



JEE (ADVANCED) 2018 PAPER-2

[PAPER WITH SOLUTION]

HELD ON SUNDAY 20TH MAY, 2018

CHEMISTRY

SECTION 1 (Maximum Marks : 24)

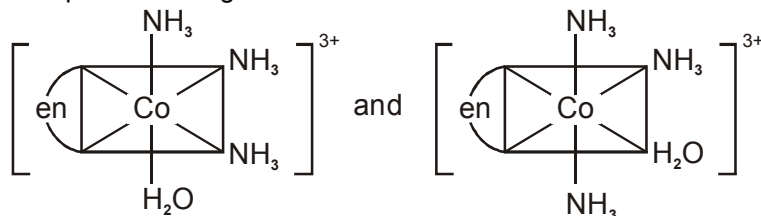
- This section contains **SIX (06)** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:
 - Full Marks : **+4** If only (all) the correct option(s) is (are) chosen.
 - Partial Marks : **+3** If all the four options are correct but **ONLY** three options are chosen.
 - Partial Marks : **+2** If three or more options are correct but **ONLY** two options are chosen, both of which are correct options.
 - Partial Marks : **+1** If two or more options are correct but **ONLY** one option is chosen and it is a correct option.
 - Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).
 - Negative Marks : **-2** In all other cases.
- For example** : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in -2 marks.

1. The correct option(s) regarding the complex $[\text{Co}(\text{en})(\text{NH}_3)_3(\text{H}_2\text{O})]^{3+}$
- (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 $[\text{Co}(\text{en})(\text{NH}_3)_4]^{3+}$

Ans. (A, B, D)

Sol. $[\text{Co}(\text{en})(\text{NH}_3)_4]^{3+}$

- $\text{Co}^{3+} \Rightarrow 3d^6$
 $\therefore \text{NH}_3, \text{H}_2\text{O}$ and ethylene diamine behaves as strong ligand field in case of Co^{3+} .
 \therefore Complex is diamagnetic.
- Complex has two geometrical isomers.



- If ethylenediamine replaced by CN^- , then

$$[\text{Co}(\text{en})(\text{NH}_3)_3(\text{H}_2\text{O})]^{3+} \xrightarrow[-2\text{en}]{+2\text{CN}^-} [\text{Co}(\text{CN})_2(\text{NH}_3)_3(\text{H}_2\text{O})]^{+}$$
(two G.I.) (three G.I.)
- It has more CFSE. So it absorbs longer wavelength.

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)

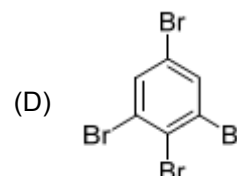
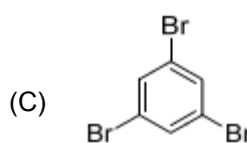
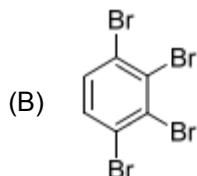
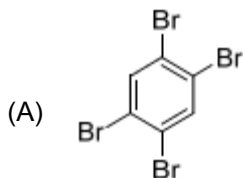
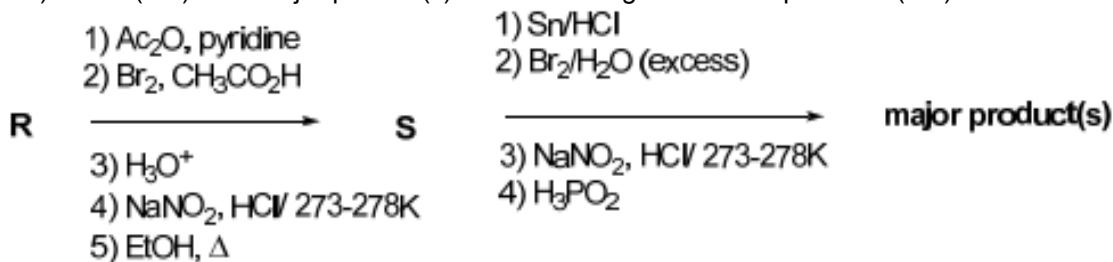
Ans. (B,D)

Sol.

- $\text{Mn}^{2+} \Rightarrow$ do not give green flame
- $\text{Cu}^{2+} \Rightarrow$ give green coloured flame (though blue glass)
- IInd and IVth group cations are ppt of sulphide in basic medium by passing H_2S .
- $E_{\text{Mn}^{2+}/\text{Mn}}^{\circ} < E_{\text{Cu}^{2+}/\text{Cu}}^{\circ}$

