JEE ADVANCED (Paper - 1)
CHEMISTRY

SECTION 1 (Maximum Marks: 15)

- This section contains **FIVE** questions
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct integer in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3 if only the bubble corresponding to the correct answer is darkened.

Zero Marks : 0 in all other cases.

Negative Marks : –1 in all other cases.

19. The increasing order of atomic radii of the following Group 13 elements is

(A) Al < Ga < In < Tl (B) Ga < Al < In < Tl

(C) Al < In < Ga < Tl (D) Al < Ga < Tl < In

Ans. (B)

Sol: As atomic radii are respectively

Al = 1.43 $\mathring{A}$

Ga = 1.35 $\mathring{A}$

In = 1.67 $\mathring{A}$

Tl = 1.70 $\mathring{A}$

So Ga < Al < In < Tl

20. Among $[Ni(CO)_4]$, $[NiCl_4]^{2-}$, $[Co(NH_3)_4Cl_2]Cl$, $Na_3[CoF_6]$, Na_2O_2 and CsO_2, the total number of paramagnetic compounds is

(A) 2 (B) 3 (C) 4 (D) 5

Ans. (C)

Sol: $[NiCl_4]^{2-}$,$[Co(NH_3)_4Cl_2]Cl$, $Na_3[CoF_6]$ and CsO_2 are paramagnetic.

21. On complete hydrogenation, a natural rubber produces

(A) ethylene-propylene copolymer (B) vulcanized rubber

(C) polypropylene (D) poylbutylene

Ans. (A)

Sol: Natural rubber is a polymer of isoprene

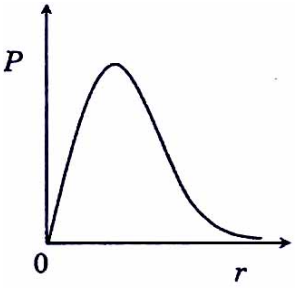
$$-\left(CH_2-\underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}}=CH-CH_2\right)_2-$$

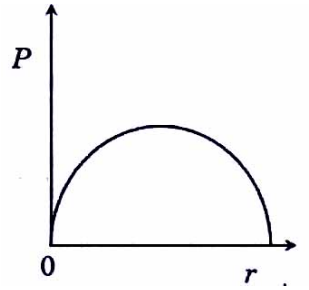
On hydrogenation it gives

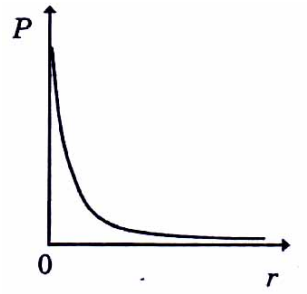
$$-\left(CH_2-\underset{\displaystyle CH_3}{\overset{\displaystyle |}{CH}}-CH_2-CH_2\right)_n-$$

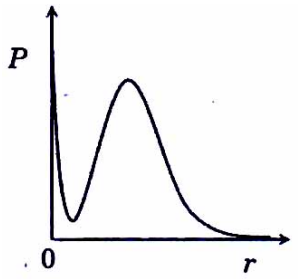
which is a copolymer of $CH_3CH = CH_2$ and $CH_2 = CH_2$

22. P is the probability of finding the 1s electron of hydrogen atom in a spherical shell of infinitesimal thickness, dr, at a distance r form the nucleus. The volume of this shell is $4\pi r^2 dr$. The qualitative sketch of the dependence of P on r is

(A) 

(B) 

(C) 

(D) 

Ans. (A)

Sol: Radial probability distribution of 1s orbital has only one peak and has no nodes.

23. One mole of an ideal gas at 300 K in thermal contact with surroundings expands isothermally form 1.0 L to 2.0 L against a constant pressure of 3.0 atm. In this process, the change in entropy of surrounding (ΔS_{surr}) in JK^{-1} is

(1 L atm = 101.3 J)

(A) 5.763 (B) 1.013 (C) –1.013 (D) –5.763

Ans. (C)

Sol: Work done by the gas = –3 atm l

= –303.9 J

As the temperate of the system remains constant so, heat supplied by the surrounding to the system = 303.9 J

$$\therefore \Delta S_{surr} = \frac{-303.9J}{300K} = -1.013\ JK^{-1}$$

SECTION 2 (Maximum Marks: 32)

- This section contains **EIGHT** questions
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct integer in the ORS.
- For each question, marks will be awarded in <u>one of the following categories</u>:

  Full Marks : +4 if only the bubble(s) corresponding to all the correct option(s) is(are) darkened.

