JEE–MAIN EXAMINATION – JANUARY 2025

(HELD ON FRIDAY 24th JANUARY 2025) **TIME : 3 : 00 PM TO 6 : 00 PM**

CHEMISTRY — TEST PAPER WITH SOLUTIONS

SECTION-A

51. Based on the data given below:

$E^0_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33V$ $E^0_{Cl_2/Cl^{(-)}} = 1.36V$

$E^0_{MnO_4^-/Mn^{2+}} = 1.51V$ $E^0_{Cr^{3+}/Cr} = -0.74V$

the strongest reducing agent is :

(1) Mn^{2+} (2) Cr

(3) MnO_4^- (4) Cl^-

Ans. (2)

Sol. For strongest reducing agent

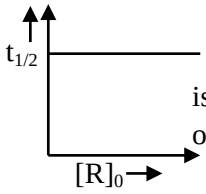
Reduction potential should be lowest

Hence Cr is the strongest reducing agent.

Options (2)

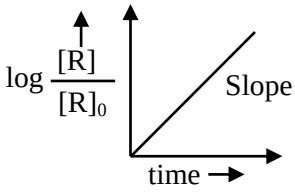
52. Given below are two statements :

Statement(I) :



is valid for first order reaction.

Statement(II) :



is valid for first order reaction

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

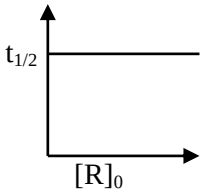
(2) **Statement I** is false but **Statement II** is true

(3) Both **Statement I** and **Statement II** are true

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

Ans. (4)

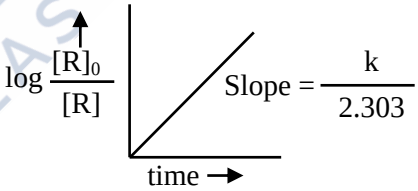
Sol. For first order reaction $t_{1/2} = \frac{\ell n 2}{k}$



For first order reaction

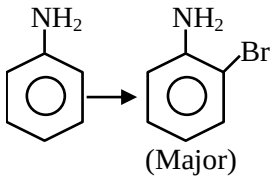
$$\log\frac{[R]_0}{[R]} = \frac{1}{2.303}kt$$

$$\log\frac{[R]_0}{[R]} = \left(\frac{k}{2.303}\right)\times t$$



Options (4)

53. For reaction



(Major)

The correct order of set of reagents for the above conversion is :

(1) $Br_2 \mid FeBr_3, H_2O(\Delta), NaOH$

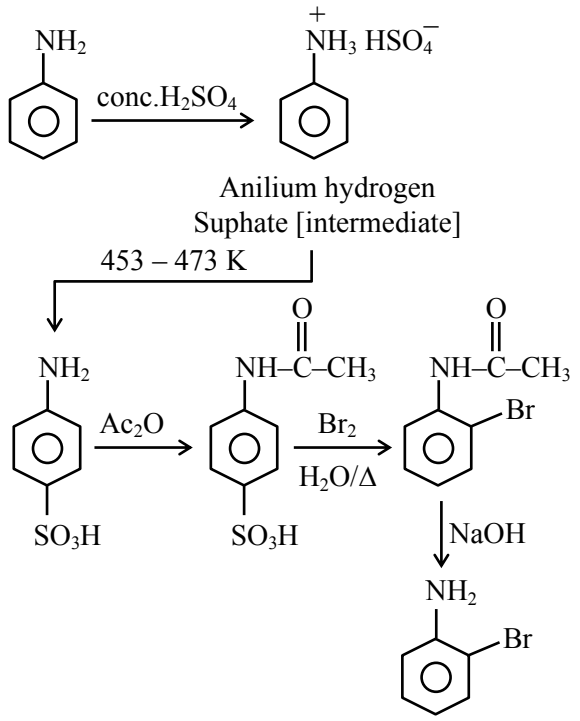
(2) $H_2SO_4, Ac_2O, Br_2, H_2O(\Delta), NaOH$

(3) $Ac_2O, Br_2, H_2O(\Delta), NaOH$

(4) $Ac_2O, H_2SO_4, Br_2, NaOH$

Ans. (2)

Sol.



