PAPER (पेपर)- 2

PAPER-2 : INSTRUCTIONS TO CANDIDATES

- **This question paper has three (03) parts: PART-I: Physics, PART-II: Chemistry and PART-III: Mathematics.**
- **Each part has total of eighteen (18) questions divided into three (03) Sections (Section-1, Section-2 and Section-3).**
- **Total number of questions in Paper-2 : Fifty four (54).**
- **Paper-2 Maximum Marks : One Hundred Eighty (180).**

Instructions for Section-1 : Questions and Marking Scheme

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 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.

Answering Section-1 Questions :

- To select the option(s), **using the mouse click** on the corresponding button(s) of the option(s).
- To deselect chosen option(s), click on the button(s) of the chosen option(s) again or click on the **Clear Response** button to clear all the chosen options.
- To change the option(s) of a previously answered question, if required, first click on the **Clear Response** button to clear all the chosen options and then select the new option(s).
- To mark a question ONLY for review (i.e. without answering it), click on the **Mark for Review & Next button**.
- To mark a question for review (after answering it), click on **Mark for Review & Next button** – answered question which is also marked for review will be evaluated.
- To save the answer, click on the **Save & Next** button – the answered question will be evaluated.

Instructions for Section-2 : Questions and Marking Scheme

SECTION-2 (Maximum Marks : 24)

- This section contains **EIGHT (08)** questions. The answer to each question is **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 6.25, 7.00, –0.33, –0.30,,30.27, –127.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks : **+3** If ONLY the correct numerical value is entered as answer.

Zero Marks : **0** In all other cases.

Answering Section-2 Questions :

- Using the attached computer mouse, click on numbers (and/or symbols) on the **on-screen virtual numeric keypad** to enter the numerical value as answer in the space provided for answer.
- To change the answer, if required, first click on the **Clear Response** button to clear the entered answer and then enter the new numerical value.
- To mark a question ONLY for review (i.e. answering it), click on **Mark for Review & Next button** – the answered question which is also marked for review will be evaluated.
- To mark a question for review (after answering it), click **Mark for Review & Next button** – the answered question which is also marked for review will be evaluated.
- To save the answer, click on the **Save & Next button** – the answered question will be evaluated.

Instructions for Section-3 : Questions and Marking Scheme

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 each question, choose the option, choose the option corresponding to the correct matching.
- For each question, mark 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.

Answering Section-3 Questions :

- To select an option, using the mouse click on the corresponding button of the option.
- To deselect the chosen answer, click on the button of the chosen option again or click on the **Clear Response button**.
- To change the chosen answer, click on the button of another option.
- To mark a question ONLY for review (i.e. without answering it), click on **Mark for Review & Next button**.
- To mark a question for review (after answering it), click on **Mark for Review & Next button** – the answered which is also marked for review will be evaluated.

To save the answer, click on the **Save & Next button** – the answered question will be evaluated.

PART–II : 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:

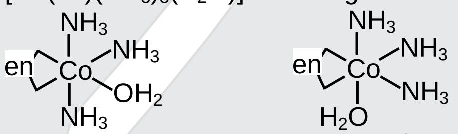
Full Marks	**: +4**	If only (all) the correct option(s) is (are) chosen.
Partial Marks	: **+3**	If all the four options are correct but ONLY three options are chosen.
Partial Marks	: **+2**	If three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial 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.

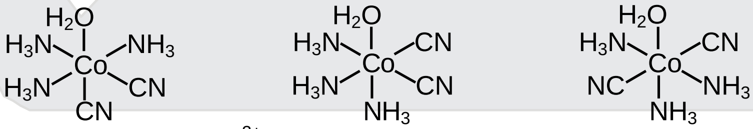
1. The correct option(s) regarding the complex $[Co(en)(NH_3)_3(H_2O)]^{3+}$
($en = H_2NCH_2CH_2NH_2$) is (are)
(A) It has two geometrical isomers
(B) It will have three geometrical isomers if bidentate 'en' is replaced by two cyanide ligands
(C) It is paramagnetic
(D) It absorbs light at longer wavelength as compared to $[Co(en)NH_3)_4]^{3+}$

Ans. **(ABD)**

Sol. **(A)** $[Co(en)(NH_3)_3(H_2O)]^{3+}$ has 2 geometrical isomers



(B) Compound $[Co(CN)_2(NH_3)_3(H_2O)]^{+}$ will have three geometrical isomers.



(C) $[Co(en)(NH_3)_3(H_2O)]^{3+}$ is diamagnetic

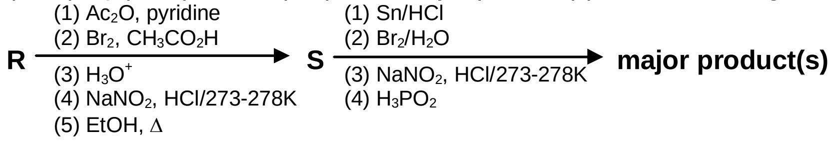
(D) $[Co(en)(NH_3)_3(H_2O)]^{3+}$ absorbs light at longer wavelength as compared to $[Co(en)(NH_3)_4]^{3+}$ as H_2O is weaker ligand than NH_3.