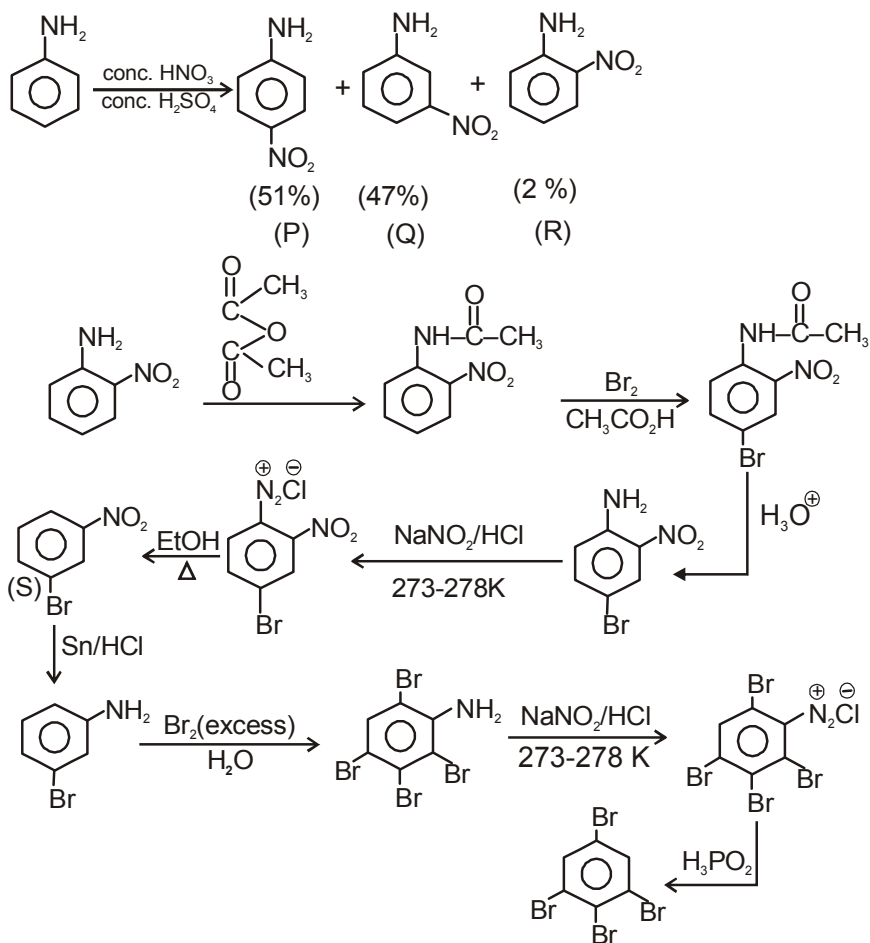
3. Aniline reacts with mixed acid (conc. HNO_3 and conc. H_2SO_4) at 288 K to give **P** (51 %),

Q (47%) and **R** (2%). The major product(s) of the following reaction sequence is (are)

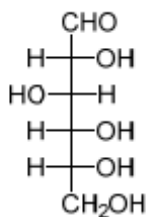


Ans. (D)

Sol.