  Partial Marks : +1 For darkening a bubble corresponding **to each correct option**, provided NO incorrect option is darkened.

  Zero Marks : 0 in all other cases.

  Negative Marks : –2 in all other cases.

- For example, if (A), (C) and (D) are all the correct options for a question, darkening all these three will result in +4 marks; darkening only (A) and (D) will result in +2 marks, and darkening (A) and (B) will result in –2 marks, as a wrong option is also darkened.

24. The correct statement(s) about the following reaction sequence is(are)

$$\text{Cumene}(C_9H_{12}) \xrightarrow[\text{(ii) } H_3O^+]{\text{(i) } O_2} P \xrightarrow{CHCl_3/NaOH} Q(\text{major}) + R(\text{minor})$$

$$Q \xrightarrow[PhCH_2Br]{NaOH} S$$

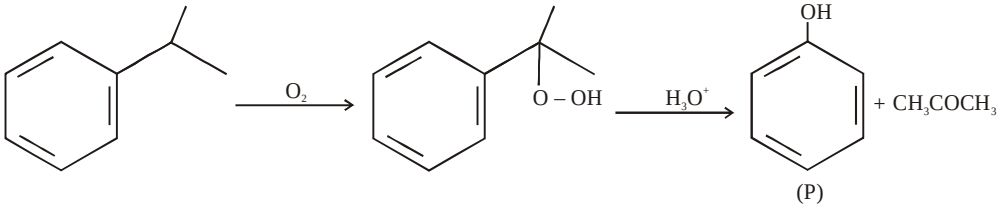
(A) R is steam volatile

(B) Q gives dark violet coloration with 1% aqueous $FeCl_3$ solution

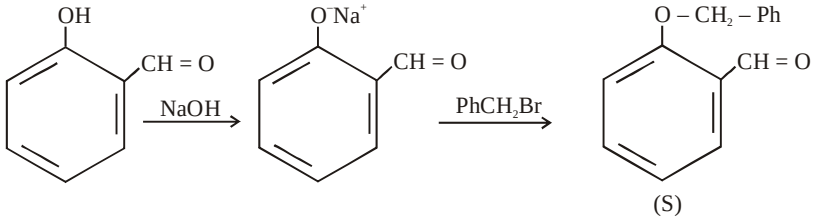
(C) S gives yellow precipitate with 2, 4-dinitrophenylhydrazine

(D) S gives dark violet coloration with 1% aqueous $FeCl_3$ solution

Sol. (B, C)



Phenolic group gives violet coloration with 1% aqueous $FeCl_3$ solution



25. The compound(s) with TWO lone pairs of electrons on the central atom is(are)

(A) BrF_5 (B) ClF_3 (C) XeF_4 (D) SF_4

Sol. (B, C)

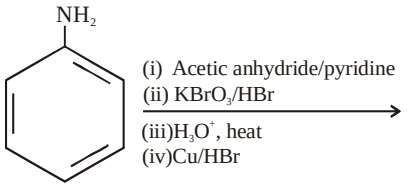
$BrF_5 \rightarrow 7+35 = \frac{42}{8} = 5+\left(\frac{2}{2}\right)$ = 5 + 1 = 6; sp^3d^2 + 1 lone pair

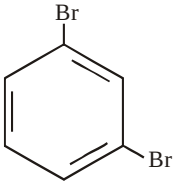
$ClF_3 \rightarrow 7+21 = \frac{28}{8} = 3+\left(\frac{4}{2}\right)$ = 3 + 2 = 5; sp^3d + 2 lone pair

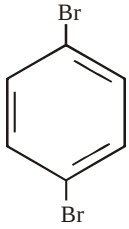
$XlF_4 \rightarrow 8+28 = \frac{36}{8} = 4+\left(\frac{4}{2}\right)$ = 6; sp^3d^2 + 2 lone pair

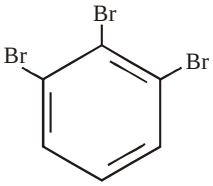
$SF_4 \rightarrow 6+28 = \frac{34}{8} = 4+\left(\frac{2}{2}\right)$ = 5; sp^3d + 1 lone pair

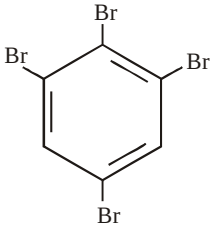
26. The product(s) of the following reaction sequence is(are)