54. For hydrogen atom, the orbital/s with lowest energy is/are :

(A) 4s (B) $3p_x$

(C) $3d_{x^2-y^2}$ (D) $3d_{z^2}$

(E) $4p_z$

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

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

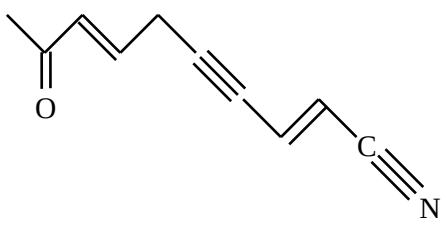
(3) (A) only (4) (B), (C) and (D) only

Ans. (4)

Sol. In hydrogen atom the orbitals in a shell are degenerate means energy depends only on 'n'

$\therefore\ E_{3p_x} = E_{3d_{x^2-y^2}} = E_{3d_{z^2}}$

55. In the given structure, number of sp and sp^2 hybridized carbon atoms present respectively are :

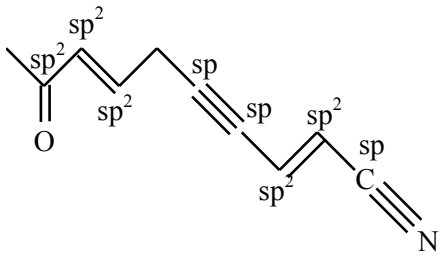


(1) 3 and 6 (2) 3 and 5

(3) 4 and 6 (4) 4 and 5

Ans. (2)

Sol.



Number of sp and sp^2 hybridised carbon atom are 3 and 5.

56. Which of the following mixing of 1M base and 1M acid leads to the largest increase in temperature?

(1) 30 mL HCl and 30 mL NaOH

(2) 30 mL CH_3COOH and 30 mL NaOH

(3) 50 mL HCl and 20 mL NaOH

(4) 45 mL CH_3COOH and 25 mL NaOH

Ans. (1)

Sol. Higher the number of milli moles of acid or base reacted higher will be temperature rise.

Option (4) n_{acid} or n_{base} reacted = 30 m mol

Option (2) n_{acid} or n_{base} reacted = 30 m mol

but less energy will be released by neutralisation reaction of weak acid hence option (2) can not be correct.

Option (3) $\Rightarrow$ 20 m mol

Option (4) $\Rightarrow$ 25 m mol

Hence Correct Option (1)

57. Given below are two statements :

Statement(I) : Experimentally determined oxygen-oxygen bond lengths in the O_3 are found to be same and the bond length is greater than that of a O = O (double bond) but less than that of a single (O – O) bond.

Statement (II) : The strong lone pair-lone pair repulsion between oxygen atoms is solely responsible for the fact that the bond length in ozone is smaller than that of a double bond (O=O) but more than that of a single bond (O – O).

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

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

(2) Both **Statement I** and **Statement II** are true

(3) Both **Statement I** and **Statement II** are false

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

Ans. (1)

Sol. Due to resonance bond length is identical in ozone. Therefore statement I is true and statement II is false

58. Find the compound 'A' from the following reaction sequences.

$$A \xrightarrow{\text{aqua-regia}} B \xrightarrow[(2)AcOH]{(1)KNO_2|NH_4OH} \text{yellow ppt}$$

(1) ZnS (2) CoS

(3) MnS (4) Nis

Ans. **(2)**

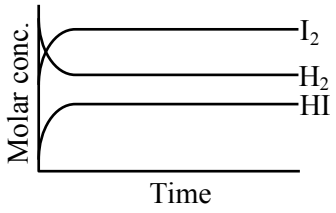
Sol. $CoS \xrightarrow{\text{Aquaregia}} CoCl_2 \xrightarrow[2.\ AcOH]{1.KNO_2/NH_4OH} K_3[Co(NO_2)_6] \downarrow \text{yellow}$

59. For the reaction,

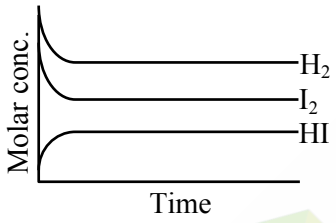
$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

Attainment of equilibrium is predicted correctly by:

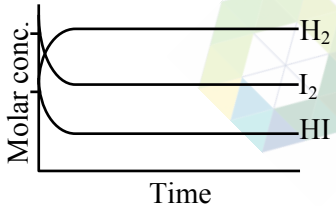
(1)



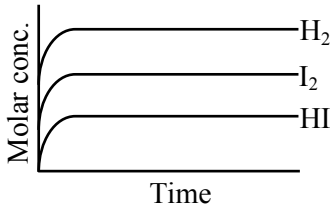
(2)



(3)



(4)



Ans. **(2)**

Sol. $H_2 + I_2 \rightleftharpoons 2HI$

Concentration of H_2 and I_2 decreases untill equilibrium condition and concentration of HI increases till equilibrium condition and after equilibrium concentration of all the reactant and products remain constant.