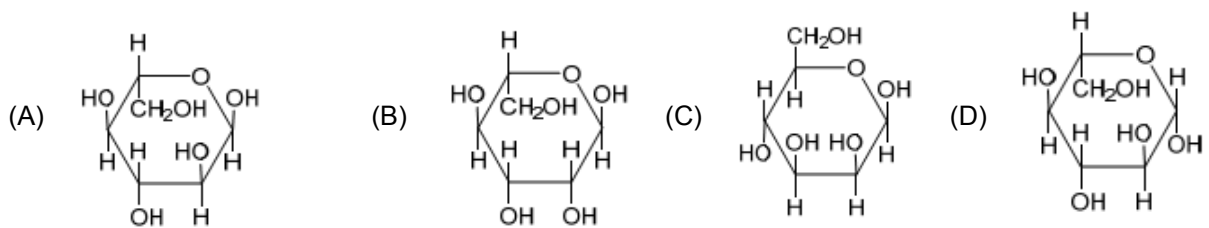


4. The Fischer presentation of D-glucose is given below.



D-glucose

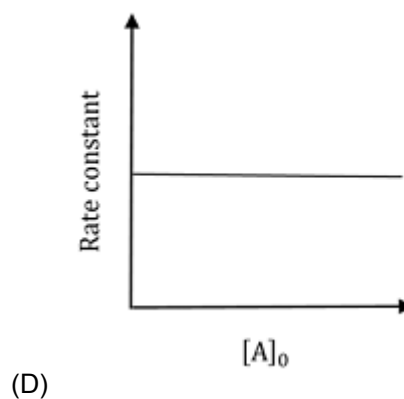
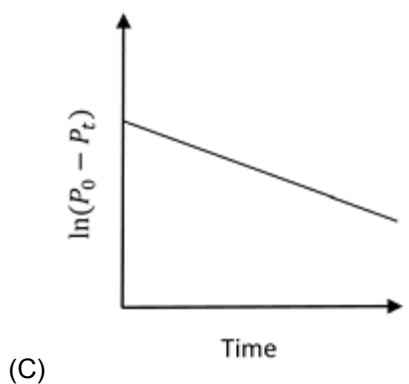
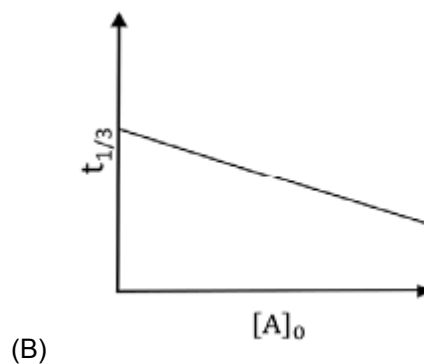
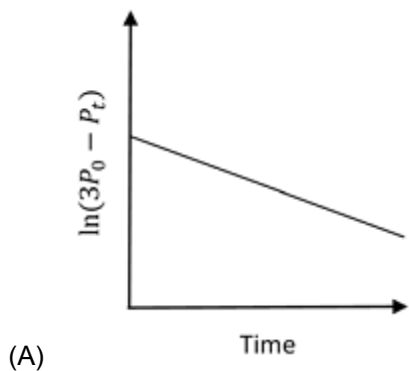
The correct structure(s) of β -L-glucopyranose is (are)



Ans. (D)

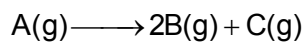
5. For a first order reaction $A(g) \rightarrow 2B(g) + C(g)$ at constant volume and 300 K, the total pressure at the beginning ($t = 0$) and at time t are P_0 and P_t , respectively. Initially, only A is present with concentration $[A]_0$, and $t_{1/3}$ is the time required for the partial pressure 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.



$$t = 0; \quad p_0$$

$$t = t; \quad p_0 - x \quad 2x \quad x$$

$$p_t = p_0 - x + 2x + x$$

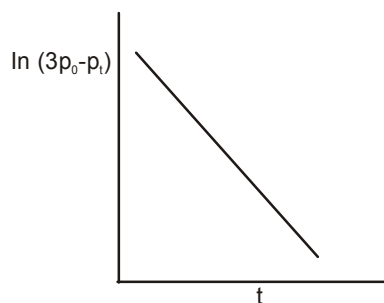
$$x = \frac{p_t - p_0}{2}$$

$$K = \frac{1}{t} \ln \frac{p_0}{p_0 - x} = \frac{1}{t} \ln \frac{p_0}{p_0 - \left(\frac{p_t - p_0}{2}\right)}$$

$$K = \frac{1}{t} \ln \frac{2p_0}{3p_0 - p_t}$$

$$Kt = \ln 2p_0 - \ln (3p_0 - p_t)$$

$$\ln (3p_0 - p_t) = \ln 2p_0 - Kt$$

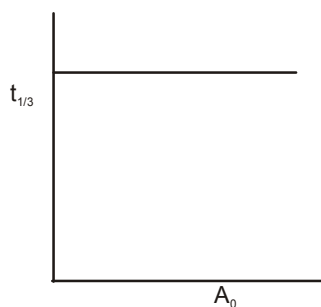


Option A correct

Option C wrong

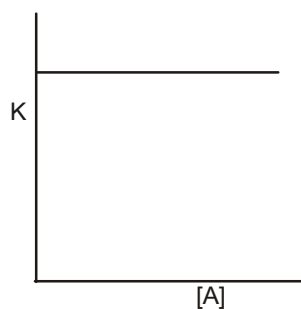
$$t_{1/3} = \frac{1}{K} \ln \frac{p_0}{p_0/3} = \frac{\ln 3}{K}$$

$t_{1/3}$ is independent of initial concentration.



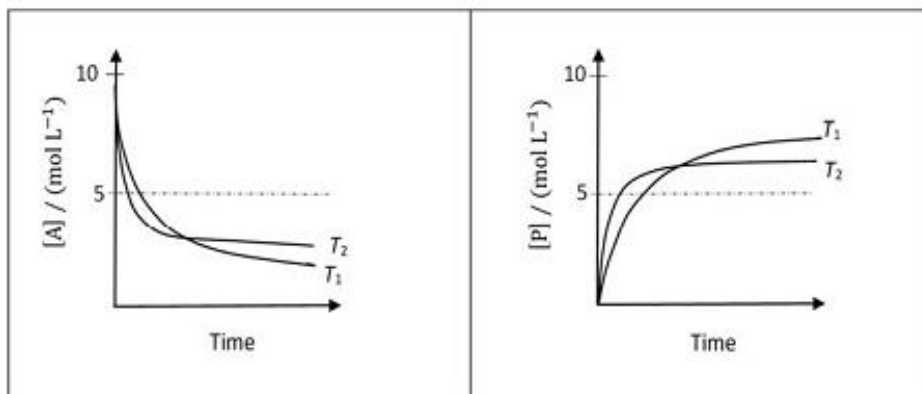
(Option B is wrong)

$R = K[A]$ rate constant does not depend on concentration.



