FINAL JEE(Advanced) EXAMINATION - 2022

(Held On Sunday 28th AUGUST, 2022)

PAPER-1 | **TEST PAPER WITH SOLUTION**

CHEMISTRY

SECTION-1 : (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 of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme:

  Full Marks : +3 **ONLY** if the correct numerical value is entered;

  Zero Marks : 0 In all other cases.

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1. 2 mol of Hg(g) is combusted in a fixed volume bomb calorimeter with excess of O_2 at 298 K and 1 atm into HgO(s). During the reaction, temperature increases from 298.0 K to 312.8 K. If heat capacity of the bomb calorimeter and enthalpy of formation of Hg(g) are 20.00 kJ K^{-1} and 61.32 kJ mol^{-1} at 298 K, respectively, the calculated standard molar enthalpy of formation of HgO(s) at 298 K is X kJ mol^{-1}. The value of |X| is ______.

[Given : Gas constant R = 8.3 J K^{-1} mol^{-1}]

Ans. (90.39)

Sol. $Q_{rxn} = C\Delta T$

$|\Delta U| \times 2 = 20 \times 14.8$

$|\Delta U| = 148$ kJ/mol

$\Delta U = -148$ kJ/mol

$Hg(g) + \frac{1}{2}O_2(g) \longrightarrow HgO(s) : \Delta U = -148$ kJ/mol

$\Delta H = \Delta U + \Delta n_g RT$

$= -148 - \frac{3}{2} \times \frac{8.3}{1000} \times 298 = -151.7101$

$Hg(l) + \frac{1}{2}O_2(g) \longrightarrow HgO(s)$

$\Delta H = -151.7101 + 61.32 = -90.39$ kJ/mol

Ans. 90.39

2. The reduction potential (E^0, in V) of $MnO_4^-(aq)/Mn(s)$ is ______.

[Given : $E^0_{(MnO_4^-(aq)/MnO_2(s))} = 1.68\,V$; $E^0_{(MnO_2(s)/Mn^{2+}(aq))} = 1.21\,V$; $E^0_{(Mn^{2+}(aq)/Mn(s))} = -1.03\,V$]

Ans. (0.77)

Sol. $\overset{+7}{MnO_4^-} \xrightarrow{(3)} \overset{+4}{MnO_2} \xrightarrow{(2)} \overset{+2}{Mn} \xrightarrow{(2)} Mn$

$$\underbrace{MnO_4^- \longrightarrow Mn}_{7}$$

For the required reaction $\Delta G^\circ = \Delta G^\circ_1 + \Delta G^\circ_2 + \Delta G^\circ_3$

$\Rightarrow 7 \times E = 1.68 \times 3 + 1.21 \times 2 + (-1.03) \times 2$

$$E = \frac{5.4}{7} = 0.7714$$

Ans. = 0.77

3. A solution is prepared by mixing 0.01 mol each of H_2CO_3, $NaHCO_3$, Na_2CO_3, and NaOH in 100 mL of water. pH of the resulting solution is ______.

[Given : pK_{a1} and pK_{a2} of H_2CO_3 are 6.37 and 10.32, respectively ; log 2 = 0.30]

Ans. (10.02)

Sol.

	H_2CO_3 +	NaOH $\longrightarrow$	$NaHCO_3 + H_2O$
Milli moles	10	10	–
At end	0	0	10 + 10 = 20

Final mixture has 20 milli moles $NaHCO_3$ and 10 milli moles Na_2CO_3

$$pH = pKa_2 + \log \frac{Salt}{Acid}$$

$$pH = pKa_2 + \log\left(\frac{10}{20}\right) \qquad [\text{Buffer} : Na_2CO_3 + NaHCO_3]$$

$= 10.32 - \log 2 = 10.02$

4. The treatment of an aqueous solution of 3.74 g of $Cu(NO_3)_2$ with excess KI results in a brown solution along with the formation of a precipitate. Passing H_2S through this brown solution gives another precipitate X. The amount of X (in g) is ______.

