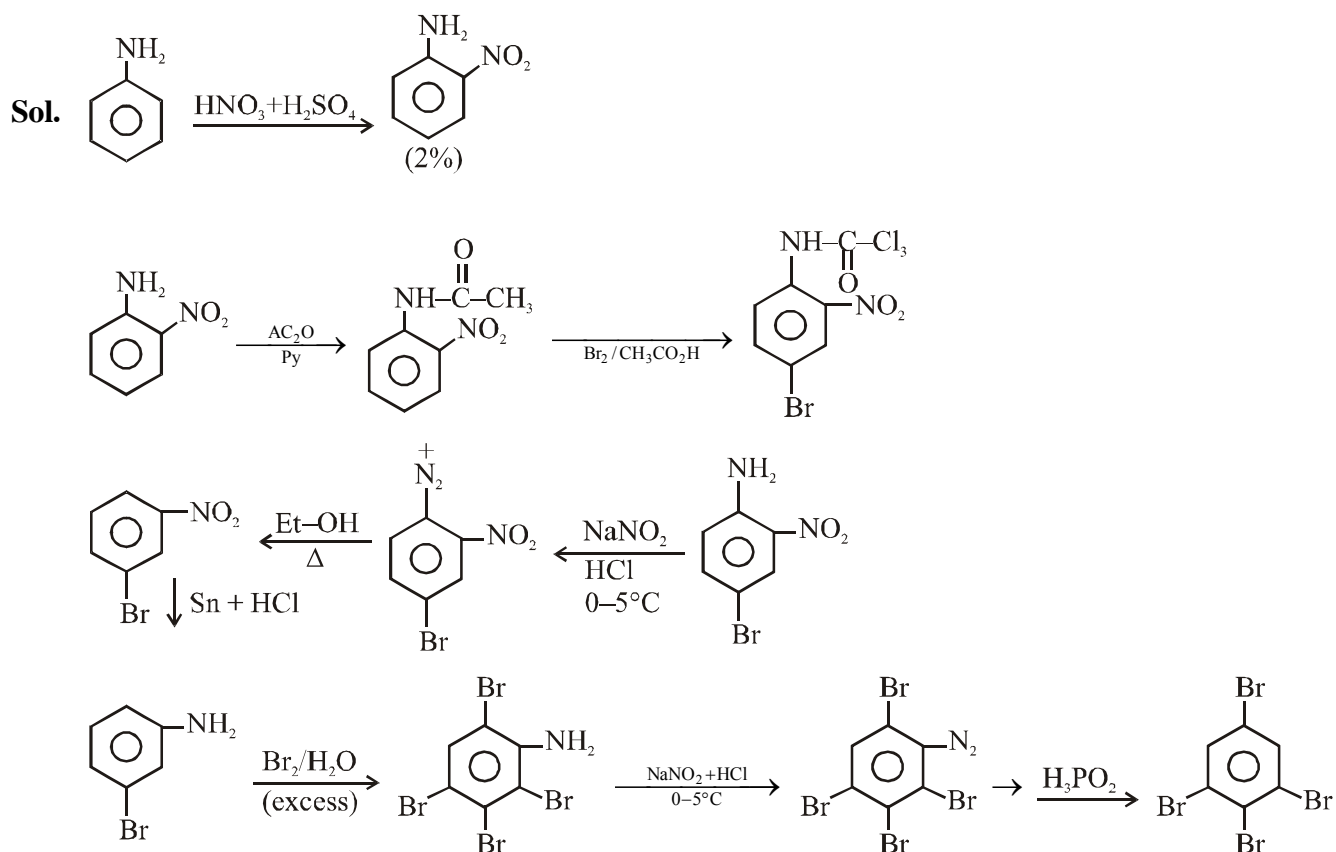
Ans. (B,D)

- Sol.** (A) Cu^{+2} and Mn^{+2} both gives green colour in flame test and cannot distinguished.
 (B) Cu^{+2} belongs to group-II of cationic radical will gives ppt. of CuS in acidic medium.
 (C) Cu^{+2} and Mn^{+2} both form ppt. in basic medium.
 (D) $\text{Cu}^{+2}/\text{Cu} = +0.34 \text{ V (SRP)}$
 $\text{Mn}^{+2}/\text{Mn} = -1.18 \text{ V (SRP)}$

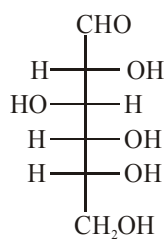
3. Aniline reacts with mixed acid (conc. HNO_3 and conc. H_2SO_4) at 288 K to give P (51%), Q (47%) and R (2%). The major product(s) the following reaction sequence is (are) :-



Ans. (D)