Option D is correct

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° and ΔS° 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) $\Delta H^\circ < 0, \Delta S^\circ < 0$ (B) $\Delta G^\circ < 0, \Delta H^\circ > 0$
 (C) $\Delta G^\circ < 0, \Delta S^\circ < 0$ (D) $\Delta G^\circ < 0, \Delta S^\circ > 0$

Ans. (A,C)

Sol. On increasing temperature yield of product is less, i.e., exothermic reaction.

$$\Delta H < 0$$

$$[A]_{\text{eq}} < 5 \quad [P]_{\text{eq}} > 5$$

$$K_{\text{eq}} = \frac{[P]_{\text{eq}}}{[A]_{\text{eq}}} \therefore K_{\text{eq}} > 1$$

$$\Delta G^\circ = -RT \ln K_{\text{eq}} \quad K_{\text{eq}} > 1$$

$$\Delta G^\circ < 0$$

$$\frac{\ln K_{T_1}}{\ln K_{T_2}} > \frac{T_2}{T_1}$$

$$\Rightarrow RT_1 \ln K_{T_1} > RT_2 \ln K_{T_2}$$

$$RT_1 \ln K_{T_1} < RT_2 \ln K_{T_2}$$

$$\Delta G_{T_1}^\circ < \Delta G_{T_2}^\circ$$

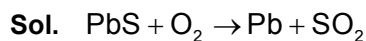
$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$\Delta H_{T_1}^\circ = \Delta H_{T_2}^\circ; \quad \Delta S_{T_1}^\circ = \Delta S_{T_2}^\circ$$

ΔG° increase with temperature

If $\Delta S^\circ < 0$

Ans. (6.47)



$$\text{mole of O}_2 = \frac{1000}{32}$$

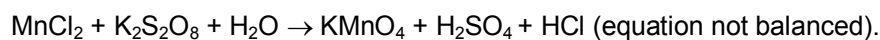
$$\text{mole of Pb} = \frac{1000}{32}$$

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

$$= 6468.75 \text{ g}$$

$$= 6.47 \text{ kg}$$

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 mg) 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. (126.00)

Sol. Mass of oxalic acid = 225 miligram

$$\text{Milimole of oxalic acid} = \frac{225}{90}$$

$$m_{\text{eq}} \text{ of oxalic acid} = 2 \times \frac{225}{90} = 5$$

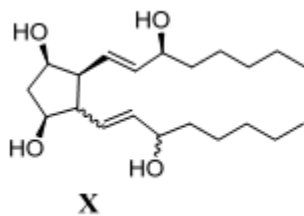
$$m_{\text{eq}} \text{ of KMnO}_4 = 5$$

$$\text{milimole of KMnO}_4 = 1$$

$$\text{milimole of MnCl}_2 = 1$$

$$\text{milligram of MnCl}_2 = 1 \times 126 = 126 \text{ mg}$$

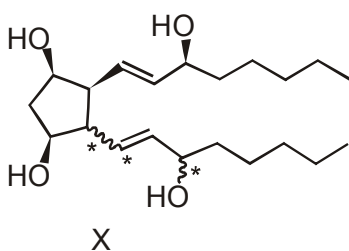
10. For the given compound X, the total number of optically active stereoisomers is ____.



