JEE–MAIN EXAMINATION – JANUARY 2025

(HELD ON WEDNESDAY 22nd JANUARY 2025) **TIME : 3 : 00 PM TO 6 : 00 PM**

CHEMISTRY

TEST PAPER WITH SOLUTIONS

SECTION-A

51. Arrange the following compounds in increasing order of their dipole moment :

HBr, H_2S, NF_3 and $CHCl_3$

(1) $NF_3 < HBr < H_2S < CHCl_3$

(2) $HBr < H_2S < NF_3 < CHCl_3$

(3) $H_2S < HBr < NF_3 < CHCl_3$

(4) $CHCl_3 < NF_3 < HBr < H_2S$

Ans. (1)

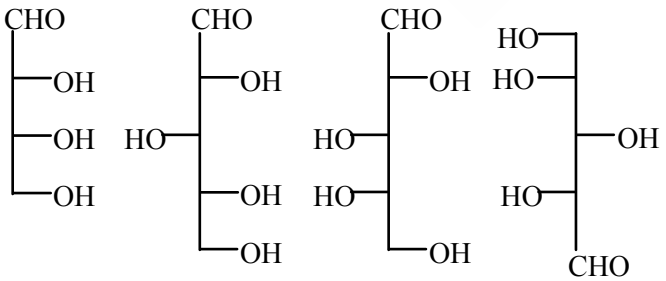
Sol. Increasing order of Dipole moment

$$NF_3 < HBr < H_2S < CHCl_3$$

$$\mu = 0.24D \quad 0.79D \quad 0.95D \quad 1.04D$$

It is NCERT Data Based

52. Identify the number of structure/s from the following which can be correlated to D-glyceraldehyde.



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

(1) three

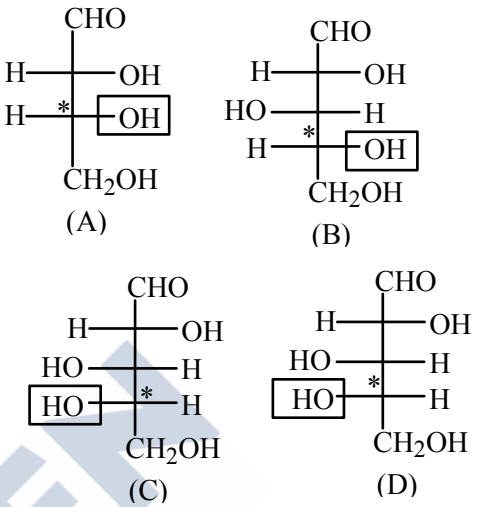
(2) two

(3) four

(4) one

Ans. (1)

Sol.



In A, B, D * –OH group in right hand side then D-configuration is assign

53. The maximum covalency of a non-metallic group 15 element 'E' with weakest E–E bond is :

(1) 5

(2) 3

(3) 6

(4) 4

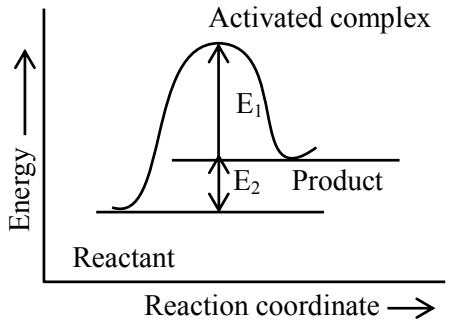
Ans. (4)

Sol. N – N < P – P : single (σ) bond strength

Due to L.P.-L.P. replusion

and maximum possible covalency of nitrogen is 4.

54. Consider the given figure and choose the **correct** option :



(1) Activation energy of backward reaction is E_1 and product is more stable than reactant.

(2) Activation energy of forward reaction is $E_1 + E_2$ and product is more stable than reactant.

(3) Activation energy of forward reaction is $E_1 + E_2$ and product is less stable than reactant.

(4) Activation energy of both forward and backward reaction is $E_1 + E_2$ and reactant is more stable than product.

Ans. (3)

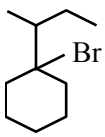
Sol. Activation energy of forward reaction = $E_1 + E_2$

Energy of product > Energy of reactant

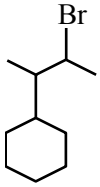
Stability

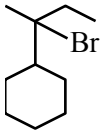
Reactant > Product

55. When sec-butylcyclohexane reacts with bromine in the presence of sunlight, the major product is :

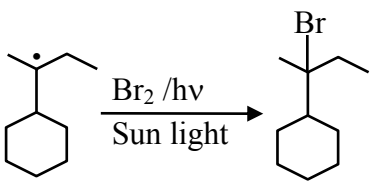
(1) 

(2) 

(3) 

(4) 

Ans. (4)

Sol. 