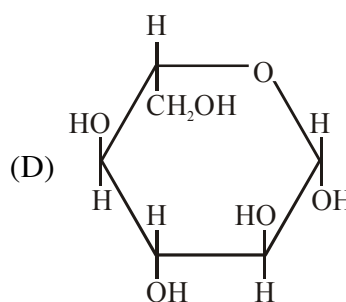
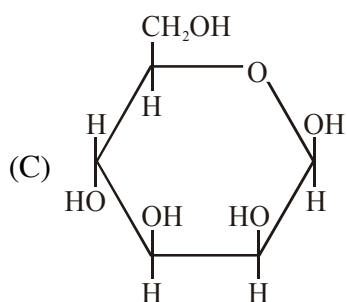
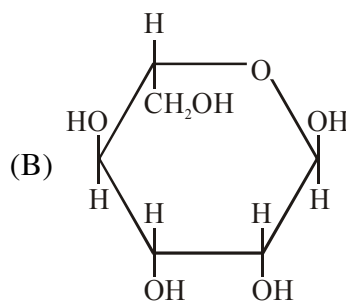
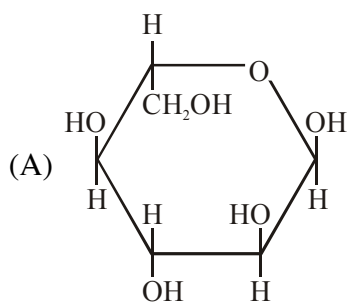


4. The Fischer presentation of D-glucose is given below.

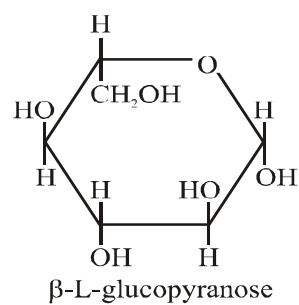
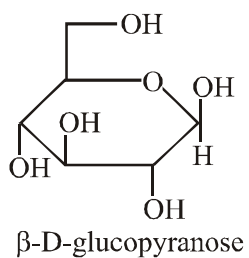
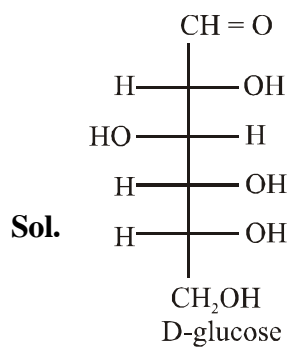


D-glucose

The correct structure(s) of β -L-glucopyranose is (are) :-

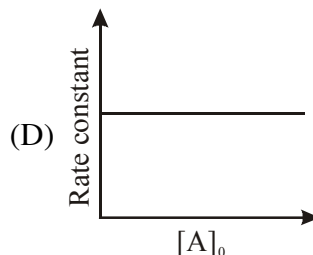
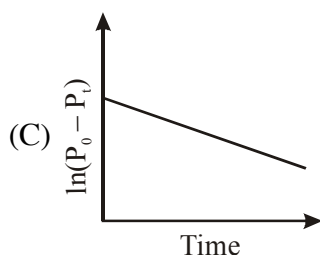
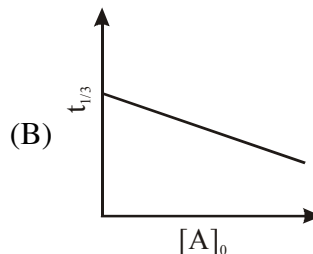
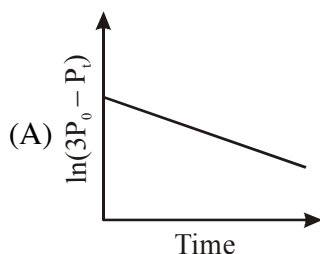


Ans. (D)



5. For a first order reaction $A(g) \rightarrow 2B(g) + C(g)$ at constant volume and 300 K, the total pressure at the beginning ($t = 0$) and at time t are P_0 and P_t , respectively. Initially, only A is present with concentration $[A]_0$, and $t_{1/3}$ is the time required for the partial pressure of A to reach $1/3^{\text{rd}}$ of its initial value. The correct option(s) is (are) :-

(Assume that all these gases behave as ideal gases)



Ans. (A,D)