- This type of bond indicates that the configuration at the specific carbon and the geometry of the double bond is fixed
- ~~~~ This type of bond indicates that the configuration at the specific carbon and the geometry of the double bond is **NOT** fixed

Ans. (7.00)

Sol.

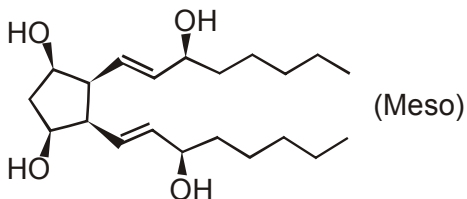


Configuration of 3 units is uncertain.

Total stereoisomers = 8

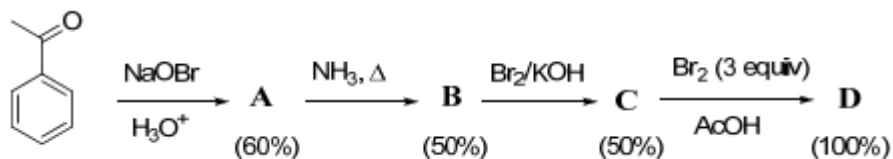
One of them is optically inactive

So optically active stereoisomers = 7



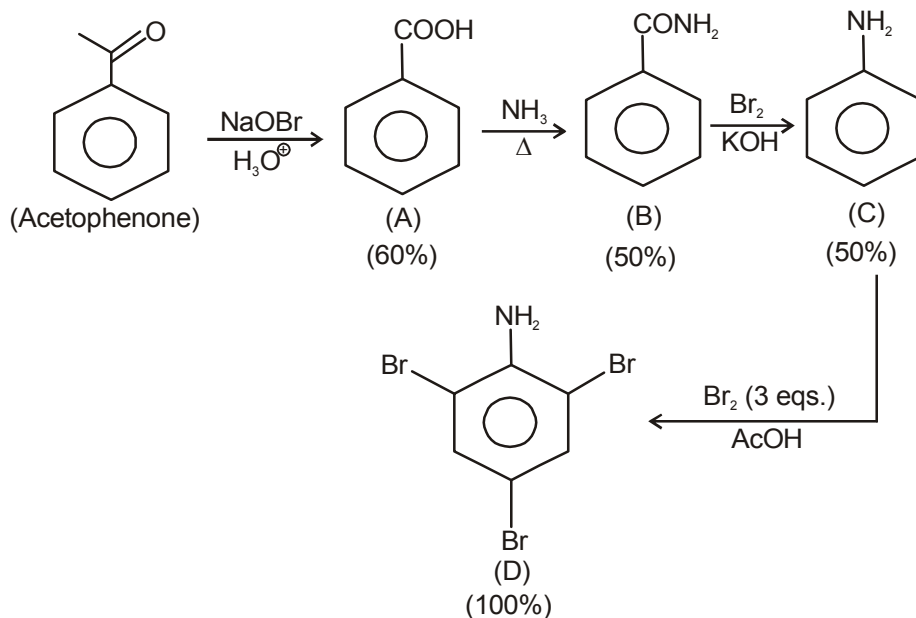
11. In the following reaction sequence, the amount of **D** (in g) formed from 10 moles of acetophenone is ____.

(Atomic weights 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. (495.00)

Sol.



Moles of Acetophenone = 10

Moles of A = 6

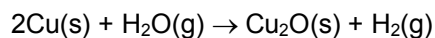
Moles of B = 3

Moles of C = 1.5

Moles of D = 1.5

Mass of D in gram = $1.5 \times 330 = 495$ **= 495.00 gm**

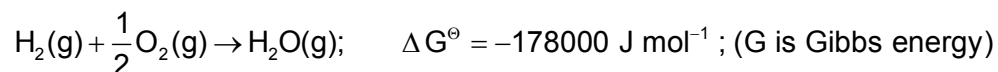
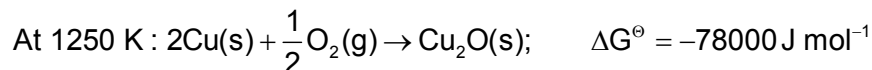
12. The surface of copper gets tarnished by the formation of copper oxide. N_2 gas was passed to prevent the oxide formation during heating of copper at 1250 K. However, the N_2 gas contains 1 mole % of water vapour as impurity. The water vapour oxidises copper as per the reaction given below:



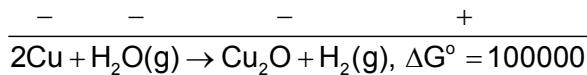
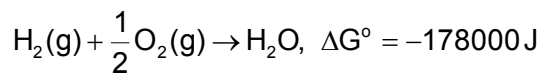
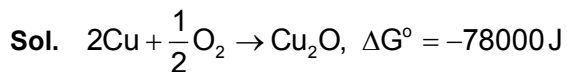
p_{H_2} is the minimum partial pressure of H_2 (in bar) needed to prevent the oxidation at

1250 K. The value of $\ln(p_{\text{H}_2})$ is ____.

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



Ans. (-14.60)



$$\Delta G^\circ = -RT \ln K_{\text{eq}}$$

$$100000 = -8 \times 1250 \ln K_{\text{eq}}$$

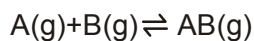
$$\ln K_{\text{eq}} = -10$$

$$K_{\text{eq}} = e^{-10} = \frac{p_{\text{H}_2}}{p_{\text{H}_2\text{O}}} = \frac{p_{\text{H}_2}}{0.01}$$