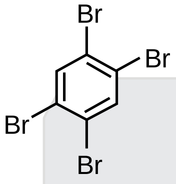
2. The correct option(s) to distinguish nitrate salts of Mn^{2+} and Cu^{2+} taken separately is (are)
(A) Mn^{2+} show the characteristic green colour in the flame test
(B) Only Cu^{2+} show the formation of precipitate by passing H_2S in acidic medium
(C) Only Mn^{2+} show the formation of precipitate by passing H_2S in faintly basic medium
(D) Cu^{2+}/Cu has higher reduction potential than Mn^{2+}/Mn (measured under similar conditions)

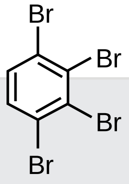
Ans. **(BD)**

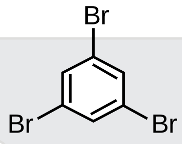
Sol. (A) Cu^{2+} shows characteristic green colour in the flame test.
(B) Only Cu^{2+} can give precipitate in acidic medium on passing H_2S.
(C) Both Cu^{2+} and Mn^{2+} show the formation of precipitate by passing H_2S in faintly basic medium.
(D) $E^{\circ}_{Cu^{2+}/Cu} > E^{\circ}_{Mn^{2+}/Mn}$, as per electrochemical series.

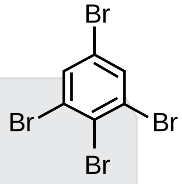
3. Aniline reacts with mixed acid (conc. HNO_3 and conc. H_2SO_4) at 288 K to give **P** (51%), **Q** (47%) and R (51%), **Q** (47%) and R (2%). The major product(s) of the following reaction sequence is(are



(A) 

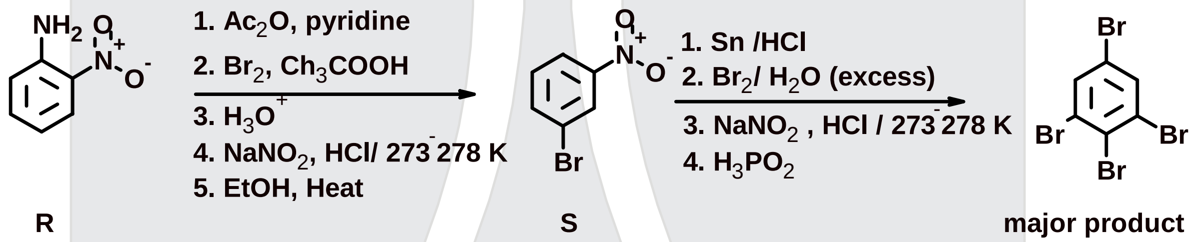
(B) 

(C) 

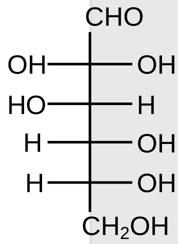
(D) 

Ans. **D**

Sol.

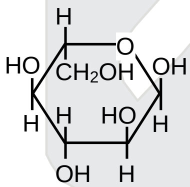


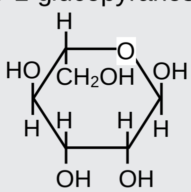
4. The Fishcher presentation of D-glucose is given below.

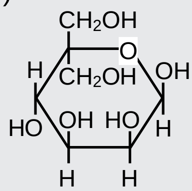


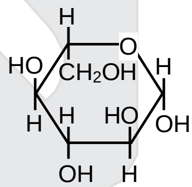
D-glucose

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

(A) 

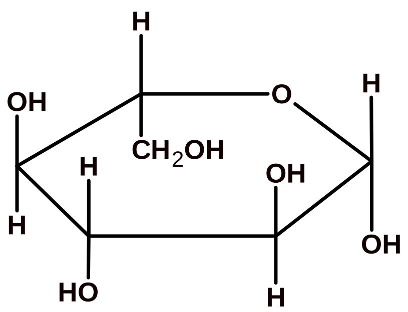
(B) 

(C) 

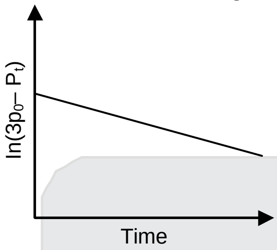
(D) 

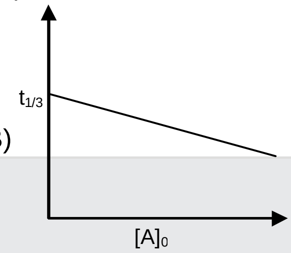
Ans. **(D)**

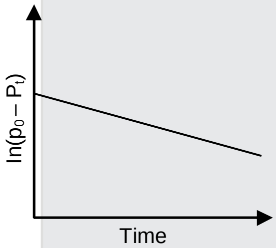
Sol.

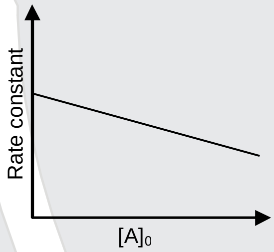


5. For a first order reaction $A(g) \rightarrow 2B(g) + C(g)$ at constant volume and 300 K, the total pressure at the beginning (t = 0) and at time t are P_0 and P_t, respectively. Initially, only A is present with concentration $[A]_0$, and $t_{1/3}$ is the time required for the partial pressure of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

(A) 

(B) 

(C) 

(D) 

Ans. **(AD)**

Sol.