Sol. $A \longrightarrow 2B + C$

$t = 0$ P_0 $-$ $-$

$t = t$ $P_0 - P$ $2P$ P

$P_0 + 2P = P_t$

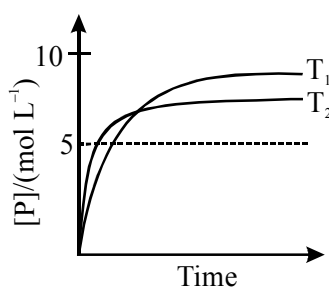
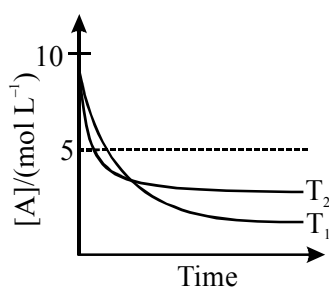
$$K = \frac{1}{t} \ln \frac{P_0}{P_0 - P} = \frac{1}{t} \ln \frac{P_0}{P_0 - \frac{(P_t - P_0)}{2}}$$

$$K = \frac{1}{t} \ln \frac{2P_0}{3P_0 - P_t} \Rightarrow -Kt + \ln 2P_0 = \ln(3P_0 - P_t)$$

$$\text{and } t_{1/3} = \frac{1}{K} \ln \frac{P_0}{P_0/3} = \frac{1}{K} \ln 3 = \text{constant } t$$

Rate constant does not depend on concentration

6. For a reaction, $A \rightleftharpoons P$, the plots of $[A]$ and $[P]$ with time at temperatures T_1 and T_2 are given below.



If $T_2 > T_1$, the correct statement(s) is (are)

(Assume ΔH^θ and ΔS^θ are independent of temperature and ratio of $\ln K$ at T_1 to $\ln K$ at T_2 is greater

than $\frac{T_2}{T_1}$. Here H, S, G and K are enthalpy, entropy, Gibbs energy and equilibrium constant, respectively.)

(A) $\Delta H^\theta < 0, \Delta S^\theta < 0$

(B) $\Delta G^\theta < 0, \Delta H^\theta > 0$

(C) $\Delta G^\theta < 0, \Delta S^\theta < 0$

(D) $\Delta G^\theta < 0, \Delta S^\theta > 0$

Ans. (A,C)

Sol. $A \rightleftharpoons P$

given $T_2 > T_1$

$$\frac{\ln K_1}{\ln K_2} > \frac{T_2}{T_1}$$

$$\Rightarrow T_1 \ln k_1 > T_2 \ln k_2$$

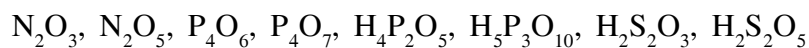
$$\Rightarrow -\Delta G_1^\circ > -\Delta G_2^\circ$$

$$\Rightarrow (-\Delta H^\circ + T_1 \Delta S^\circ) > (-\Delta H^\circ + T_2 \Delta S^\circ)$$

$$\Rightarrow T_1 \Delta S^\circ > T_2 \Delta S^\circ$$

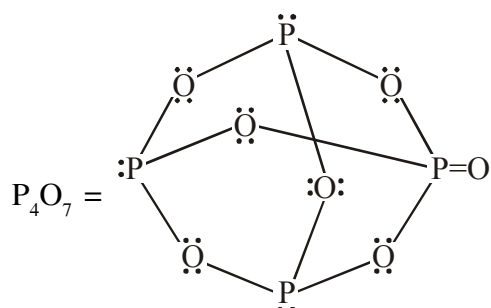
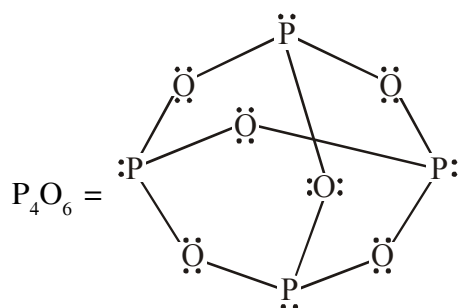
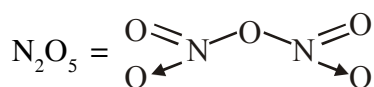
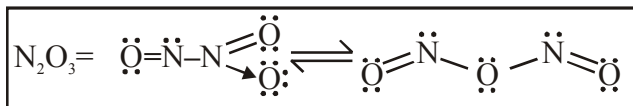
$$\Rightarrow \Delta S^\circ < 0$$

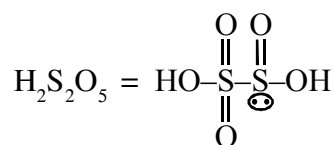
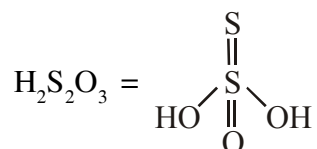
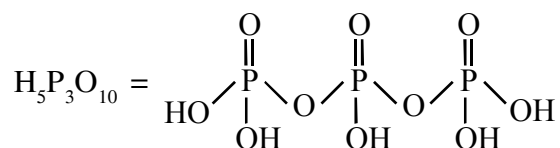
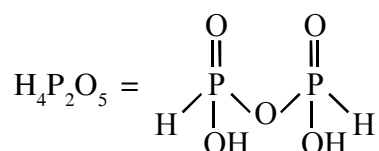
7. The total number of compounds having at least one bridging oxo group among the molecules given below is_____.