$$p_{\text{H}_2} = .01e^{-10}$$

$$\ln p_{\text{H}_2} = \ln 10^{-2} - 10 = -2 \ln 10 - 10 = -2 \times 2.3 - 10 = -14.6$$

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° (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. (8500.00)

Sol. $E_{\text{af}} - E_{\text{ab}} = \Delta H = -2 RT$

$$K_{\text{f}} = 4A e^{-E_{\text{af}}/RT}$$

$$K_{\text{b}} = A e^{-E_{\text{ab}}/RT}$$

$$\frac{K_{\text{f}}}{K_{\text{b}}} = K_{\text{eq}} = 4e^{-\Delta H/RT} = 4e^2$$

$$\Delta G^\circ = -RT \ln K_{\text{eq}}$$

$$= -RT \ln (4e^2)$$

$$= -2500 [2 \times 0.7 + 2]$$

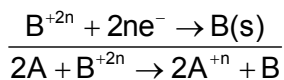
$$= -2500 [3.4]$$

$$= -8500$$

14. Consider an electrochemical cell: $A(s) | A^{n+}(aq, 2M) || B^{2n+}(aq, 1M) | B(s)$. The value of ΔH^\ominus for the cell reaction is twice that of ΔG^\ominus at 300 K. If the emf of the cell is zero, the ΔS^\ominus (in $J K^{-1} mol^{-1}$) of the cell reaction per mole of B formed at 300 K is ____.
- (Given: $\ln(2) = 0.7$, R (universal gas constant) = $8.3 J K^{-1} mol^{-1}$. H , S and G are enthalpy, entropy and Gibbs energy, respectively.)

Ans. (-11.62)

Sol. $A \rightarrow A^{n+} + ne^- \times 2$



$$\text{At equilibrium, } E_{\text{cell}} = 0, K_{\text{eq}} = \frac{[A^{n+}]^2}{[B^{2n+}]} = \frac{2^2}{1} = 4$$

$$\Delta G^\ominus = -RT \ln K$$

$$= -8.3 \times 300 \times \ln 4$$

$$= -8.3 \times 300 \times 1.4$$

$$\Delta H^\ominus = 2 \times (-8.3 \times 300 \times 1.4)$$

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

$$\Delta S^\ominus = \frac{\Delta H^\ominus - \Delta G^\ominus}{T}$$

$$= -\frac{8.3 \times 300 \times 1.4}{300}$$

$$= -8.3 \times 1.4$$

$$= -11.62 \text{ J per mole.}$$

SECTION 3 (Maximum Marks : 12)

- This section contains **FOUR (04)** questions.
- Each question has **TWO (02)** matching lists: **LIST-I** and **LIST-II**.