$$A(g) \xrightarrow{\text{First order}} 2B(g) + C(g) \quad V = \text{constant},\ T = 300\ K$$

t=0 $\quad P_0$

t=$t_{1/3}$ $\quad \left(P_0 - \frac{2P_0}{3}\right) = \frac{P_0}{3} \qquad \frac{4P_0}{3} \qquad \frac{2P_0}{3}$

t=t $\quad P_0 - x \qquad 2x \qquad x$

So, $\quad P_t = P_0 - x + 2x + x = P_0 + 2x$

or $\quad 2x = P_t - P_0$

$$t = \frac{1}{k}\ln\frac{P_0}{(P_0 - x)}$$

or $$t = \frac{1}{k}\ln\frac{P_0}{P_0 - \frac{(P_t - P_0)}{2}} = \frac{1}{k}\ln\frac{2P_0}{2P_0 - P_t + P_0}$$

or $\quad Kt = \ln\frac{2P_0}{3P_0 - P_t}$, $Kt = \ln 2P_0 - \ln(3P_0 - P_t)$

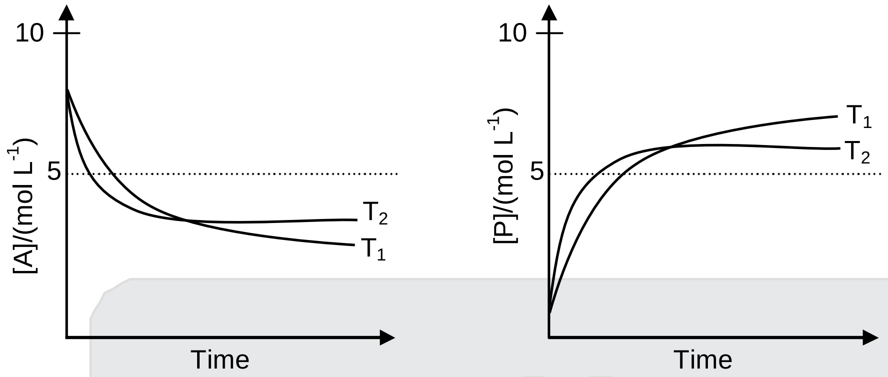
or $\quad \ln(3P_0 - P_t) = -Kt + \ln 2P_0$

Graph between $\ln(3P_0 - P_t)$ vs 't' is a straight line with negative slope.
So (A) is correct option.

$$t_{1/3} = \frac{1}{K}\ln\frac{P_0}{(P_0/3)} = \frac{1}{K}\ln 3 \Rightarrow \text{It is independent of initial concentration.}$$

So (B) is wrong option.
As rate constant is a constant quantity and independent of initial concentration.
So Graph (D) is correct.

6. For a reaction, $A \rightleftharpoons P$, the plots of [A] and [P] with time at temperature 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 lnK at T_1 to lnK at T_2 is greater than 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. **(AC)**

Sol. As temperature increases concentration of product decreases

so reaction is exothermic $\Rightarrow \Delta H° < 0$

$$\frac{\ln K_{T_1}}{\ln K_{T_2}} > 1 \Rightarrow \ln K_{T_1} > \ln K_{T_2} \quad \text{so, } K_{T_1} > K_{T_2}$$

Also, $\dfrac{\ln K_{T_1}}{\ln K_{T_2}} > \dfrac{T_2}{T_1}$

or $T_1 \ln K_{T_1} > T_2 \ln K_{T_2} \Rightarrow -R\, T_1 \ln K_{T_1} < -R\, T_2 \ln K_{T_2}$

or $\Delta G^\circ_{T_1} < \Delta G^\circ_{T_2}$

or $\Delta H^\circ - T_1 \Delta S^\circ < \Delta H^\circ - T_2 \Delta S^\circ$

As $\Delta G^\circ_{T_1} < \Delta G^\circ_{T_2}$, since as temperature increases ΔG increases this is possible only when $\Delta S° < 0$

SECTION 2 (Maximum Marks: 24)

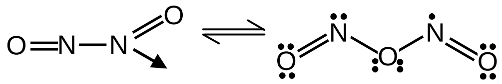
- This section contains **EIGHT (08)** questions. The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded□off to the **second decimal place**; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30) using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : 3 If ONLY the correct numerical value is entered as answer.
  Zero Marks : 0 In all other cases.

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

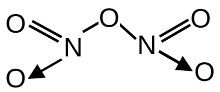
N_2O_3, N_2O_5, P_4O_6, P_4O_7, $H_4P_2O_5$, $H_5P_3O_{10}$, $H_2S_2O_3$, $H_2S_2O_5$

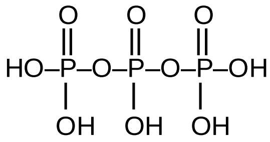
Ans. **6**

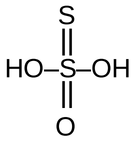
Sol. N_2O_3 =

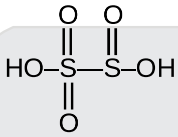


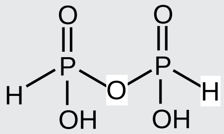
N_2O_5 =

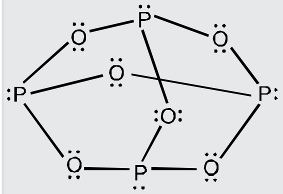


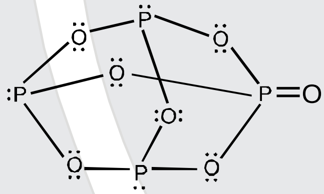
$H_5P_3O_{10}$ = 

$H_2S_2O_3$ = 

$H_2S_2O_5$ = 

$H_4P_2O_5$ = 

P_4O_6 = 

P_4O_7 = 

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 kg

Sol. $PbS + O_2 \longrightarrow Pb + SO_2$

Mole $\frac{10^3}{32}$

Moles of Pb formed = $\frac{10^3}{32}$

$\therefore$ Mass of Pb formed = $\frac{10^3}{32} \times 207 = 6468.75$ gm

= 6.46875 kg

= 6.47 kg

9. To measure the quantity of $MnCl_2$ dissolved in an aqueous solution, it was completely converted to $KMnO_4$ using the reaction.
$MnCl_2 + K_2S_2O_8 + H_2O \rightarrow KMnO_4 + H_2SO_4 + HCl$ (equation not balanced).
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 mg**