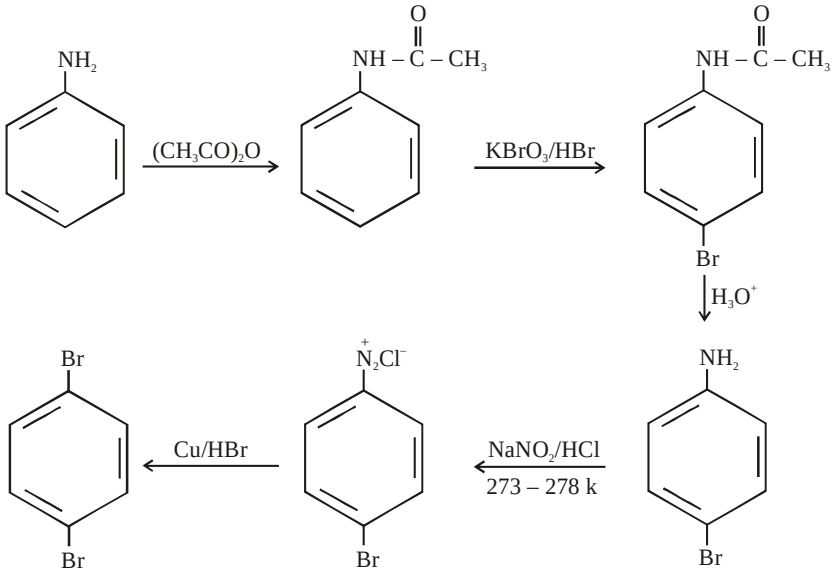
(A) 

(B) 

(C) 

(D) 

Sol. (B)



27. According to the Arrhenius equation

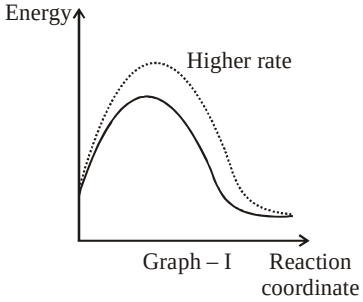
(A) a high activation energy usually implies a fast reaction

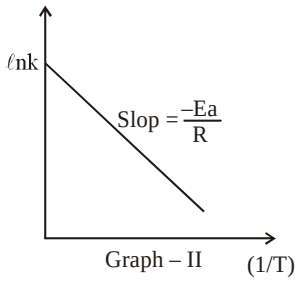
(B) rate constant increases with increase in temperature. This ia due to a greater number of collisions whose energy exceeds the activation energy

(C) higher the magnitude of activation energy, stronger is the temperature dependence of the rate constant

(D) the pre-exponential factor is a measure of the rate at which collisions occur, irrespective of their energy

Sol. (B, C, D)





According to Arrhenius equation

$K = Ae^{-Ea/RT}$ ... (i)

$$\ln k = \frac{-Ea}{RT} + \ln A$$

By increasing the temperature rate constant of reaction will increases.

By differentiation of equation (i)

$$\frac{dK}{dT} = +A\left(\frac{Ea}{RT^2}\right)e^{-Ea/RT}$$

So slope $\left(\frac{dK}{dT}\right) \rightarrow$ rate of change of rate constant depends strongly on higher magnitude of activation energy (graph – I).

28. The crystalline form of borax has

(A) tetranuclear $[B_4O_5(OH)_4]^{2-}$

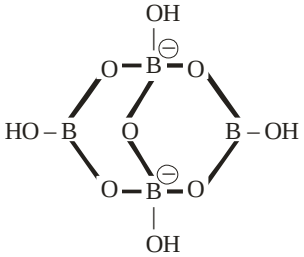
(B) all boron atoms in the same plane

(C) equal number of sp^2 and sp^3 hybridized boron atoms

(D) one terminal hydroxide per boron atom

Key. (A, C, D)

Sol. A, C, D



Negatively charged 'B' are sp^3 hybridised whereas other two 'B' are sp^2 hybridised.