Ans. (5 or 6)

Sol.

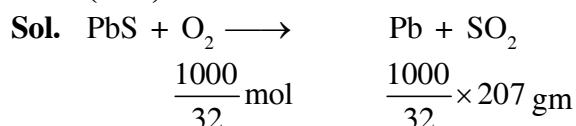




8. Galena (an ore) is partially oxidized by passing air through it at high temperature. After some time, the passage of air is stopped, but the heating is continued in a closed furnace such that the contents undergo self-reduction. The weight (in kg) of Pb produced per kg of O_2 consumed is _____.

(Atomic weights in g mol^{-1} : O = 16, S = 32, Pb = 207)

Ans. (6.47)



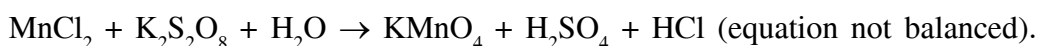
mol of Pb = mol of O_2

$$= \frac{1000}{32} \text{ mol}$$

$$\therefore \text{mass of Pb} = \frac{1000}{32} \times 207 \text{ g}$$

$$= \frac{207}{32} \text{ kg} = 6.47 \text{ kg}$$

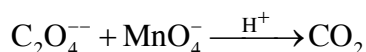
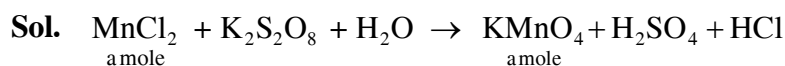
9. To measure the quantity of MnCl_2 dissolved in an aqueous solution, it was completely converted to KMnO_4 using the reaction,



Few drops of concentrated HCl were added to this solution and gently warmed. Further, oxalic acid (225 g) was added in portions till the colour of the permanganate ion disappeared. The quantity of MnCl_2 (in mg) present in the initial solution is _____.

(Atomic weights in g mol^{-1} : Mn = 55, Cl = 35.5)

Ans. (126)



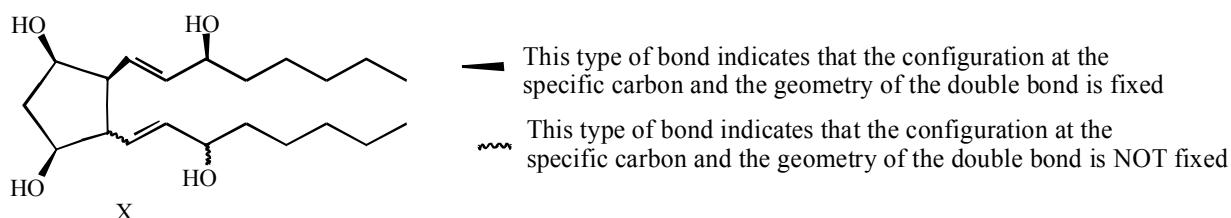
$$m_{\text{eq}} \text{ of } \text{C}_2\text{O}_4^{--} = m_{\text{eq}} \text{ of } \text{MnO}_4^-$$

$$2 \times 0.225/90 = a \times 5$$

$$a = 1 \times [55 + 71]$$

$$= 126 \text{ mg}$$

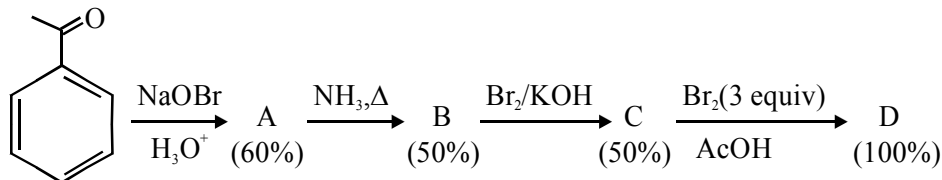
- 10.** For the given compound X, the total number of optically active stereoisomers is_____.