Sol. $2MnCl_2 + 5K_2S_2O_8 + 8H_2O \longrightarrow 2KMnO_4 + 4K_2SO_4 + 6H_2SO_4 + 4HCl$ ....(1)

$2KMnO_4 + 5H_2C_2O_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 10CO_2$ ....(2)

Mass of oxalic acid added = 225 mg

Milimoles of oxalic acid added = $\frac{225}{90} = 2.5$

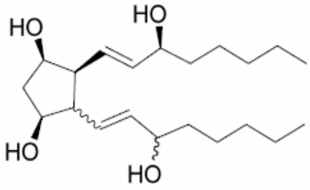
From equation (2)

Milimoles of $KMnO_4$ used to react with oxalic acid = 1

and milimoles of $MnCl_2$ required initially = 1

$\therefore$ Mass of $MnCl_2$ required initially = 1 × 126 = 126 mg

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



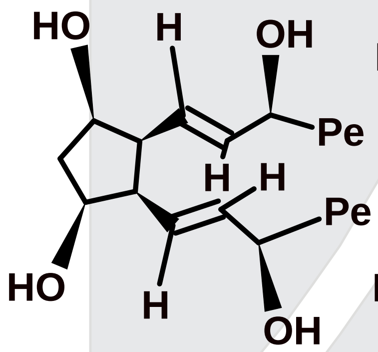
X

 This type of bond indicates that the configuration at the specific carbon and the geometry of the double bond is fixed

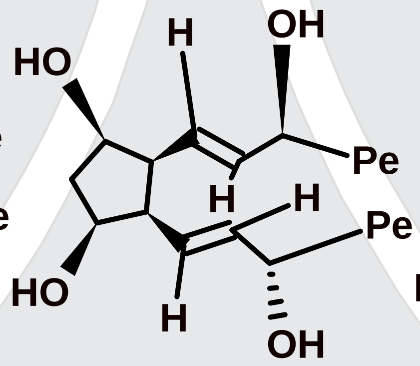
 This type of bond indicates that the configuration at the specific carbon and the geometry of the double bond is **NOT** fixed

Ans. (7)

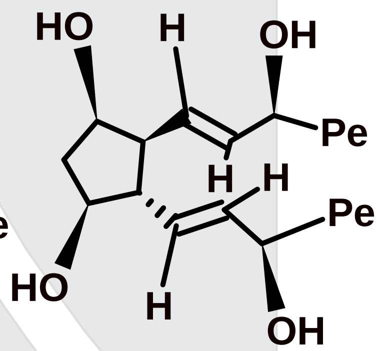
Sol.



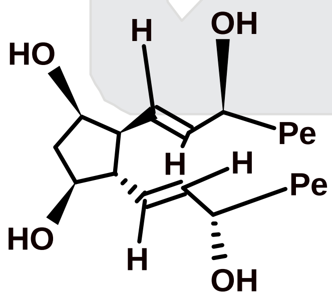
Optically Inactive



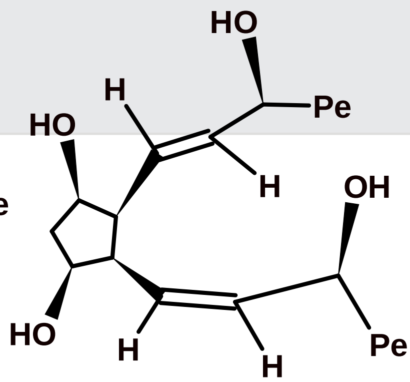
Optically Active



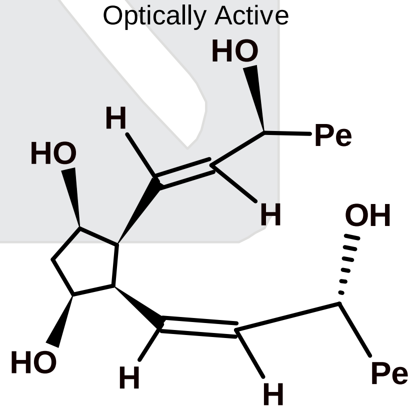
Optically Active



Optically Active



Optically Active



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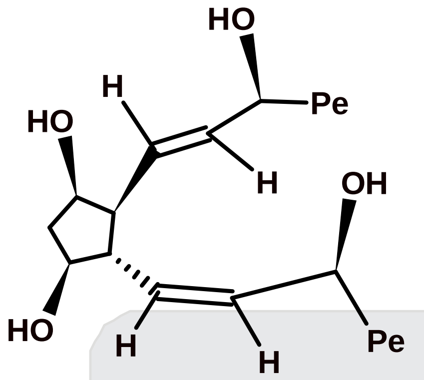
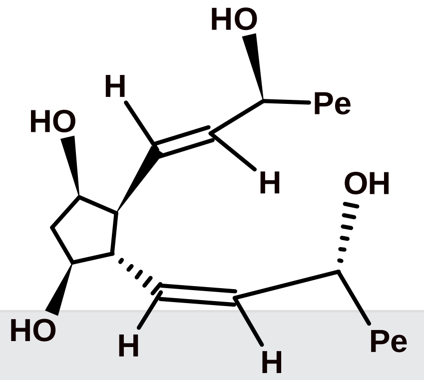
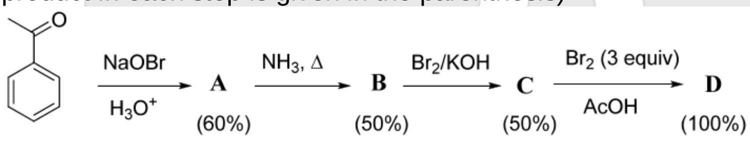