Formation of more stable free radical intermediate

56. The species which does not undergo disproportionation reaction is :

(1) ClO_2^- (2) ClO_4^-

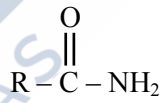
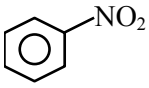
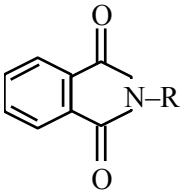
(3) ClO^- (4) ClO_3^-

Ans. (2)

Sol. $ClO_4^- \rightarrow x + \{(-2) \times 4\} = -1 \Rightarrow x = +7$

Chlorine is in its maximum oxidation state, so disproportionation not possible in ClO_4^-.

57. Match the Compounds **(List-I)** with the appropriate Catalyst/Reagents **(List-II)** for their reduction into corresponding amines.

List-I (Compounds)		**List-II (Catalyst/Reagents)**
(A) 	(I)	NaOH (aqueous)
(B) 	(II)	H_2/Ni
(C) R–C≡N	(III)	$LiAlH_4$, H_2O
(D) 	(IV)	Sn, HCl

Choose the **correct** answer from the options given below :

(1) (A)-(III), (B)-(II), (C)-(IV), (D)-(I)

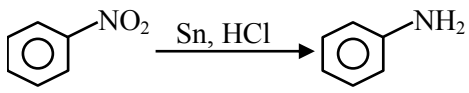
(2) (A)-(II), (B)-(IV), (C)-(III), (D)-(I)

(3) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)

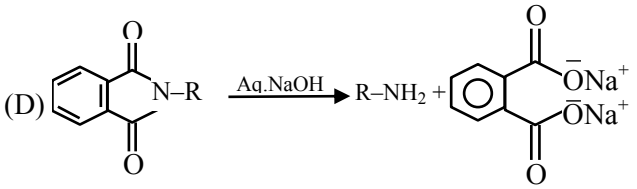
(4) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

Ans. (4)

Sol. (A) $R-\underset{\underset{O}{\|}}{C}-NH_2 \xrightarrow[H_2O]{LiAlH_4} R-CH_2-NH_2$

(B) 

(C) $R-C\equiv N \xrightarrow{H_2/Ni} R-CH_2NH_2$

(D) 

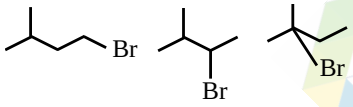
58. $RBr \xrightarrow[(ii)\ H_2O]{(i)\ Mg,\ dry\ ether}$ 2-Methylbutane

The maximum number of RBr producing 2-methylbutane by above sequence of reactions is _____. (Consider the structural isomers only)

(1) 4 (2) 5

(3) 3 (4) 1

Ans. (1)



Sol. 

Total number of possible structural RBr = 4

59. Match **List-I** with **List-II**.

	List-I (Partial Derivatives)		**List-II (Thermodynamic Quantity)**
(A)	$\left(\frac{\partial G}{\partial T}\right)_P$	(I)	C_P
(B)	$\left(\frac{\partial H}{\partial T}\right)_P$	(II)	$-S$
(C)	$\left(\frac{\partial G}{\partial P}\right)_T$	(III)	C_V
(D)	$\left(\frac{\partial U}{\partial T}\right)_V$	(IV)	V

Choose the **correct** answer from the options given below :

(1) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)

(2) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(3) (A)-(I), (B)-(II), (C)-(IV), (D)-(III)

(4) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

Ans. (2)

Sol. (A) $dG = VdP - SdT$

Constant pressure

$dG = -SdT$

$\left(\frac{\partial G}{\partial T}\right)_P = -S$

(B) $dH = (dq)_P = nC_PdT$

$\left(\frac{\partial H}{\partial T}\right)_P = C_P$

(C) $dG = VdP - SdT$

At constant temperature

$dG = VdP$

$\left(\frac{\partial G}{\partial P}\right)_T = V$

(D) $dU = nC_VdT = (q)_V$

$\left(\frac{\partial U}{\partial T}\right)_V = C_V$

60. The correct order of the following complexes in terms of their crystal field stabilization energies is :

(1) $[Co(NH_3)_4]^{2+} < [Co(NH_3)_6]^{2+} < [Co(en)_3]^{3+} < [Co(NH_3)_6]^{3+}$