[Given : Atomic mass of H = 1, N = 14, O = 16, S = 32, K = 39, Cu = 63, I = 127]

Ans. (0.32)

Sol. $2Cu(NO_3)_2 + 5KI \longrightarrow Cu_2I_2 + KI_3 + 4KNO_3$

0.02   0.01

$KI_3 + H_2S \longrightarrow S\downarrow + KI + 2HI$

0.01   0.01

$n_S = 0.01$ mole

weight of sulphur = $32 \times 0.01 = 0.32$ gm

5. Dissolving 1.24 g of white phosphorous in boiling NaOH solution in an inert atmosphere gives a gas **Q**. The amount of $CuSO_4$ (in g) required to completely consume the gas **Q** is ______.

[Given : Atomic mass of H = 1, O = 16, Na = 23, P = 31, S = 32, Cu = 63]

Ans. (2.38 / 2.39)

Sol. Mole of $P_4 = \frac{1.24}{31\times 4} = 0.01$

$$P_4 + 3NaOH + 3H_2O \longrightarrow PH_3 + 3NaH_2PO_2$$

0.01 mole 0.01 mole

$$2PH_3 + 3CuSO_4 \rightarrow Cu_3P_2 + 3H_2SO_4$$

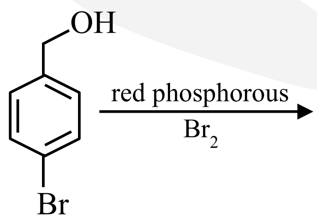
$$0.01 \qquad \frac{3}{2} \times 0.01$$

$$= \frac{0.03}{2} \text{ moles}$$

$$W_{CuSO_4} = \frac{0.03}{2}\times 159 = 2.385 \text{ gm}$$

Ans. = 2.38 or 2.39

6. Consider the following reaction.



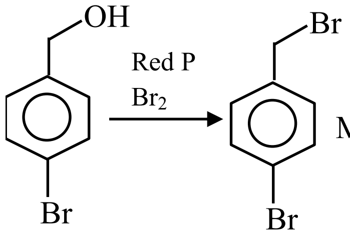
R (major product)

On estimation of bromine in 1.00 g of **R** using Carius method, the amount of AgBr formed (in g) is ______.

[Given : Atomic mass of H = 1, C = 12, O = 16, P = 31, Br = 80, Ag = 108]

Ans. (1.50)

Sol.



M.W. = 250 g/mol

(R)

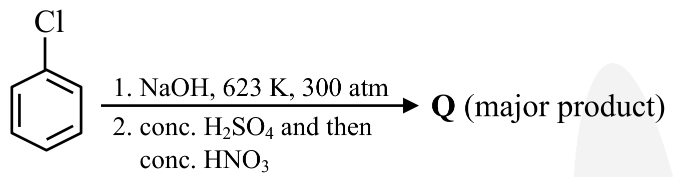
$$1g\ R \rightarrow \frac{1}{250} \text{moles}$$

$$\text{No. of Br Atoms} \rightarrow \frac{2}{250} \text{moles}$$

$$\text{Moles of AgBr} \rightarrow \frac{2}{250} \text{moles}$$

$$\text{Mass of AgBr} = \frac{2}{250} \times (108+80) = 1.504$$

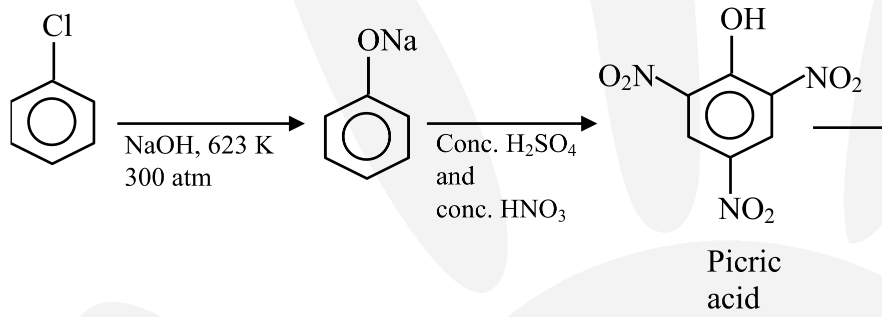
7. The weight percentage of hydrogen in **Q**, formed in the following reaction sequence, is ______.