- **FOUR** options are given representing matching of elements from **LIST-I** and **LIST-II**. **ONLY ONE** of these four options corresponds to a correct matching.
- For each question, choose the option corresponding to the correct matching.
- For each question, marks will be awarded according to the following marking scheme:
Full Marks : **+3** If **ONLY** the option corresponding to the correct matching is chosen.
Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).
Negative Marks : **-1** In all other cases.

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

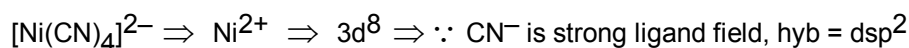
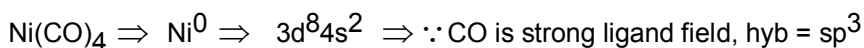
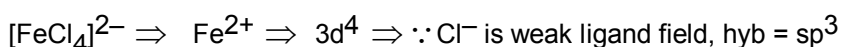
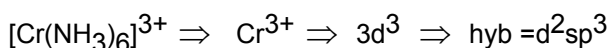
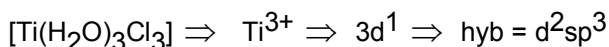
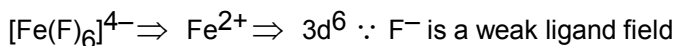
LIST-I**P.** dsp^2 **Q.** sp^3 **R.** sp^3d^2 **S.** d^2sp^3 **LIST-II****1.** $[FeF_6]^{4-}$ **2.** $[Ti(H_2O)_3Cl_3]$ **3.** $[Cr(NH_3)_6]^{3+}$ **4.** $[FeCl_4]^{2-}$ **5.** $Ni(CO)_4$ **6.** $[Ni(CN)_4]^{2-}$

The correct option is

- (A) **P** → 5; **Q** → 4,6; **R** → 2,3; **S** → 1
 (B) **P** → 5,6; **Q** → 4; **R** → 3; **S** → 1,2
 (C) **P** → 6; **Q** → 4,5; **R** → 1; **S** → 2,3
 (D) **P** → 4,6; **Q** → 5,6; **R** → 1,2; **S** → 3

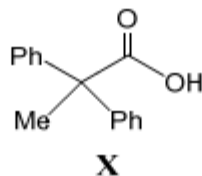
Ans. (C)

Sol. P-6, Q-4,5, R-1, S- 2,3



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)



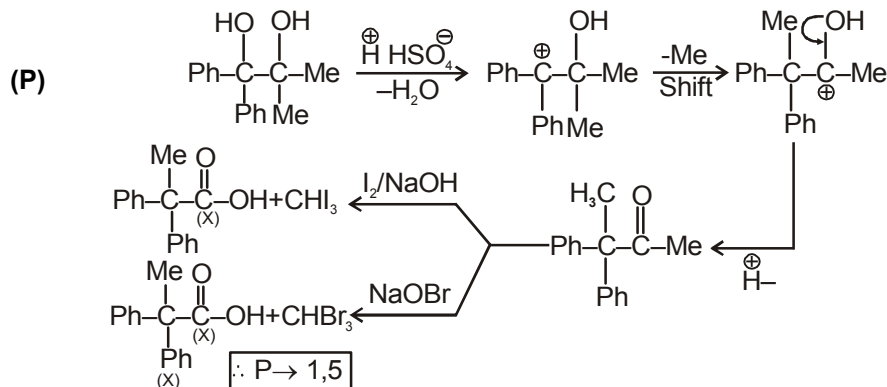
LIST-I	LIST-II
<p>P. + H₂SO₄</p>	1. I ₂ , NaOH
<p>Q. + HNO₂</p>	2. [Ag(NH ₃) ₂]OH
<p>R. + H₂SO₄</p>	3. Fehling solution
<p>S. + AgNO₃</p>	4. HCHO, NaOH
	5. NaOBr

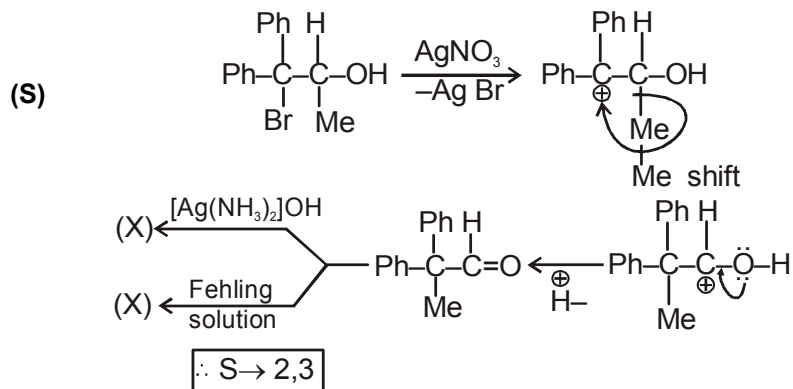
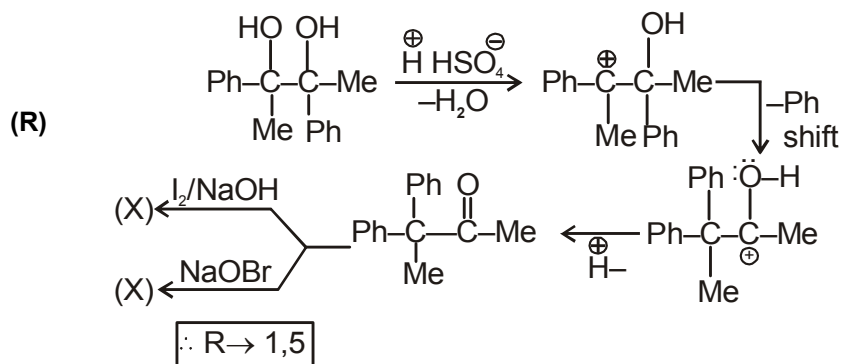
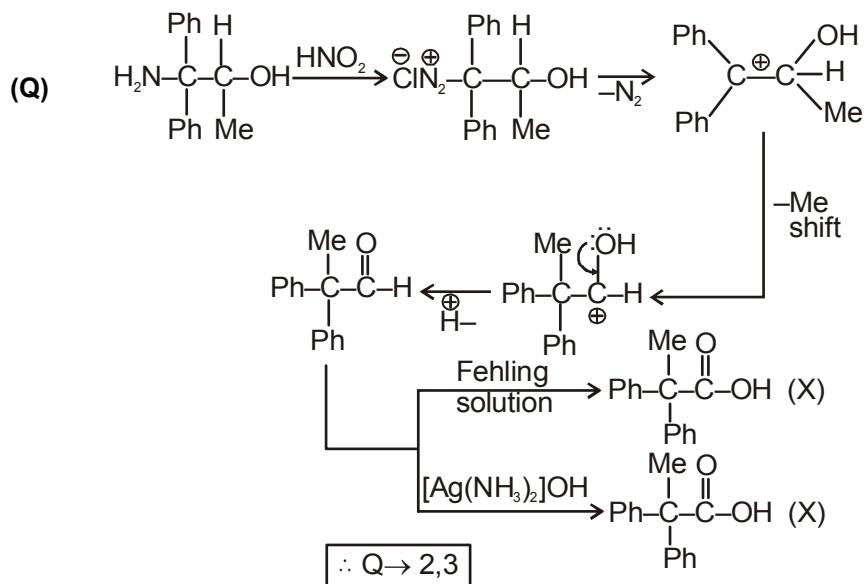
The correct option is

- (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

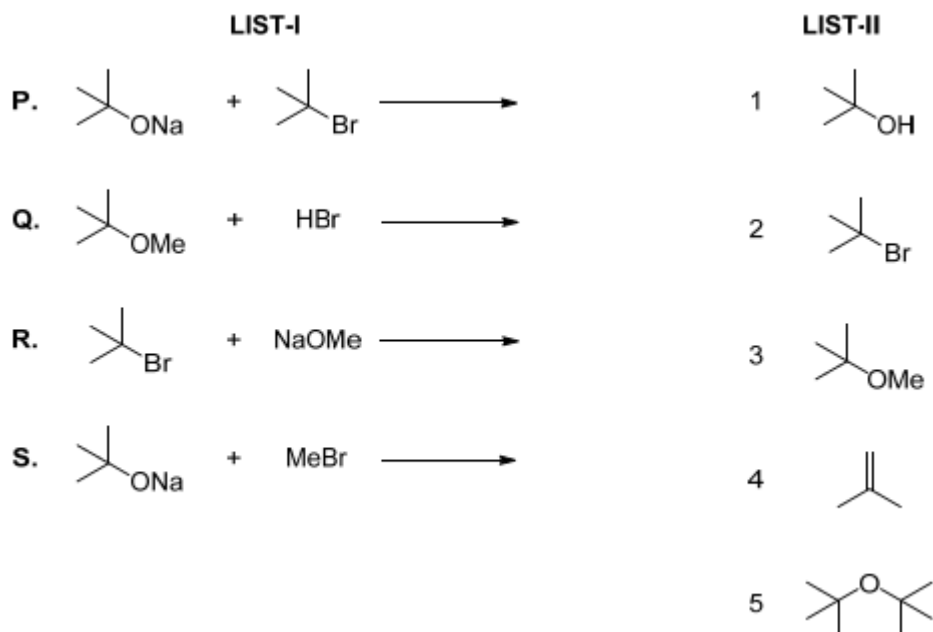
Ans. (D)

Sol. P → 1,5; Q → 2,3; R → 1,5; S → 2,3