Correct option (2)

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

List-I (Transition metal ion)	**List-II (Spin only magnetic moment (B.M.))**
(A) Ti^{3+}	(I) 3.87
(B) V^{2+}	(II) 0.00
(C) Ni^{2+}	(III) 1.73
(D) Sc^{3+}	(IV) 2.84

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

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

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

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

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

Ans. **(2)**

Sol. $Sc^{+3} = 3d^0$ $\therefore \mu_{spin} = 0$

$V^{+2} = 3d^3$ $\therefore \mu_{spin} = 3.87$ B.M.

$Ni^{+2} = 3d^8$ $\therefore \mu_{spin} = 2.84$ B.M.

$Ti^{+3} = 3d^1$ $\therefore \mu_{spin} = 1.73$ B.M.

61. The elemental composition of a compound is 54.2%, C, 9.2% H and 36.6% O. If the molar mass of the compound is 132 g mol^{-1}, the molecular formula of the compound is :

[Given : The relative atomic mass of C : H : O = 12 : 1 : 16]

(1) $C_4H_9O_3$ (2) $C_6H_{12}O_6$

(3) $C_6H_{12}O_3$ (4) $C_4H_8O_2$

Ans. **(3)**

Sol.

C	:	H	:	O
$\frac{54.2}{12}$	:	9.2	:	$\frac{36.6}{16}$
4.516	:	9.2	:	2.287
$\frac{4.516}{2.287}$	:	$\frac{9.2}{2.287}$	:	$\frac{2.287}{2.287}$
1.97	:	4.02	:	1

$C_2H_4O \Rightarrow$ Empirical formula

E.F. mass = 24 + 4 + 16 = 44

and molar mass = 132

Hence molecular formula $= (C_2H_4O)_3$

$= C_6H_{12}O_3$

Correct Option (3)

62. When Ethane-1,2-diamine is added progressively to an aqueous solution of Nickel (II) chloride, the sequence of colour change observed will be :

(1) Pale Blue → Blue → Green → Violet

(2) Pale Blue → Blue → Violet → Green

(3) Green → Pale Blue → Blue → Violet

(4) Violet → Blue → Pale Blue → Green

Ans. (3)

Sol.

$[Ni(H_2O)_6]^{+2}_{(aq)} + en_{(aq)} \rightarrow [Ni(H_2O)_4(en)]^{+2}_{(aq)} + 2H_2O$

Green

$[Ni(H_2O)_4(en)]^{+2}_{(aq)} + en_{(aq)} \rightarrow [Ni(H_2O)_2(en)_2]^{+2}_{(aq)} + 2H_2O$

Pale Blue

$[Ni(H_2O)_2(en)]^{+2}_{(aq)} + en_{(aq)} \rightarrow [Ni(en)_3]^{+2}_{(aq)} + 2H_2O$

Blue / purple

63. The conditions and consequence that favours the t_{2g}^3, e_g^1 configuration in a metal complex are :

(1) weak field ligand, high spin complex

(2) strong field ligand, high spin complex

(3) strong field ligand, low spin complex

(4) weak field ligand, low spin complex

Ans. (1)

Sol. For $3d^4$

If ligand is SFL : $t_{2g}^4 e_g^0$ (Low spin)

If ligand is WFL : $t_{2g}^3 e_g^1$ (High spin)

64. Identify correct statement/s :

(A) —OCH_3 and —$NHCOCH_3$ are activating group

(B) —CN and —OH are meta directing group

(C) —CN and —SO_3H are meta directing group

(D) Activating groups act as ortho – and para directing groups

(E) Halides are activating groups

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

(1) (A), (C) and (D) only

(2) (A) , (B) and (E) only

(3) (A) only

(4) (A) and (C) only

Ans. (1)

Sol. (B) –CN is meta directing But –OH is ortho / pera directing.

(E) Halides are deactivating groups.

65. Given below are two statements :

Statement (I) : The first ionization energy of Pb is greater than that of Sn

Statement(II) : The first ionization energy of Ge is greater than that of Si.