[Given : Atomic mass of H = 1, C = 12, N = 14, O = 16, S = 32, Cl = 35]

Ans. (1.31)

Sol.

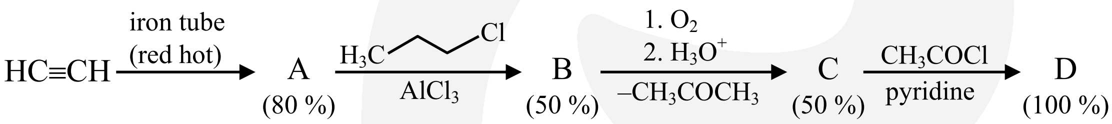


$\longrightarrow C_6H_3N_3O_7$

Mass % of H

$= \frac{3}{229} \times 100 = 1.31\%$

8. If the reaction sequence given below is carried out with 15 moles of acetylene, the amount of the product **D** formed (in g) is ______.

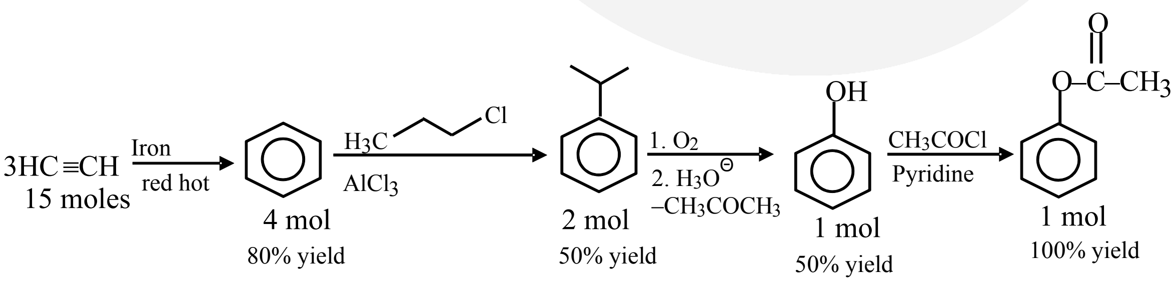


The yields of **A, B, C** and **D** are given in parentheses.

[Given : Atomic mass of H = 1, C = 12, O = 16, Cl = 35]

Ans. (136)

Sol.



$C_8H_8O_2$

136 g

SECTION-2 : (Maximum Marks : 24)

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	: +4	**ONLY** if (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;
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.

9. For diatomic molecules, the correct statement(s) about the molecular orbitals formed by the overlap to two $2p_z$ orbitals is(are)

(A) σ orbital has a total of two nodal planes.

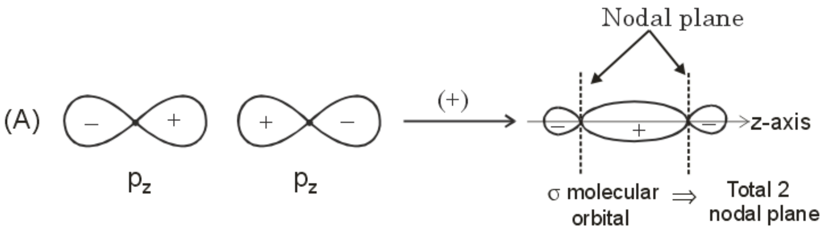
(B) σ^* orbital has one node in the xz-plane containing the molecular axis.

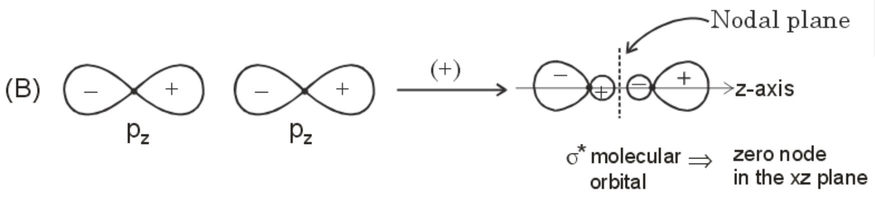
(C) π orbital has one node in the plane which is perpendicular to the molecular axis and goes through the center of the molecule.