(2) $[Co(NH_3)_4]^{2+} < [Co(NH_3)_6]^{2+} < [Co(NH_3)_6]^{3+} < [Co(en)_3]^{3+}$

(3) $[Co(NH_3)_6]^{2+} < [Co(NH_3)_6]^{3+} < [Co(NH_3)_4]^{2+} < [Co(en)_3]^{3+}$

(4) $[Co(en)_3]^{3+} < [Co(NH_3)_6]^{3+} < [Co(NH_3)_6]^{2+} < [Co(NH_3)_4]^{2+}$

Ans. (2)

Sol. Order of CFSE

$[Co(NH_3)_4]^{+2} < [Co(NH_3)_6]^{+2} < [Co(NH_3)_6]^{+3} < [Co(en)_3]^{+3}$

Charge↑ CFSE↑ ; On increasing strength of ligand CFSE↑

SFL : NH_3 < en

61. Density of 3 M NaCl solution is 1.25 g/mL. The molality of the solution is :

(1) 1.79 m (2) 2 m

(3) 3 m (4) 2.79 m

Ans. **(4)**

Sol. 3M NaCl, d_{sol} = 1.25 gm/mol

$$\text{Molality} = \frac{M \times 1000}{1000d - M \times M_w}$$

$$= \frac{3000}{1250 - 175.5} = 2.79$$

62. The molar solubility(s) of zirconium phosphate with molecular formula $(Zr^{4+})_3 \left(PO_4^{3-}\right)_4$ is given by relation :

(1) $\left(\frac{K_{sp}}{6912}\right)^{\frac{1}{7}}$ (2) $\left(\frac{K_{sp}}{5348}\right)^{\frac{1}{6}}$

(3) $\left(\frac{K_{sp}}{8435}\right)^{\frac{1}{7}}$ (4) $\left(\frac{K_{sp}}{9612}\right)^{\frac{1}{3}}$

Ans. **(1)**

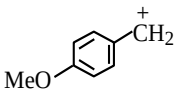
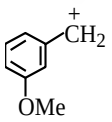
Sol. $Zr_3(PO_4)_4(s) \rightleftharpoons 3Zr^{+4}(aq) + 4PO_4^{-3}(aq)$

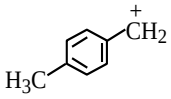
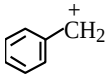
– 3s 4s

$K_{sp} = (3s)^3 (4s)^4 = 6912\ s^7$

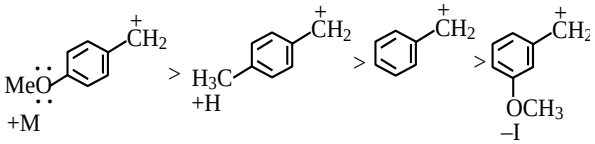
$s = \left(\frac{K_{sp}}{6912}\right)^{1/7}$

63. The most stable carbocation from the following is :

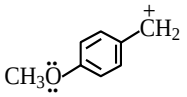
(1)  (2) 

(3)  (4) 

Ans. **(1)**

Sol. 

Due to +M effect of –OMe at para position

 Will be most stable among these

64. Given below are two statements :

Statement (I) : An element in the extreme left of the periodic table forms acidic oxides.

Statement (II) : Acid is formed during the reaction between water and oxide of a reactive element present in the extreme right of the periodic table.

In the light of the above statements, choose the **correct** answer from the options given below :

(1) **Statement-I** is false but **Statement-II** is true.

(2) Both **Statement-I** and **Statement-II** are false.

(3) **Statement-I** is true but **Statement-II** is false.

(4) Both **Statement-I** and **Statement-II** are true.

Ans. **(1)**

Sol. Statement-I : False but Statement-II is true.

On moving left to right in periodic table non-metallic character increases and we know that non-metal oxides are acidc in nature.

Non metallic character ↑ Acidic strength of oxide↑

65. Given below are two statements :

Statement (I) : A spectral line will be observed for a $2p_x \rightarrow 2p_y$ transition.

Statement (II) : $2p_x$ and $2p_y$ are degenerate orbitals.

In the light of the above statements, choose the **correct** answer from the options given below :

(1) Both **Statement-I** and **Statement-II** are true.

(2) Both **Statement-I** and **Statement-II** are false.

(3) **Statement-I** is true but **Statement-II** is false.