Optically Active

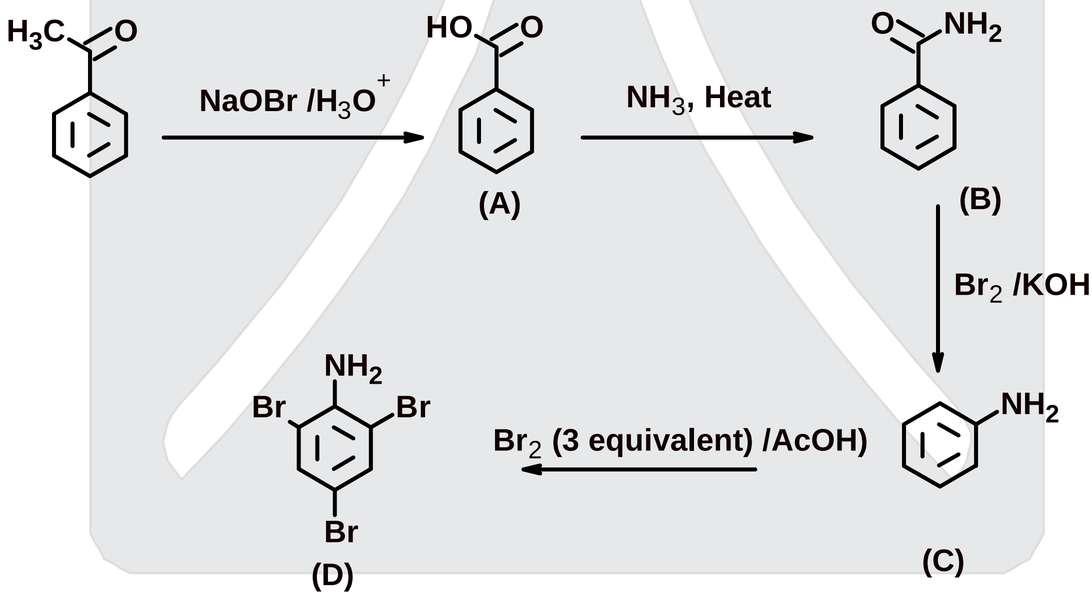


Optically Active

11. In the following reaction seuqnce, 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.



Moles of D formed = 10 x 0.6 x 0.5 x 0.5 x 1 =1.5
Mass of D formed = 1.5 x 330 = 495 gram

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 :

$$2Cu(s) + H_2O(g) \longrightarrow Cu_2O(s) + H_2(g)$$

pH_2 is the minimum partial pressure of H_2 (in bar) needed to prevent the oxidation at 1250 K. The value of $\ln(p_{H_2})$ is_______.

(Given : total pressure = 1 bar, R (universal gas constant) = 8 J K^{-1} mol^{-1}, ln(10) = 2.3, Cu(s) and $Cu_2O(s)$ are mutually immiscible.

At 1250 K : $2Cu(s) + \frac{1}{2}O_2(g) \longrightarrow Cu_2O(s)$; $\Delta G° = -78,000\ J\ mol^{-1}$

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(g)$; $\Delta G° = -1,78,000\ J\ mol^{-1}$; G is the Gibbs energy)

Ans. **–14.6**

Sol. (i) $2Cu(s) + \frac{1}{2}O_2(g) \longrightarrow Cu_2O(s)$: $\Delta G^o = -78000$ J/mol

(ii) $H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(g)$, $\Delta G^o = -178000$ J/mol

(i) – (ii) then

$2Cu(s) + H_2O(g) \longrightarrow Cu_2O(s) + H_2(g)$

$\Delta G^o = -78000 + 178000 = 100000$ J/mol

Now for the above reaction

$$\Delta G = \Delta G^o + RT\ell n\left(\frac{P_{H_2}}{P_{H_2O}}\right)$$

To prevent the above reaction :

$\Delta G \geq 0$

$$\Delta G^o + RT\ell n\left(\frac{P_{H_2}}{P_{H_2O}}\right) \geq 0$$

$10^4(\ell nP_{H_2} - \ell nP_{H_2O}) \geq -10^5$

$\ell nP_{H_2} \geq -10 + \ell nP_{H_2O}$

$\geq -10 + 2.3\log(0.01)$

$\ell nP_{H_2} \geq -10 + 4.6$

$\ell nP_{H_2} \geq -14.6$

$\therefore$ Minimum $\ell nP_{H_2} = -14.6$

13. Consider the following reversible reaction,

$$A(g) + B(g) \rightleftharpoons AB(g)$$

The activation energy of the backward reaction exceeds that of the forward reaction by 2 RT (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 $mole^{-1}$) for the reaction at 300 K is _____.