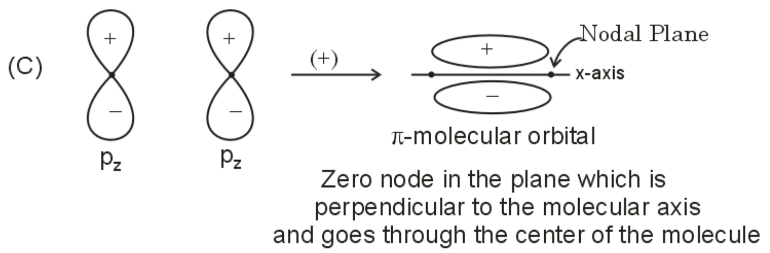
(D) π^* orbital has one node in the xy-plane containing the molecular axis.

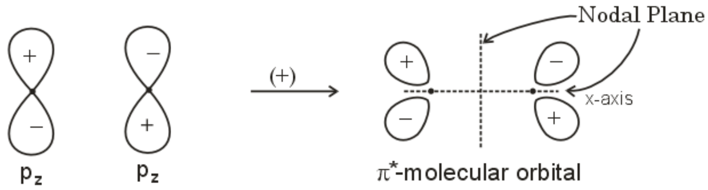
Ans. **(A,D)**

Sol.







(D) 

One node in xy plane containing the molecular axis

10. The correct option(s) related to adsorption processes is(are)

(A) Chemisorption results in a unimolecular layer.

(B) The enthalpy change during physisorption is in the range of 100 to 140 kJ mol^{-1}.

(C) Chemisorption is an endothermic process.

(D) Lowering the temperature favors physisorption processes.

Ans. (A,D)

Sol. (A) Chemisorption is unimolecular layered.

(B) Enthalpy of physisorption is much less in magnitude.

(C) Chemisorption of gases on solids is exothermic.

(D) As physisorption is exothermic so lowering temperature favours it.

11. The electrochemical extraction of aluminum from bauxite ore involves.

(A) the reaction of Al_2O_3 with coke (C) at a temperature > 2500°C.

(B) the neutralization of aluminate solution by passing CO_2 gas to precipitate hydrated alumina ($Al_2O_3.3H_2O$)

(C) the dissolution of Al_2O_3 in hot aqueous NaOH.

(D) the electrolysis of Al_2O_3 mixed with Na_3AlF_6 to give Al and CO_2.

Ans. (B,C,D)

Sol. (A) Electrochemical extraction of Aluminum from bauxite done below 2500°C

(B) $2Na[Al(OH)_4]_{aq.} + 2CO_{2(g)} \rightarrow Al_2O_3.3H_2O_{(s)} \downarrow + 2NaHCO_{3(aq.)}$

The sodium aluminate present in solution is neutralised by passing CO_2 gas and hydrated Al_2O_3 is precipitated.

(C) $Al_2O_{3(s)} + 2NaOH_{(aq.)} + 3H_2O_{(l)} \rightarrow 2Na[Al(OH)_4]_{aq.}$

Concentration of bauxite is carried out by heating the powdered ore with hot concentrated solution of NaOH

(D) In metallurgy of aluminum, Al_2O_3 is mixed with Na_3AlF_6

12. The treatment of galena with HNO_3 produces a gas that is

(A) paramagnetic (B) bent in geometry

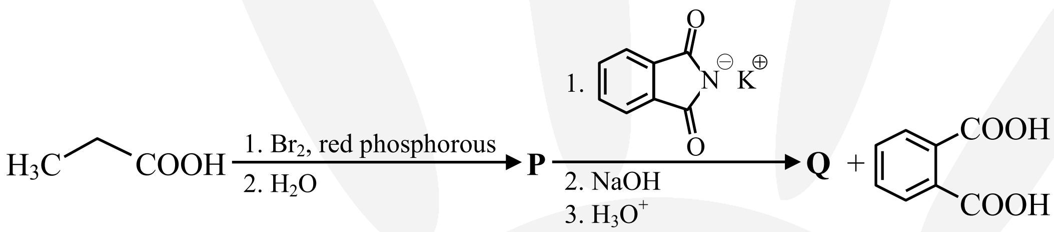
(C) an acidic oxide (D) colorless

Ans. **(A,D)**

Sol. $3PbS + 8HNO_3 \rightarrow 3Pb(NO_3)_2 + 2NO + 4H_2O + S$

NO $\Rightarrow$ Neutral oxide, Paramagnetic, Linear geometry, Colourless gas

13. Considering the reaction sequence given below, the correct statement(s) is(are)



(A) **P** can be reduced to a primary alcohol using $NaBH_4$.