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

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

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

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

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

Ans. (1)

Sol. Order of I.E. (in KJ/mol) :

C > Si > Ge > Sn < Pb

1086 786 761 708 715

66. $S(g) + \frac{3}{2} O_2(g) \rightarrow SO_3(g) + 2x$ kcal

$SO_2(g) + \frac{1}{2} O_2(g) \rightarrow SO_3(g) + y$ kcal

The heat of formation of $SO_2(g)$ is given by :

(1) $\frac{2x}{y}$ kcal

(2) y – 2x kcal

(3) 2x + y kcal

(4) x + y kcal

Ans. (2)

Sol. $SO_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow SO_{3(g)} \quad \Delta H = -y$

$\Delta H_r = (\Delta H_f)_{SO_3} - (\Delta H_f)_{SO_2}$

$-y = -2x - (\Delta H_f)_{SO_2}$

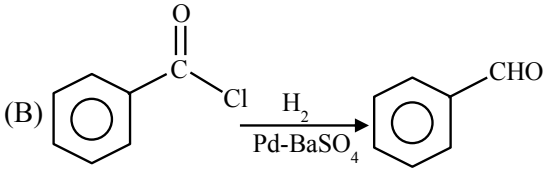
$(\Delta H_f)_{SO_2} = y - 2x$

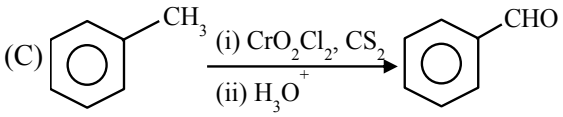
Option (2)

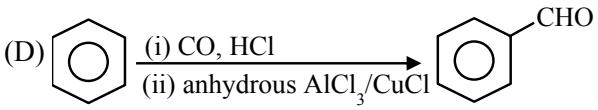
67. Match **List-I** with **List-II**

List-I

(A) $RCN \xrightarrow[(ii)H_3O^+]{(i)SnCl_2,HCl} RCHO$

(B) 

(C) 

(D) 

List-II

(I) Etard reaction

(II) Gatterman –Koch reaction

(III) Rosenmund reduction

(IV) Stephen reaction

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

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

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

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

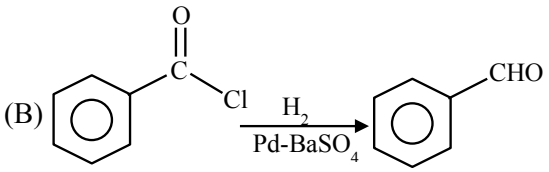
(4) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

Ans. (1)

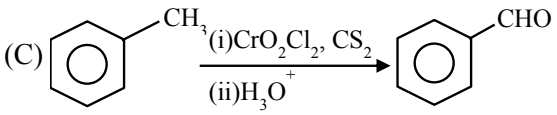
Sol. List-I

(A) $RCN \xrightarrow[(ii)H_3O^+]{(i)SnCl_2,HCl} RCHO$

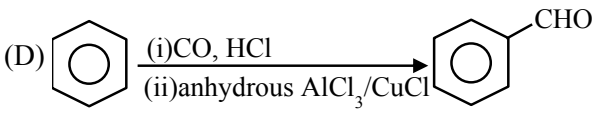
Stephen reaction

(B) 

Rosenmund reduction

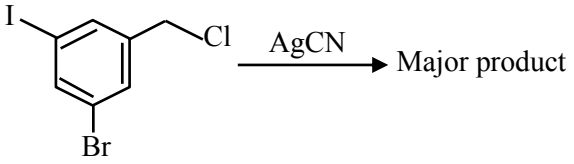
(C) 

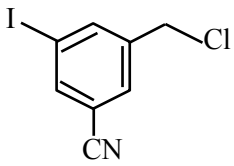
Etard reaction

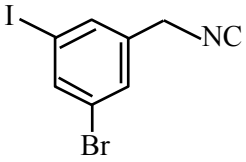
(D) 

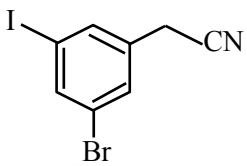
Gatterman –Koch reaction

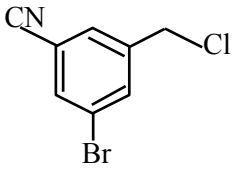
68. The structure of the major product formed in the following reaction is :



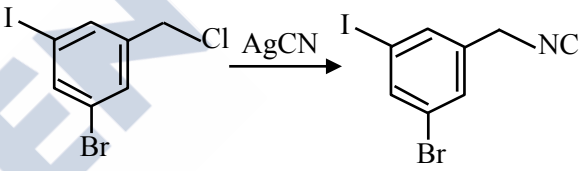
(1) 

(2) 

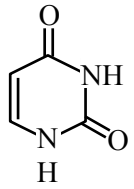
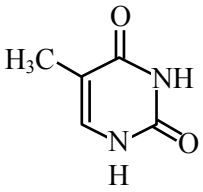
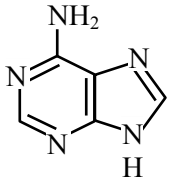
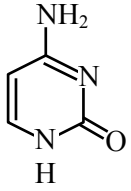
(3) 

(4) 

Ans. (2)

Sol. 