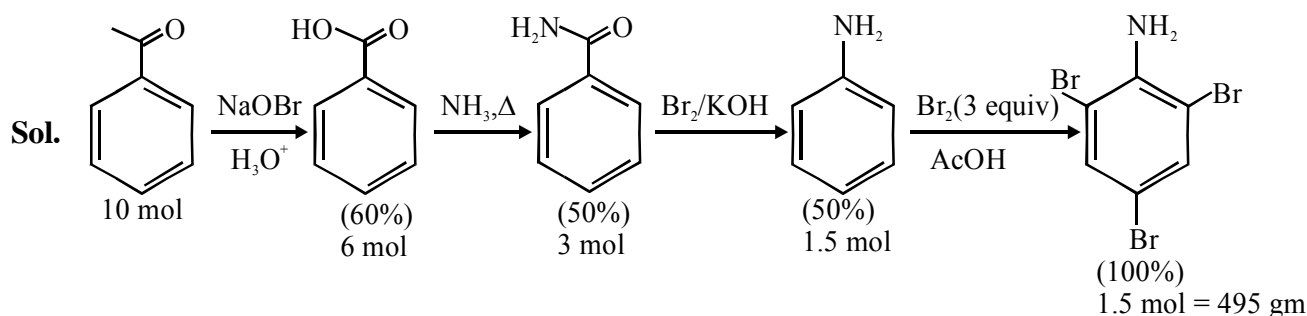
Ans. (7)

- 11.** In the following reaction sequence, the amount of D (in g) formed from 10 moles of acetophenone is_____.

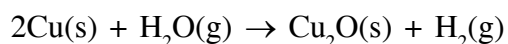
(Atomic weight in g mol^{-1} : H = 1, C = 12, N = 14, O = 16, Br = 80. The yield (%) corresponding to the product in each step is given in the parenthesis)



Ans. (495)



- 12.** The surface of copper gets tarnished by the formation of copper oxide. N_2 gas was passed to prevent the oxide formation during heating of copper at 1250 K. However, the N_2 gas contains 1 mole % of water vapour as impurity. The water vapour oxidises copper as per the reaction given below :



p_{H_2} is the minimum partial pressure of H_2 (in bar) needed to prevent the oxidation at 1250 K. The value of $\ln(p_{\text{H}_2})$ is _____.

(Given : total pressure = 1 bar, R (universal gas constant) = $8 \text{ JK}^{-1} \text{ mol}^{-1}$, $\ln(10) = 2.3$. Cu(s) and $\text{Cu}_2\text{O(s)}$ are mutually immiscible.

At 1250 K : $2\text{Cu(s)} + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{Cu}_2\text{O(s)}$; $\Delta G^\theta = -78,000 \text{ J mol}^{-1}$

$\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O(g)}$; $\Delta G^\theta = -1,78,000 \text{ J mol}^{-1}$; G is the Gibbs energy)

Ans. (-14.6)

Sol. $2\text{Cu(s)} + \frac{1}{4}\text{O}_2(\text{g}) \rightarrow \frac{1}{2}\text{Cu}_2\text{O(s)}$ $\Delta G^\theta = -78 \text{ kJ}$

$[\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{O(g)} \quad \Delta G^\theta = -178 \text{ kJ}] \times (-1)$

Hence, $2\text{Cu(s)} + \text{H}_2\text{O(g)} \rightarrow \text{Cu}_2\text{O} + \text{H}_2(\text{g}) \quad \Delta G^\theta = +100 \text{ kJ}$

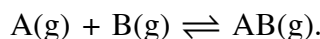
$\Delta G = \Delta G^\theta + RT \ln Q$

$$0 = +100 + \frac{8}{1000} \times 1250 \ln \frac{p_{\text{H}_2}}{p_{\text{H}_2\text{O}}}$$

$$-\frac{100 \times 1000}{8} = 1250 \ln \left(\frac{p_{\text{H}_2}}{\left(\frac{1}{100} \times 1\right)} \right)$$

$$\ln p_{\text{H}_2} = -14.6$$

13. Consider the following reversible reaction,



The activation energy of the backward reaction exceeds that of the forward reaction by $2RT$ (in J mol^{-1}). If the pre-exponential factor of the forward reaction is 4 times that of the reverse reaction, the absolute value of ΔG^θ (in J mol^{-1}) for the reaction at 300 K is_____.

(Given ; $\ln(2) = 0.7$, $RT = 2500 \text{ J mol}^{-1}$ at 300 K and G is the Gibbs energy)

Ans. (8500)

Sol. $\text{A}_{(\text{g})} + \text{B}_{(\text{g})} \rightleftharpoons \text{AB}_{(\text{g})}$

$$E_{\text{ab}} - E_{\text{af}} = 2RT \quad \Rightarrow \quad \Delta H = -2RT \quad \text{and} \quad \frac{A_{\text{f}}}{A_{\text{b}}} = 4$$

$$K_{\text{eq}} = \left(\frac{K_{\text{f}}}{K_{\text{b}}} \right) = \frac{A_{\text{f}} e^{-E_{\text{af}}/RT}}{A_{\text{b}} e^{-E_{\text{ab}}/RT}} = 4(e^2)$$

$$\Delta G^\theta = -RT \ln K = -2500 \times \ln(4 \times e^2) = -8500 \text{ J/mol}$$