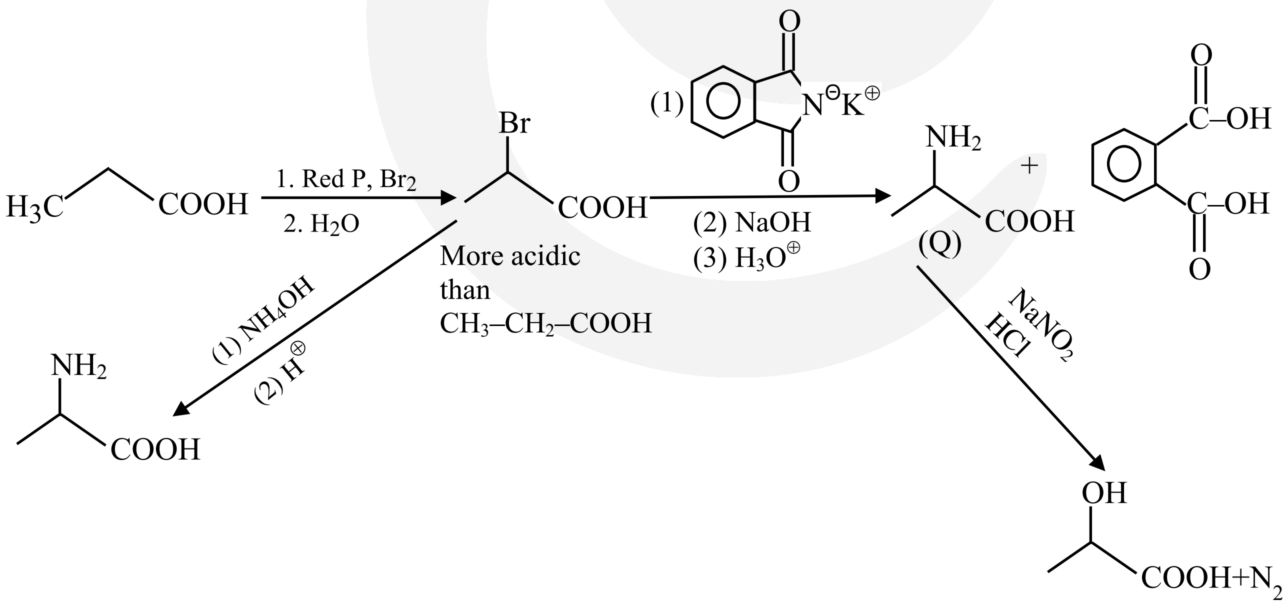
(B) Treating **P** with conc. NH_4OH solution followed by acidification gives **Q**.

(C) Treating **Q** with a solution of $NaNO_2$ in aq. HCl liberates N_2.

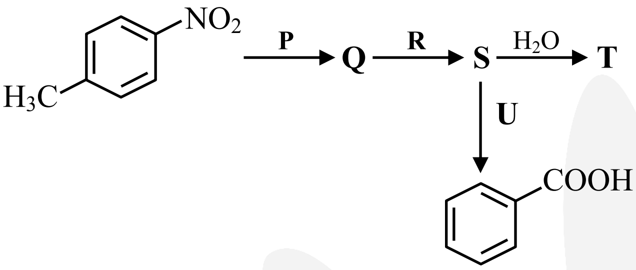
(D) **P** is more acidic than CH_3CH_2COOH.

Ans. **(B,C,D)**

Sol.