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

	List-I		**List-II**
(A)	Adenine	(I)	
(B)	Cytosine	(II)	
(C)	Thymine	(III)	
(D)	Uracil	(IV)	

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

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

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

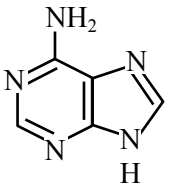
(3) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

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

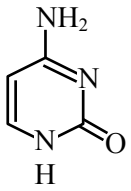
Ans. (1)

Sol.

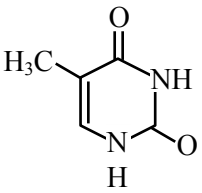
(A) Adenine (III)



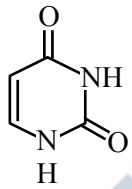
(B) Cytosine (IV)



(C) Thymine (II)



(D) Uracil (I)



70. The successive 5 ionisation energies of an element are 800, 2427, 3658, 25024 and 32824 kJ/mol, respectively. By using the above values predict the group in which the above element is present :

(1) Group 2

(2) Group 13

(3) Group 4

(4) Group 14

Ans. (2)

Sol. The IE_4 is suddenly very high therefore element must have 3 valence e^-(s) and it belong to group 13

SECTION-B

71. The observed and normal masses of compound MX_2 are 65.6 and 164 respectively. The percent degree of ionisation of MX_2 is _____%. (Nearest integer)

Ans. (75)

Sol. $MX_2 \rightarrow M^{+2} + 2X^-$

$$i = \frac{\text{normal molar mass}}{\text{observed molar mass}}$$

$$i = \frac{164}{65.6}$$

$$1 + (3-1)\alpha = \frac{164}{65.6}$$

$$2\alpha = \frac{98.4}{65.6}$$

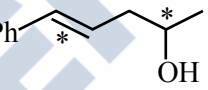
$\alpha = 0.75$

percent dissociation = 75%

Ans. 75

72. The possible number of stereoisomers for 5-phenylpent-4-en-2-ol is _____.

Ans. (4)

Sol. Ph  OH

n (stereogenic unit) = 2, $2^2 = 4$ stereoisomers are possible.

73. Consider a complex reaction taking place in three steps with rate constants k_1, k_2 and k_3 respectively. The overall rate constant k is given by the expression $k = \sqrt{\frac{k_1 k_3}{k_2}}$. If the activation energies of the three steps are 60, 30 and 10 kJ mol^{-1} respectively, then the overall energy of activation in kJ mol^{-1} is _____. (Nearest integer)

Ans. (20)

Sol. $$K = \sqrt{\frac{K_1 K_3}{K_2}}$$

$$A.e^{-Ea/RT} = \sqrt{\frac{A_1 e^{-Ea_1/RT} \times A_3 e^{-Ea_3/RT}}{A_2 e^{-Ea_2/RT}}}$$

By comparinig exponential term

$$\frac{E_a}{RT} = \frac{1}{2} \times \left(\frac{E_{a_1}}{RT} + \frac{E_{a_3}}{RT} - \frac{E_{a_2}}{RT} \right)$$

$$E_a = (E_{a_1} + E_{a_3} - E_{a_2})/2$$

$E_a = (60 + 10 - 30)/2 = 20$ kJ mol^{-1}

Ans. 20

74. The hydrocarbon (X) with molar mass 80 g mol^{-1} and 90% carbon has _____ degree of unsaturation.

Ans. **(3)**

Sol. Mass of carbon = $\frac{80\times90}{100}=72gm$

Number of C-atoms = $\frac{72}{12}=6$

Mass of hydrogen = $\frac{80\times10}{800}=8gm$

Number of H-atoms = $\frac{8}{1}=8$

So molecular formula C_6H_8

D.U. = 6 + 1 –8/2 = 7 – 4 = 3

75. In Carius method of estimation of halogen, 0.25 g of an organic compound gave 0.15 g of silver bromide (AgBr). The percentage of Bromine in the organic compound is _____ × 10^{-1}% (Nearest integer).

(Given : Molar mass of Ag is 108 and Br is 80 g mol^{-1})

Ans. **(255)**

Sol. % Bromine = $\frac{\text{Molar Mass of Bromine}}{\text{Molar Mass of Silver bromide}}$

$\times \frac{\text{Weight of AgBr}}{\text{Weight of sample}}\times100$

$=\frac{80}{188}\times\frac{0.165}{0.25}\times100$

$=\frac{4800}{188}=25.53=255\times10^{-1}$