29. The reagent(s) that can selectively precipitate S^{2-} from a mixture of S^{2-} and SO_4^{2-} in aqueous solution is (are)

(A) $CuCl_2$ (B) $BaCl_2$

(C) $Pb(OOCCH_3)_2$ (D) $Na_2[Fe(CN)_5NO]$

Key. (A)

Sol. $CuCl_2 + S^{2-} \rightarrow \underset{\text{Black}}{CuS\downarrow} + 2Cl^-$

But $CuCl_2 + SO_4^{2-} \rightarrow \underset{\text{Soluble}}{CuSO_4} + 2Cl^-$

$BaCl_2 + SO_4^{2-} \rightarrow \underset{\text{white}}{BaSO_4\downarrow} + 2Cl^-$

BaS is soluble in water

$Pb(OOCCH_3)_2 + S^{2-} \rightarrow \underset{\text{Black}}{PbS\downarrow} + 2CH_3COO^-$

$Pb(OOCCH_3)_2 + SO_4^{2-} \rightarrow \underset{\text{White}}{PbSO_4\downarrow} + 2CH_3COO^-$

$Na_2[Fe(CN)_5NO] + S^{2-} \rightarrow \underset{\text{Violet solution}}{Na_4[Fe(CN)_5NOS]}$, and

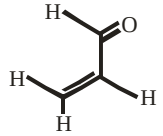
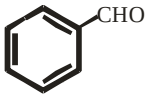
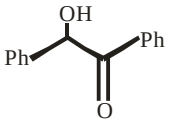
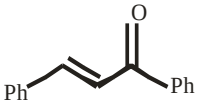
$Na_2[Fe(CN)_5NO] \xrightarrow{h\nu} Na_2[Fe(CN)_5NO]^*$

$Na_2[Fe(CN)_5NO]^* + H_2O \xrightarrow{h\nu} Na_3[Fe(CN)_5(H_2O)] + NO^+$

$Na_3[Fe(CN)_5(H_2O)] + SO_4^{2-} \longrightarrow Na_5[Fe(CN)_5(SO_4)] + H_2O$

$Na_5[Fe(CN)_5(SO_4)] + SO_4^{2-} \longrightarrow \underset{\text{Peacock blue}}{Na_6[Fe(CN)_4(SO_4)_2]\downarrow} + CN^-$

30. Positive Tollen's test is observed for

(A)  (B)  (C)  (D) 

Key. (A, B, C)

Sol. Aliphatic aldehyde **(A)**, Aromatic aldehyde **(B)** and α hydroxyl ketone gives tollen's test.

31. A plot of the number of neutrons(N) against the number of protons (P) of stable nuclei exhibit unpward deviation from linearity for atomic number, Z>20. For an unstable nucleus having N/P ratio less than 1, the possible mode(s) of decay is(are)

(A) β^--decay (β emission) (B) orbital or K-electron capture

(C) neutron emission (D) β^+-decay (positron emission)

Key. (B, D)

Sol. If $\frac{N}{P}$ ratio is less than one in Z > 20

Then possible modes of decay are K electron capture and positron decay.

$${}_ZA^M + {}_{-1}e^0 \rightarrow {}_{(z-1)}B^M \text{ (K capture)}$$

$${}_ZA^M \longrightarrow {}_{(z-1)}B^M + {}_{+1}\beta^0 \text{ (Positron emission)}$$

SECTION 3 (Maximum Marks: 15)

- This section contains FIVE questions
- The answer to each question is SINGLE DIGIT INTEGER ranging from 0 to 9, both inclusive.
- For each question, darken the bubble corresponding to the correct integer in the ORS.
- For each question, marks will be awarded in one of the following categories:

  Full Marks : +3 if only the bubble corresponding to the correct answer is darkened.

  Zero Marks : 0 in all other cases

32. The diffusion coefficient of an ideal gas is proportional to its mean free path and mean speed. The absolute temperature of an ideal gas is increased 4 times and pressure is increased 2 times. As a result, the diffusion coefficient of this gas increases x times. The value of x is

Ans. (4)

Sol. $K \propto \frac{T^{3/2}}{P} \Rightarrow \frac{K_2}{K_1} = \frac{(4)^{3/2}}{2}$

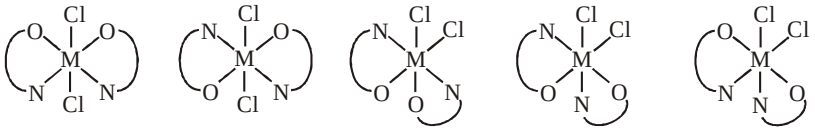
$= \frac{8}{2} = 4$

33. The number of geometric isomers possible for the complex $[CoL_2Cl_2]^-$ ($L=H_2NCH_2CH_2O^-$) is

Ans. (5)