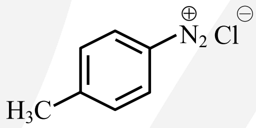
14. Consider the following reaction sequence,



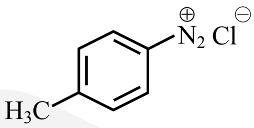
the correct option(s) is(are)

(A) **P** = H_2/Pd, ethanol **R** = $NaNO_2$/HCl **U** = 1. H_3PO_2
2. $KMnO_4$ - KOH, heat

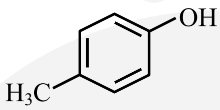
(B) **P** = Sn/HCl **R** = HNO_2 **S** =



(C) **S** =

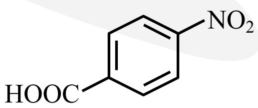


T =

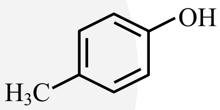


U = 1. CH_3CH_2OH
2. $KMnO_4$ - KOH, heat

(D) **Q** =

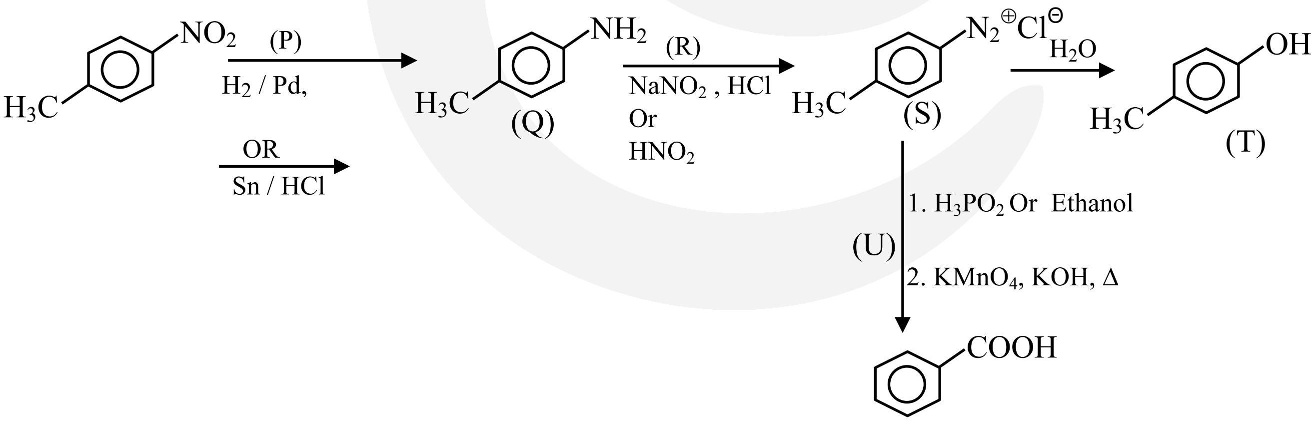


R = H_2/Pd, ethanol **T** =



Ans. (A,B,C)

Sol.

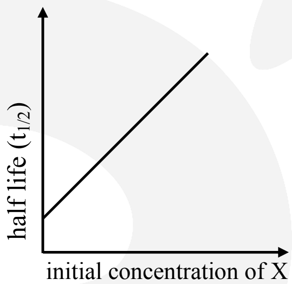
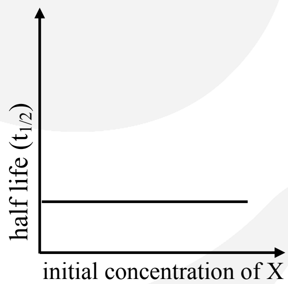
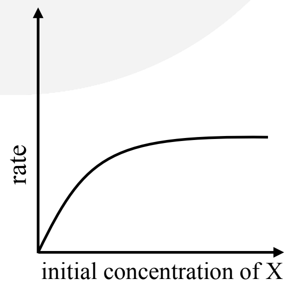


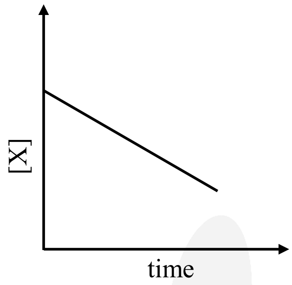
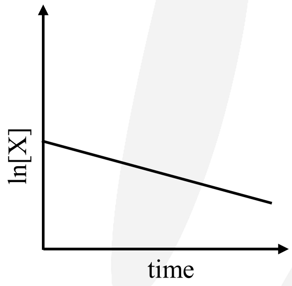
SECTION-3 : (Maximum Marks : 12)

- This section contains **FOUR (04)** Matching List Sets.
- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists : **List-I** and **List-II**.
- **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five** entries (P), (Q), (R), (S) and (T).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme:

  Full Marks : +3 **ONLY** if the option corresponding to the correct combination 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 the rate expressions in LIST-I for the decomposition of X with the corresponding profiles provided in LIST-II. X_s and k constants having appropriate units.