(4) **Statement-I** is false but **Statement-II** is true.

Ans. **(4)**

Sol. No spectral line will be observed for a $2p_x \rightarrow 2p_y$ transition because $2p_x$ and $2p_y$ orbitals are degenerate orbitals.

66. Given below are two statement :

Statement (I) : Nitrogen, sulphur, halogen and phosphorus present in an organic compound are detected by Lassaigne's Test.

Statement (II) : The elements present in the compound are converted from covalent form into ionic form by fusing the compound with Magnesium in Lassaigne's test.

In the light of the above statements, choose the **correct** answer from the options given below :

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

(3) Statement I is true but Statement II is false

(4) Statement I is false but Statement II is true

Ans. **(3)**

Sol. The elements present in the compound are converted from covalent form into ionic form by fusing the compound with sodium in Lassigne's test

67. Identify the homoleptic complex(es) that is/are low spin.

(A) $[Fe(CN)_5NO]^{2-}$ (B) $[CoF_6]^{3-}$

(C) $[Fe(CN)_6]^{4-}$ (D) $[Co(NH_3)_6]^{3+}$

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

Choose the **correct** answer from the options given below :

(1) (B) and (E) only (2) (A) and (C) only

(3) (C) and (D) only (4) (C) only

Ans. **(3)**

Sol. (A) $[Fe(CN)_5NO]^{-2}$ → Heteroleptic, Fe^{+2}, $3d^6$, $t_{2g}^6 e_g^0$, d^2sp^3, Low spin (3d series + SFL)

(B) $[CoF_6]^{-3}$ → Homoleptic, sp^3d^2, High spin, Co^{+3}, $3d^6$ (3d series + WFL)

(C) $[Fe(CN)_6]^{-4}$ → Homoleptic

Fe^{+2}, $3d^6$, d^2sp^3, $t_{2g}^6\ eg^0$ Low spin

(3d series + SFL)

(D) $[Co(NH_3)_6]^{+3}$ → Homoleptic, Co^{+3} $3d^6$, d^2sp^3, $t_{2g}^6\ eg^0$, Low spin (3d series + SFL)

(E) $[Cr(H_2O)_6]^{+2}$ → Homoleptic

Cr^{+2} $3d^4$, d^2sp^3, High spin $t_{2g}^3\ e_g^1$

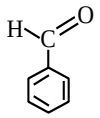
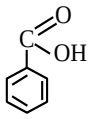
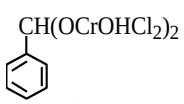
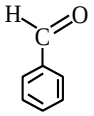
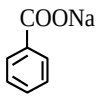
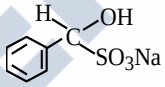
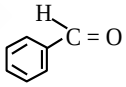
(3d series + WFL)

68. Toluene (excess) $\xrightarrow[\text{(ii) } H_3O^+ \text{ (iii) } NaHSO_3]{\text{(i) } CrO_2Cl_2,\ CS_2}$ Filter ⟶ Residue (A)

Residue (A) + HCl (dil.) → Compound (B)

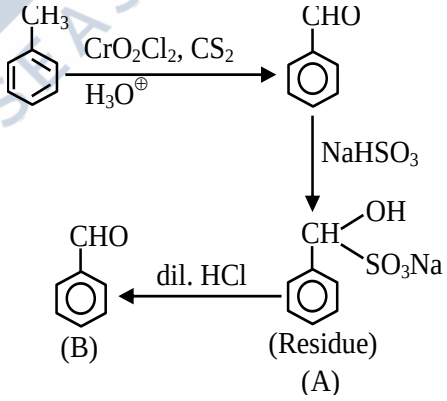
Structure of residue (A) and compound (B)

Formed respectively is :

	[A]	[B]
(1)		
(2)		
(3)		
(4)		

Ans. **(4)**

Sol.



69. Given below are two statements :

Statement (I) : Corrosion is an electrochemical phenomenon in which pure metal acts as an anode and impure metal as a cathode.

Statement (II) : The rate of corrosion is more in alkaline medium than in acidic medium.

In the light of the above statements, choose the **correct** answer from the options given below :

(1) Both Statement I and Statement II are false

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are true

(4) Statement I is true but Statement II is false

Ans. **(4)**

Sol. **Statement I :**

Corrosion is an example of electrochemical phenomenon

In which pure metal act as anode and impure metal (rusted metal) act as cathode.