Sol. Compound $[ML_2B_2]$ has total geometrical isomers = 3, (L = Bidentate ligand)

cis = 2 and trans = 1



34. The mole fraction of a solute in a solution is 0.1. At 298 K, molarity of this solution is the same as its molality. Density of this solution at 298 K is 2.0 g cm^{-3}. The ratio of the molecular weights of the solute and solvent, $\left(\frac{MW_{solute}}{MW_{solvent}}\right)$, is

Ans. (9)

Sol. $\chi_{solute} = \frac{1}{10}$

If $n_{solute} = 1$ then $n_{solvent} = 9$

Let MW of solute = x and solvent = y

Mass of solution = x + 9y

Let total volume of solution = v

Molality = molarity

$$\frac{1}{9y}=\frac{1}{V} \Rightarrow \frac{V}{y}=9 \quad \text{....(i)}$$

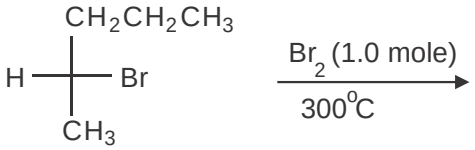
as density = 2

$$\Rightarrow \frac{x+9y}{V}=2 \quad \text{.....(ii)}$$

from equation (i) and (ii)

$$\frac{x}{y}=9$$

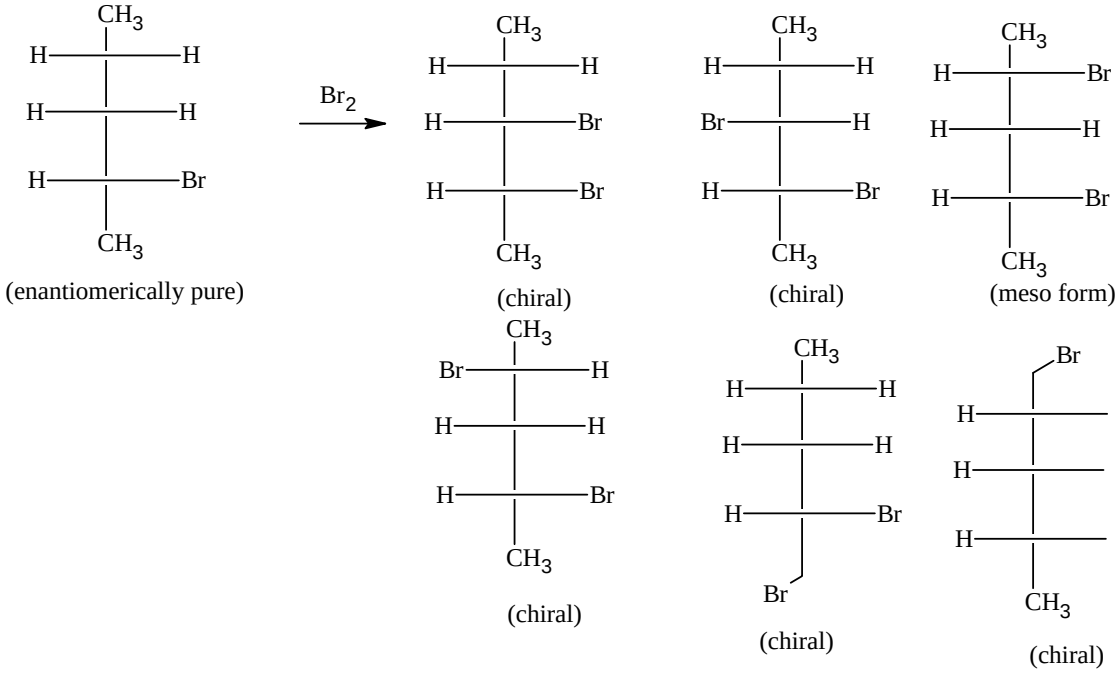
35. In the following monobromination reaction, the number of possible chiral products is



(1.0 mole)
(enantiomerically pure)

Ans. (5)

Sol.



(enantiomerically pure)

(chiral)

(chiral)

(meso form)

(chiral)

(chiral)

(chiral)

36. In neutral or faintly alkaline solution, 8 moles of permanganate anion, quantitatively oxidize thiosulphate anions to produce X moles of a sulphur containing product. The magnitude of X is

Ans. (6)

Sol.

$$3S_2O_3^{2-}+8MnO_4^-+H_2O \rightarrow 6SO_4^{2-}+8MnO_2+2OH^-$$