LIST-I	**LIST-II**
(I) $\text{rate} = \dfrac{k[X]}{X_s + [X]}$ under all possible initial concentration of X	(P) 
(II) $\text{rate} = \dfrac{k[X]}{X_s + [X]}$ where initial concentration of X are much less than X_s	(Q) 
(III) $\text{rate} = \dfrac{k[X]}{X_s + [X]}$ where initial concentration of X are much higher than X_s	(R) 

(IV) $\text{rate} = \dfrac{k[X]^2}{X_s + [X]}$ where initial concentration of X is much higher than X_s	(S)	
	(T)	

(A) $I \to P$; $II \to Q$; $III \to S$; $IV \to T$

(B) $I \to R$; $II \to S$; $III \to S$; $IV \to T$

(C) $I \to P$; $II \to Q$; $III \to Q$; $IV \to R$

(D) $I \to R$; $II \to S$; $III \to Q$; $IV \to R$

Ans. **(A)**

Sol. (I) $\text{rate} = \dfrac{k[x]}{x_s + [x]} = \dfrac{k}{\dfrac{x_s}{[x]} + 1}$

If $[x] \to \infty \Rightarrow \text{rate} \to k \Rightarrow \text{order} = 0$

$\Rightarrow$ (I) – (R), (P)

(II) $[x] << x_s \Rightarrow \text{rate} = \dfrac{k[x]}{x_s} \Rightarrow \text{order} = 1$

$\Rightarrow$ (II) – (Q), (T)

(III) $[x] >> x_s \Rightarrow \text{rate} = k \Rightarrow \text{order} = 0$

$\Rightarrow$ (III) – (P), (S)

(IV) $\text{rate} = \dfrac{k[x]^2}{x_s + [x]}$

$[x] >> x_s \Rightarrow \text{rate} = k[x]$

$\Rightarrow$ (IV) – (Q), (T)

Ans. (A)

16. LIST-I contains compounds and LIST-II contains reaction

LIST-I	LIST-II
(I) H_2O_2	(P) $Mg(HCO_3)_2 + Ca(OH)_2 \rightarrow$
(II) $Mg(OH)_2$	(Q) $BaO_2 + H_2SO_4 \rightarrow$
(III) $BaCl_2$	(R) $Ca(OH)_2 + MgCl_2$
(IV) $CaCO_3$	(S) $BaO_2 + HCl \rightarrow$
	(T) $Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow$

Match each compound in LIST – I with its formation reaction(s) in LIST-II, and choose the correct option

(A) I $\rightarrow$ Q; II $\rightarrow$ P; III $\rightarrow$ S; IV $\rightarrow$ R
(B) I $\rightarrow$ T; II $\rightarrow$ P; III $\rightarrow$ Q; IV $\rightarrow$ R
(C) I $\rightarrow$ T; II $\rightarrow$ R; III $\rightarrow$ Q; IV $\rightarrow$ P
(D) I $\rightarrow$ Q; II $\rightarrow$ R; III $\rightarrow$ S; IV $\rightarrow$ P

Ans. (D)

Sol. (P) $Mg(HCO_3)_2 + 2Ca(OH)_2 \rightarrow Mg(OH)_2 + 2CaCO_3 + 2H_2O$

(Q) $BaO_2 + H_2SO_4 \rightarrow H_2O_2 + BaSO_4$

(R) $Ca(OH)_2 + MgCl_2 \rightarrow Mg(OH)_2 + CaCl_2$

(S) $BaO_2 + 2HCl \rightarrow BaCl_2 + H_2O_2$

(T) $Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O$

17. LIST-I contains metal species and LIST-II contains their properties.

LIST-I	LIST-II
(I) $[Cr(CN)_6]^{4-}$	(P) t_{2g} orbitals contain 4 electrons
(II) $[RuCl_6]^{2-}$	(Q) μ(spin-only) = 4.9 BM
(III) $[Cr(H_2O)_6]^{2+}$	(R) low spin complex ion
(IV) $[Fe(H_2O)_6]^{2+}$	(S) metal ion in 4+ oxidation state
	(T) d^4 species