$\therefore$ Absolute value of $\Delta G^\theta = 8500 \text{ J/mol}$

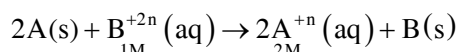
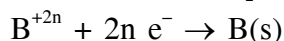
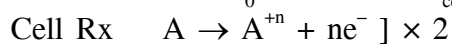
14. Consider an electrochemical cell: $\text{A(s)} \mid \text{A}^{n+}(\text{aq}, 2\text{M}) \parallel \text{B}^{2n+}(\text{aq}, 1\text{M}) \mid \text{B(s)}$. The value of ΔH^θ for the cell reaction is twice that of ΔG^θ at 300 K. If the emf of the cell is zero, the ΔS^θ (in $\text{JK}^{-1} \text{ mol}^{-1}$) of the cell reaction per mole of B formed at 300 K is_____.

(Given : $\ln(2) = 0.7$, R (universal gas constant) = $8.3 \text{ J K}^{-1} \text{ mol}^{-1}$. H , S and G are enthalpy, entropy and Gibbs energy, respectively.)

Ans. (-11.62)



$$\Delta H^\circ = 2\Delta G_0^\circ \quad E_{\text{cell}} = 0$$



$$\Delta G = \Delta G^\circ + RT \ln \frac{[A^{+n}]^2}{[B^{+2n}]}$$

$$\Delta G^\circ = -RT \ln \frac{[A^{+n}]^2}{[B^{+2n}]} = -RT \ln \frac{2^2}{1} = -RT \ln 4$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$\Delta G^\circ = 2\Delta G^\circ - T\Delta S^\circ$$

$$\Delta S^\circ = \frac{\Delta G^\circ}{T} = -\frac{RT \ln 4}{T}$$

$$= -8.3 \times 2 \times 0.7 = -11.62 \text{ J/K.mol}$$

15. Match each set of hybrid orbitals from LIST-I with complex (es) given in LIST-II.

LIST-I

P. dsp^2

Q. sp^3

R. sp^3d^2

S. d^2sp^3

LIST-II

1. $[\text{FeF}_6]^{4-}$

2. $[\text{Ti}(\text{H}_2\text{O})_3\text{Cl}_3]$

3. $[\text{Cr}(\text{NH}_3)_6]^{3+}$

4. $[\text{FeCl}_4]^{2-}$

5. $\text{Ni}(\text{CO})_4$

6. $[\text{Ni}(\text{CN})_4]^{2-}$

The correct option is

(A) P $\rightarrow$ 5; Q $\rightarrow$ 4,6; R $\rightarrow$ 2,3; S $\rightarrow$ 1

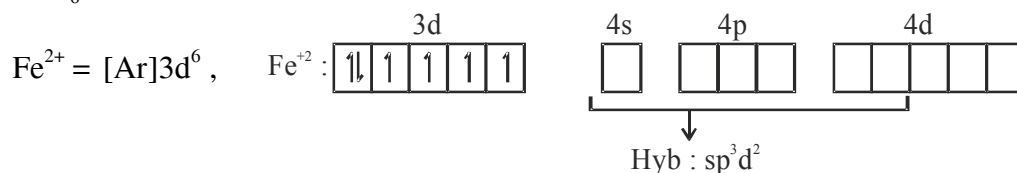
(B) P $\rightarrow$ 5,6; Q $\rightarrow$ 4; R $\rightarrow$ 3; S $\rightarrow$ 1,2

(C) P $\rightarrow$ 6; Q $\rightarrow$ 4,5; R $\rightarrow$ 1; S $\rightarrow$ 2,3

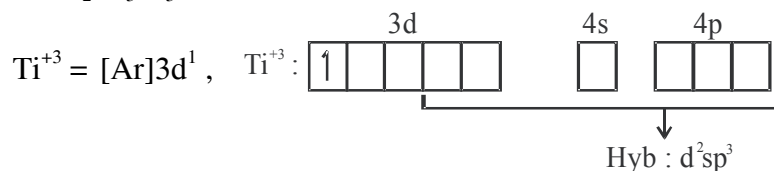
(D) P $\rightarrow$ 4,6; Q $\rightarrow$ 5,6; R $\rightarrow$ 1,2; S $\rightarrow$ 3

Ans. (C)