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

Ans. **8500 J/mole**

Sol. $A(g) + B(g) \rightleftharpoons AB(g)$

$E_{a_b} = E_{a_f} + 2RT$ & $A_f = 4\,A_b$

Now, Rate constant of forward reaction $k_f = A_f e^{-Ea_f/RT}$

Rate constant of reverse reaction $K_b = A_b e^{-E_{ab}/RT}$

Equilibrium constant

$$K_{eq} = \frac{K_f}{K_b} = \frac{A_f}{A_b} e^{-(E_{af}-E_{ab})/RT}$$

$$= 4e^{+2} = 4e^2$$

Now, $\Delta G° = -RT \ln K_{eq} = -2500 \ln(4e^2)$

$= -2500 (\ln 4 + \ln e^2)$

$= -2500 (1.4 + 2) = -2500 \times 3.4 =$ **–8500 J/mole**

“Absolute value = 8500 J/mole”

14. Consider an electrochemical cell : A(s) | A^{n+}(aq, 2 M) || B^{2n+}(aq, 1 M) | B(s). The value of $\Delta H°$ for the cell reaction is twice that of $\Delta G°$ at 300 K. If the emf of the cell is zero, the $\Delta S°$(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 $JK^{-1}mol^{-1}$**

Sol. A(s)|A^{n+} (aq, 2M) || B^{2n+} (aq, 1M) | B(s)

Reactions

Anode $(A \longrightarrow A^{n+} + ne) \times 2$

Cathode $B^{2n+} + 2ne \longrightarrow B$

Overall reaction :

$$2A(s) + B^{2n+} \longrightarrow 2A^{n+} + B.$$

$$E = E^o - \frac{RT}{2nF}\ell nQ$$

$$O = E^o - \frac{RT}{2nF}\ell n\frac{[A^{n+}]^2}{[B^{2n+}]}$$

$$E^o = \frac{RT}{2nF}\ell n4$$

Now $\Delta G^o = -2nFE^o = \frac{-2nFRT}{2nF}\ell n4 = -RT\ell n4.$

$\Delta G^o = \Delta H^o - T\Delta S^o = 2\Delta G^o = -T\Delta S^o$

$T\Delta S^o = \Delta G^o$

$$\Delta S^o = \frac{\Delta G^o}{T} = \frac{-RT\ell n4}{T} = -R\ell n4$$

$= -8.3 \times 2 \times 0.7 = -11.62\ JK^{-1}mol^{-1}$

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

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

Sol.
1. FeF_6^{4-} $3d^6$ & weak field ligand
   $\therefore$ Hybridization is sp^3d^2

2. $[Ti(H_2O)_3Cl_3]$ $3d^1$ & weak field ligand
   $\therefore$ Hybridization is d^2sp^3

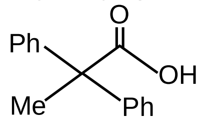
3. $[Cr(NH_3)_6]^{3+}$, $3d^3$ & strong field ligand.
   $\therefore$ Hybridization is d^2sp^3

4. $[FeCl_4]^{2-}$ $3d^6$ & weak field ligand.
   $\therefore$ Hybridization is sp^3

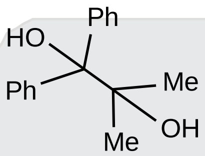
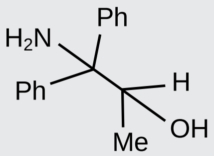
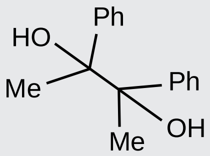
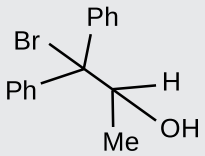
5. $Ni(CO)_4$, $3d^{10}$
   $\therefore$ Hybridization is sp^3

6. $[Ni(CN)_4]^{2-}$, $3d^8$
   $\therefore$ dsp^2 hybridization

16. The desired product **X** can be prepared by reacting the major product of the reactionsin LIST-**I** with one or more appropriate reagents in LIST-**II**.
(given, order of migratory aptitude: ary > alkyl > hydrogen)