Statement II :

Corrosion is more favourable in acid medium than alkaline so rate of corrosion is high is acid medium then alkaline.

70. The alkane from below having two secondary hydrogens is :

(1) 4-Ethyl-3,4-dimethyloctane

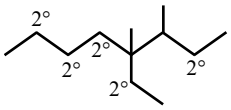
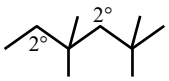
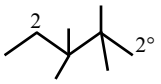
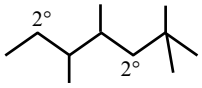
(2) 2,2,4,4-Tetramethylhexane

(3) 2,2,3,3-Tetramethylpentane

(4) 2,2,4,5-Tetramethylheptane

Ans. **(3)**

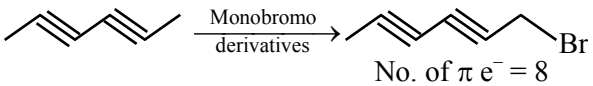
Sol.

Alkane	2°H
1. 	10
2. 	4
3. 	2
4. 	4

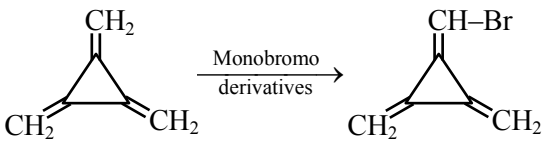
SECTION-B

71. The compound with molecular formula C_6H_6, which gives only one monobromo derivative and takes up four moles of hydrogen per mole for complete hydrogenation has _____ π electrons.

Ans. **Allen Ans. (8 & 6 both)**
NTA Ans. (8)

Sol. 

No. of π e⁻ = 8



N. of π e⁻ = 6

72. Niobium (Nb) and ruthenium (Ru) have "x" and "y" number of electrons in their respective 4d orbitals. The value of x + y is _____

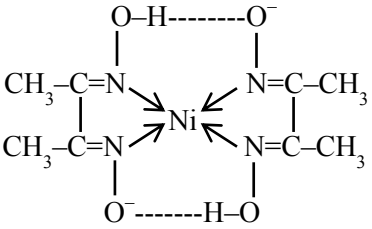
Ans. **(11)**

Sol. Z = 41 → Nb (Niobium) : $[Kr]_{36}\ 4d^4\ 5s^1$
Number of electron in 4d = 4 = x
Z = 44 → Ru (Ruthenium) $[Kr]_{36}\ 4d^7\ 5s^1$
Number of electron in 4d = 7 = y
x + y = 11

73. The complex of Ni^{2+} ion and dimethyl glyoxime contains _____ number of Hydrogen (H) atoms.

Ans. **(14)**

Sol. $[Ni(dmg)_2]$



Number of H-atom = 14

74. Consider the following cases of standard enthalpy of reaction $\left(\Delta H_r^\circ \text{ in kJ mol}^{-1}\right)$

$$C_2H_6(g)+\frac{7}{2}O_2(g)\rightarrow 2CO_2(g)+3H_2O(\ell)\,\Delta H_1^\circ=-1550$$

$$C(\text{graphite})+O_2(g)\rightarrow CO_2(g)\,\Delta H_2^\circ=-393.5$$

$$H_2(g)+\frac{1}{2}O_2(g)\rightarrow H_2O(\ell)\,\Delta H_3^\circ=-286$$

The magnitude of $\Delta H^\circ_{f\,C_2H_6(g)}$ is _____ kJ mol^{-1} (Nearest integer).

Ans. **(95)**

Sol. $2C_{(graphite)} + 3H_2(g) \rightarrow C_2H_6(g)\quad \Delta H_f = ?$

$C_2H_6(g) + \frac{7}{2}\ O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

$\Delta H_1 = -1550$

$C_{(graphite)} + O_2(g) \rightarrow CO_2(g)\quad \Delta H_2 = -393.5$

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(/)\quad \Delta H_3 = -286$

$\Delta H_f = 2\Delta H_2 + 3\Delta H_3 - \Delta H_1$
$= 95$ kJ/mole.

75. 20 mL of 2 M NaOH solution is added to 400 mL of 0.5 M NaOH solution. The final concentration of the solution is _____ × 10^{-2} M. (Nearest integer).

Ans. **(57)**

Sol. $M_F = \frac{M_1V_1 + M_2V_2}{V_1 + V_2}$

$= \frac{2\times 20 + 0.5\times 400}{420} = 0.571$ M

$= 57.1 \times 10^{-2}$ M

$= 57$