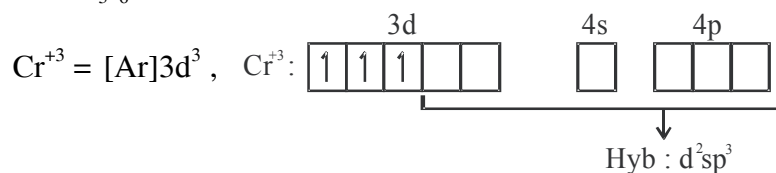
Sol. [1] $[\text{FeF}_6]^{4-}$



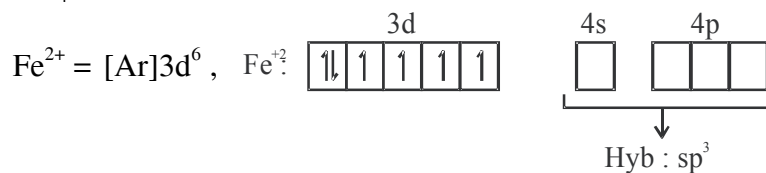
[2] $[\text{Ti}(\text{H}_2\text{O})_3\text{Cl}_3]$



[3] $[\text{Cr}(\text{NH}_3)_6]^{3+}$

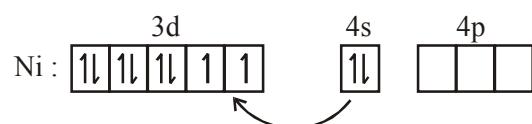


[4] $[\text{FeCl}_4]^{2-}$

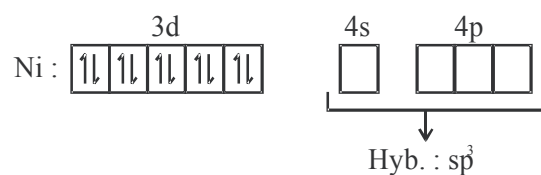


[5] $[\text{Ni}(\text{CO})_4]$

$\text{Ni} : 3d^8 4s^2$



Back pairing of electrons due to presence of strong field ligand

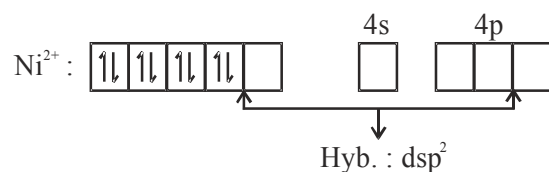


[6] $[\text{Ni}(\text{CN})_4]^{2-}$

$\text{Ni}^{2+} : 3d^8$

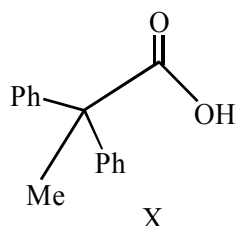


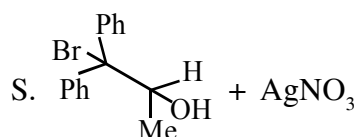
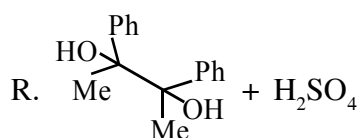
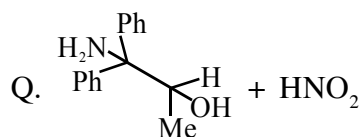
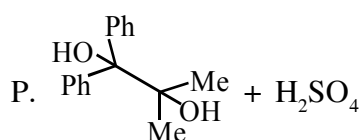
Electron pairing take place due to presence of S.F.L.



16. The desired product X can be prepared by reacting the major product of the reactions in LIST-I with one or more appropriate reagents in LIST-II.

(given, order of migratory aptitude: aryl > alkyl > hydrogen)



LIST-I**LIST-II**

1. I₂, NaOH

2. [Ag(NH₃)₂]OH

3. Fehling solution

4. HCHO, NaOH

5. NaOBr

The correct option is

(A) P → 1; Q → 2,3; R → 1,4; S → 2,4

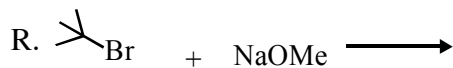
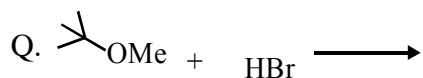
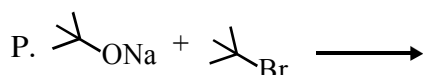
(B) P → 1,5; Q → 3,4; R → 4,5; S → 3

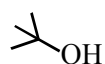
(C) P → 1,5; Q → 3,4; R → 5; S → 2,4

(D) P → 1,5; Q → 2,3; R → 1,5; S → 2,3

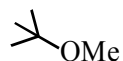
Ans. (D)

17. LIST-I contains reactions and LIST-II contains major products.

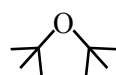
LIST-I**LIST-II**

1. 

2. 

3. 

4. 

5. 

Match each reaction in LIST-I with one or more product in LIST-II and choose the correct option.