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

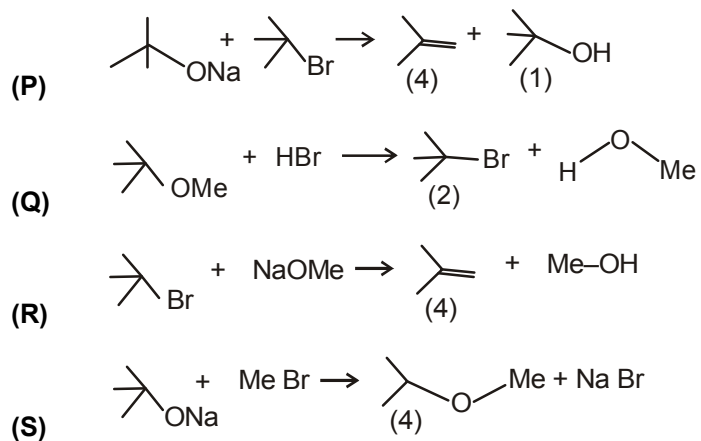


Match each reaction in LIST-I with one or more products in LIST-II and choose the correct option.

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

Ans. (B)

Sol. P \rightarrow 1,4; Q \rightarrow 2; R \rightarrow 4; S \rightarrow 3



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

(Note: Degree of dissociation (α) of weak acid and weak base is $\ll 1$; degree of hydrolysis of salt $\ll 1$; $[H^+]$ 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 $Ni(OH)_2$ in equilibrium with excess solid $Ni(OH)_2$ is diluted to 20 mL (solid $Ni(OH)_2$ is still present after dilution).

LIST-II

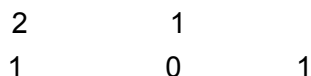
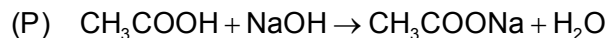
1. the value of $[H^+]$ does not change on dilution
2. the value of $[H^+]$ changes to half of its initial value on dilution
3. the value of $[H^+]$ changes to two times of its initial value on dilution
4. the value of $[H^+]$ changes to $\frac{1}{\sqrt{2}}$ times of its initial value on dilution
5.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

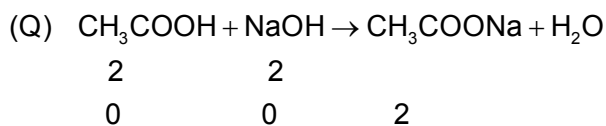
Ans. (D)

Sol. P \rightarrow 1; Q \rightarrow 5; R \rightarrow 4; S \rightarrow 1



Buffer solution

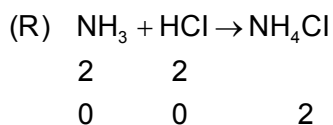
$[H^+]$ does not change with dilution



Salt of weak acid and strong base.

$$H^+ = \sqrt{\frac{K_w \times K_a}{C}}$$

Vol is doubled from 40 ml to 80 ml H^+ will be $\sqrt{2}$ times.



Salt of weak base and strong acid

$$H^+ = \sqrt{\frac{K_w \times C}{K_b}}$$

Vol. of solution is doubled C will be half

$$H^+ = \frac{1}{\sqrt{2}} \text{ time of original}$$

(S) Solution contains excess of solid $\text{Ni}(\text{OH})_2$

On dilution more solute get dissolved but $[\text{OH}^-]$ will not change, so $[\text{H}^+]$ will not change