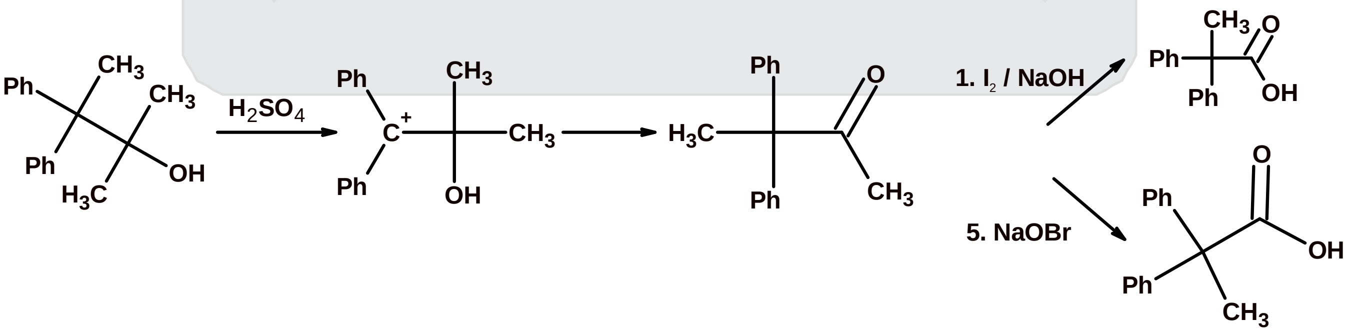
X

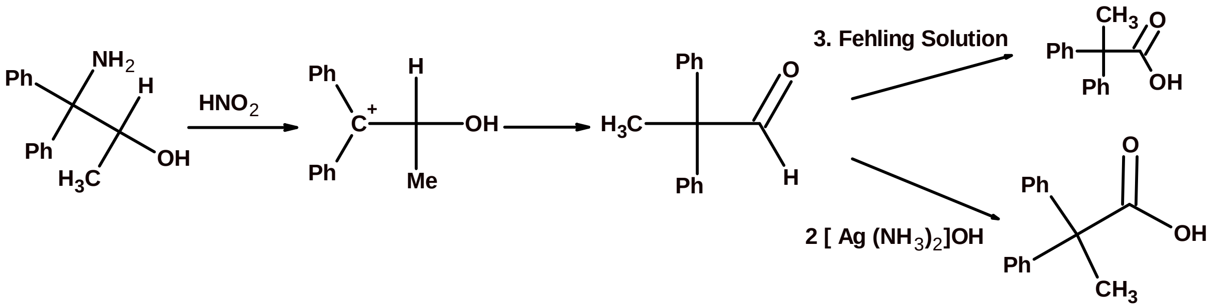
LIST-I			LIST-II	
(P)		+ H_2SO_4	(1)	I_2, NaOH
(Q)		+ HNO_2	(2)	$[Ag(NH_3)_2]OH$
(R)		+ H_2SO_4	(3)	Fehling solution
(S)		+ $AgNO_3$	(4)	HCHO, NaOH
			(5)	NaOBr

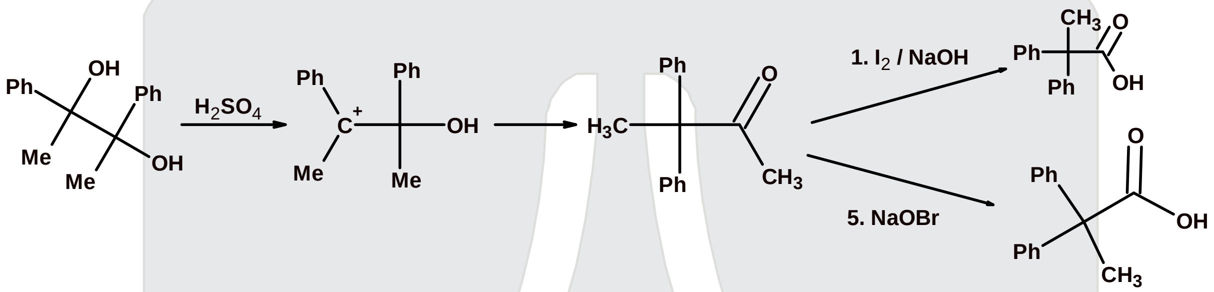
The correct option is
(A) P $\rightarrow$ 1 ; Q $\rightarrow$ 2, 3 ; R $\rightarrow$ 1, 4 ; S $\rightarrow$ 2, 4
(B) P $\rightarrow$ 1, 5 ; Q $\rightarrow$ 3, 4 ; R $\rightarrow$ 4, 5 ; S $\rightarrow$ 3
(C) P $\rightarrow$ 1, 5 ; Q $\rightarrow$ 3, 4 ; R $\rightarrow$ 5 ; S $\rightarrow$ 2, 4
(D) P $\rightarrow$ 1, 5 ; Q $\rightarrow$ 2, 3 ; R $\rightarrow$ 1, 5 ; S $\rightarrow$ 2, 3

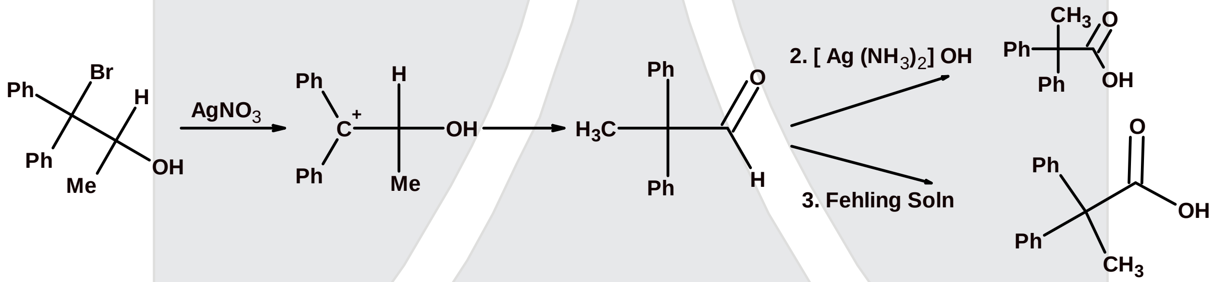
Ans. **(D)**

P:

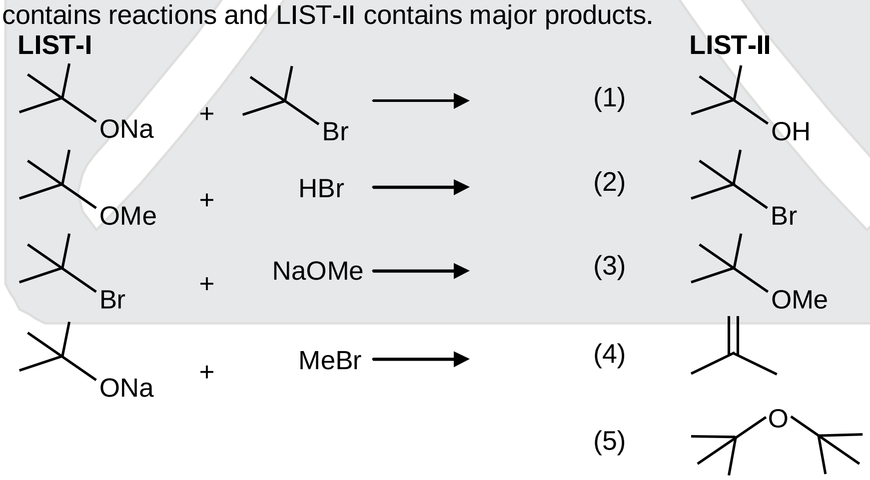


Q.