[Given : Atomic number of Cr = 24, Ru = 44, Fe = 26]

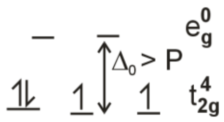
Metal each metal species in LIST-I with their properties in LIST-II, and choose the correct option

(A) I $\rightarrow$ R, T; II $\rightarrow$ P, S; III $\rightarrow$ Q, T; IV $\rightarrow$ P, Q
(B) I $\rightarrow$ R, S; II $\rightarrow$ P, T; III $\rightarrow$ P, Q; IV $\rightarrow$ Q, T
(C) I $\rightarrow$ P, R; II $\rightarrow$ R, S; III $\rightarrow$ R, T; IV $\rightarrow$ P, T
(D) I $\rightarrow$ Q, T; II $\rightarrow$ S, T; III $\rightarrow$ P, T; IV $\rightarrow$ Q, R

Ans. (A)

Sol. (1) $[Cr(CN)_6]^{4-}$

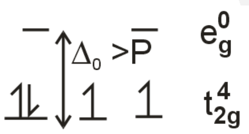
$Cr^{+2} = [Ar]_{18}\ 3d^4 4s^0$; low spin complex



P,R,T

(2) $[RuCl_6]^{2-}$

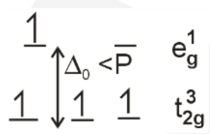
$Ru^{+4} = [Kr]_{36} 4d^4 5s^0$; low spin complex



P,R,S,T

(3) $[Cr(H_2O)_6]^{2+}$

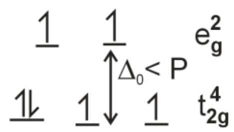
$Cr^{+2} = [Ar]_{18} 3d^4 4s^0$; high spin complex



Q,T

(4) $[Fe(H_2O)_6]^{2+}$

$Fe^{+2} = [Ar]_{18} 3d^6$; High spin complex



P,Q

18. Match the compounds in LIST-I with the observation in LIST-II, and choose the correct option.

LIST-I	LIST-II
(I) Aniline	(P) Sodium fusion extract of the compound on boiling with $FeSO_4$, followed by acidification with conc. H_2SO_4, gives Prussian blue color.
(II) o-Cresol	(Q) Sodium fusion extract of the compound on treatment with sodium nitroprusside gives blood red color.
(III) Cysteine	(R) Addition of the compound to a saturated solution of $NaHCO_3$ results in effervescence.

(IV) Coprolactam

(S) The compound reacts with bromine water to give a white precipitate.

(T) Treating the compound with neutral $FeCl_3$ solution produces violet color.

(A) $I \rightarrow P, Q; II \rightarrow S; III \rightarrow Q, R; IV \rightarrow P$

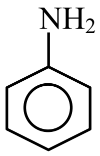
(B) $I \rightarrow P ; II \rightarrow R, S; III \rightarrow R; IV \rightarrow Q, S$

(C) $I \rightarrow Q, S; II \rightarrow P, T; III \rightarrow P; IV \rightarrow S$

(D) $I \rightarrow P, S; II \rightarrow T; III \rightarrow Q, R; IV \rightarrow P$

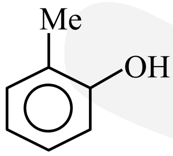
Ans. (D)

Sol.



Aniline

: Blue colour in Lassign test due to presence of N



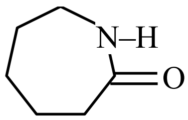
o-Cresol

:Violet colour with $FeCl_3$ due to presence of phenolic OH

$HS–CH_2–CH(NH_2)–COOH$

Cystein

: It gives blod red colour with NaSCN



Caprolactam

: Blue colour in Lassign test due to presence of N