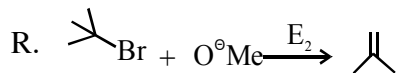
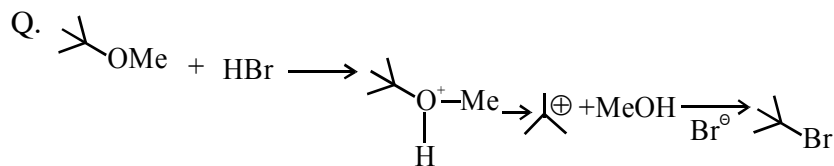
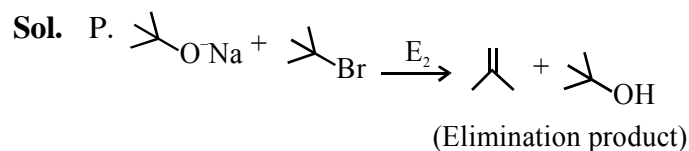
(A) P → 1,5; Q → 2; R → 3; S → 4

(B) P → 1,4; Q → 2; R → 4; S → 3

(C) P → 1,4; Q → 1,2; R → 3,4; S → 4

(D) P → 4,5; Q → 4; R → 4; S → 3,4

Ans. (B)



18. Dilution process of different aqueous solutions; with water, are given in LIST-I. The effects of dilution of the solutions on $[\text{H}^+]$ are given in LIST-II.

(Note : Degree of dissociation (α) of weak acid and weak base is $\ll 1$; degree of hydrolysis of salt $\ll 1$; $[\text{H}^+]$ represents the concentration of H^+ ions)

LIST-I

- P. (10 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 60 mL
Q. (20 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 80 mL
R. (20 mL of 0.1 M HCl + 20 mL of 0.1 M ammonia solution) diluted to 80 mL
S. 10 mL saturated solution of $\text{Ni}(\text{OH})_2$ in equilibrium with excess solid $\text{Ni}(\text{OH})_2$ is diluted to 20 mL (solid $\text{Ni}(\text{OH})_2$ is still present after dilution).

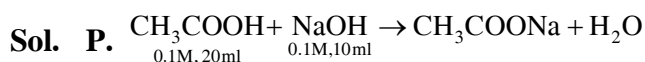
List-II

1. the value of $[\text{H}^+]$ does not change on dilution
2. the value of $[\text{H}^+]$ change to half of its initial value on dilution
3. the value of $[\text{H}^+]$ changes to two times of its initial value on dilution
4. the value of $[\text{H}^+]$ changes to $\frac{1}{\sqrt{2}}$ times of its initial value on dilution
5. the value of $[\text{H}^+]$ changes to $\sqrt{2}$ times of its initial value on dilution

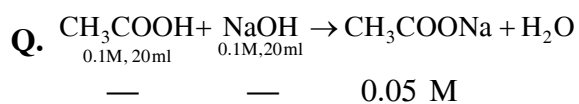
Match each process given in LIST-I with one or more effect(s) in LIST-II. The correct option is

- (A) P $\rightarrow$ 4; Q $\rightarrow$ 2; R $\rightarrow$ 3; S $\rightarrow$ 1
(B) P $\rightarrow$ 4; Q $\rightarrow$ 3; R $\rightarrow$ 2; S $\rightarrow$ 3
(C) P $\rightarrow$ 1; Q $\rightarrow$ 4; R $\rightarrow$ 5; S $\rightarrow$ 3
(D) P $\rightarrow$ 1; Q $\rightarrow$ 5; R $\rightarrow$ 4; S $\rightarrow$ 1

Ans. (D)



$\text{pH} = \text{pK}_a \Rightarrow [\text{H}^+]$ will not change on dilution
correct match : P-1

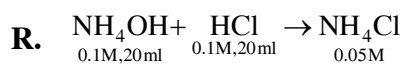


$$[\text{OH}^-] = \sqrt{K_H C} = \sqrt{\left(\frac{k_w}{k_a} C\right)}$$

$$[\text{H}^+]_1 = \sqrt{\frac{k_w k_a}{C}}$$

$$\frac{[\text{H}^+]_2}{[\text{H}^+]_1} = \sqrt{\frac{C_1}{C_2}} = \sqrt{\frac{0.05}{0.025}} = \sqrt{2}$$

correct match : Q-5



$$[\text{H}^+] = \sqrt{K_H C}$$

$$\frac{[\text{H}^+]_2}{[\text{H}^+]_1} = \sqrt{\frac{C_2}{C_1}} = \frac{1}{\sqrt{2}}$$

correct match : R-4

S. Because of dilution solubility does not change so $[\text{H}^+] = \text{constant}$