R.


S.


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

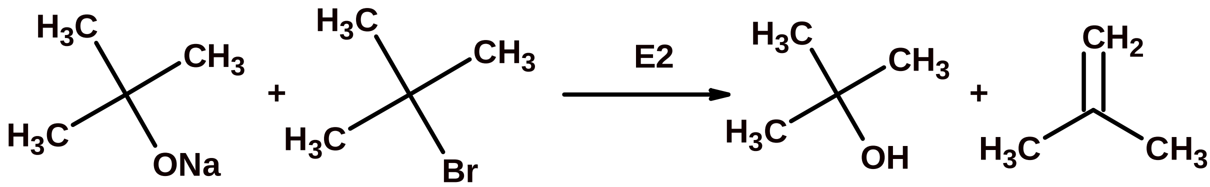


Match each reaction in LIST-I with one or more products in LIST-II and choose the correct option.

(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)**

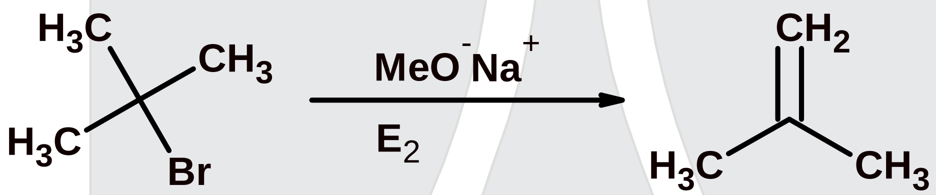
P:



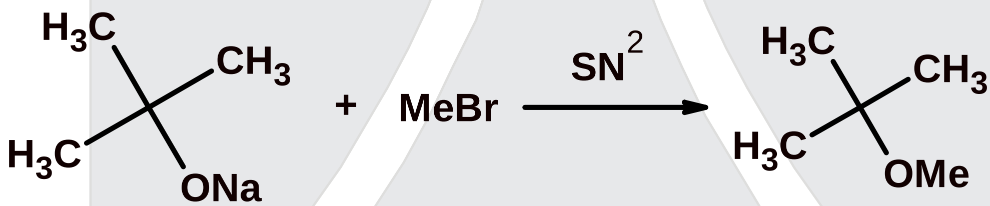
(1) (4)

Q:

R:



S:



18. Dilution processes of different aqueous solutions, with water, are given in LIST-I. The effects of dilution of the solution on $[H^+]$ are given in LIST-II.
(Note : degree of dissociation (α) of weak acid and weak base is <<1; degree of hydrolysis of salt <<1; $[H^+]$ represents the concentration of H^+ ions)

LIST-I	LIST-II
(P) (10 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 60 mL	(1) the value of $[H^+]$ does not change on dilution
(Q) (20 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 80 mL	(2) the value of $[H^+]$ changes to half of its initial value on dilution
(R) (20 mL of 0.1 M HCl + 20 mL of 0.1 M ammonia solution) diluted to 80 mL	(3) the value of $[H^+]$ changes to two times of its initial value on dilution
(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).	(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) $P \to 4$; $Q \to 2$; $R \to 3$; $S \to 1$
(B) $P \to 4$; $Q \to 3$; $R \to 2$; $S \to 3$
(C) $P \to 1$; $Q \to 4$; $R \to 5$; $S \to 3$
(D) $P \to 1$; $Q \to 5$; $R \to 4$; $S \to 1$

Ans. **(D) ($P \to 1$) ; ($Q \to 5$); ($R \to 4$) ; ($S \to 1$)**

Sol.

(P) $NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$
M.Mole 1 2

Now solution contains 1 m. mole CH_3COOH & 1 m.mole CH_3COONa in 30 ml solution.
It is a Buffer solution
$\therefore$ $[H^+]$ does not change with dilution.

(Q) $NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$
M.Mole 2 2

Now solution contain 2 m.mole of CH_3COONa in 40 ml solution (salt of weak acid strong base)

$$[H^+]_{initial} = \sqrt{\frac{K_wKa}{C}}$$

Now on dilution upto 80 ml, now can. Becomes $\frac{C}{2}$.

$$\therefore \; [H^+]_{new} = \sqrt{\frac{K_wK_a}{C/2}} = [H^+]_{initial} \times \sqrt{2}$$

(R) $HCl + NH_3 \longrightarrow NH_4Cl$
M.Mole 2 2

Now solution contain 2 m.mole of NH_4Cl in 40 ml solution (salt of SA & WB)

$$[H^+]_{initial} = \sqrt{\frac{K_w\,C}{K_b}}$$

Now on dilution upto 80 ml, new conc. becomes $\frac{C}{2}$.

$$\therefore \; [H^+]_{new} = \sqrt{\frac{K_w}{K_b}\frac{C}{2}} = \frac{[H^+]_{initial}}{\sqrt{2}}$$

(S) $Ni(OH)2\ (s) \longrightarrow Ni^{2+} + 2OH^-$
$\because$ it is sparingly soluble salt
$\therefore$ on dilution $[OH^-]$ conc. in saturated solution of Ni(OH)2 remains const.
$\therefore$ $[H^+]_{new} = [H^+]_{initial}$