JEE–MAIN EXAMINATION – JANUARY 2025

(HELD ON WEDNESDAY 29th JANUARY 2025) **TIME : 9 : 00 AM TO 12 : 00 NOON**

CHEMISTRY

TEST PAPER WITH SOLUTION

SECTION-A

51. Total number of nucleophiles from the following is :-

NH_3, PhSH, $(H_3C)_2S$, $H_2C{=}CH_2$, $\overset{\ominus}{O}H$, $H_3O^{\oplus}$, $(CH_3)_2CO$, $\rangle{=}NCH_3$

(1) 5 (2) 4

(3) 7 (4) 6

Ans. **(1)**

Sol. Total five nucleophiles are present

NH_3, PhSH, $(H_3C)_2S$, $CH_2{=}CH_2$, $\overset{\ominus}{O}H$

52. The standard reduction potential values of some of the p-block ions are given below. Predict the one with the strongest oxidising capacity.

(1) $E^{\ominus}_{Sn^{4+}/Sn^{2+}} = +1.15V$ (2) $E^{\ominus}_{Tl^{3+}/Tl} = +1.26V$

(3) $E^{\ominus}_{Al^{3+}/Al} = -1.66V$ (4) $E^{\ominus}_{Pb^{4+}/Pb^{2+}} = +1.67V$

Ans. **(4)**

Sol. Standard reduction potential value (+ve) increases oxidising capacity increases.

53. The molar conductivity of a weak electrolyte when plotted against the square root of its concentration, which of the following is expected to be observed?

(1) A small decrease in molar conductivity is observed at infinite dilution.

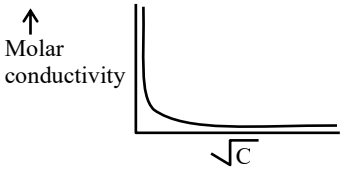
(2) A small increase in molar conductivity is observed at infinite dilution.

(3) Molar conductivity increases sharply with increase in concentration.

(4) Molar conductivity decreases sharply with increase in concentration.

Ans. **(4)**

Sol.



54. At temperature T, compound $AB_{2(g)}$ dissociates as $AB_{2(g)} \rightleftharpoons AB_{(g)} + \frac{1}{2}B_{2(g)}$ having degree of dissociation x (small compared to unity). The correct expression for x in terms of K_p and p is

(1) $\sqrt[3]{\frac{2K_p}{p}}$ (2) $\sqrt[4]{\frac{2K_p}{p}}$

(3) $\sqrt[3]{\frac{2K_p^2}{p}}$ (4) $\sqrt{K_p}$

Ans. **(3)**

Sol. $AB_{2(g)} \rightleftharpoons AB_{(g)} + \frac{1}{2}B_{2(g)}$

$$t_{eq.}\ \frac{(1-x)}{1+\frac{x}{2}}P\ \ \frac{xP}{1+\frac{x}{2}}\ \ \frac{\left(\frac{x}{2}\right)P}{1+\frac{x}{2}}$$

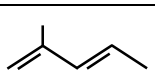
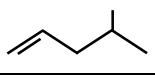
$\Rightarrow x << 1 \Rightarrow 1+\frac{x}{2} \simeq 1$ and $1 - x \simeq 1$

$$\Rightarrow k_P = \frac{(xp).\left(\frac{xp}{2}\right)^{\frac{1}{2}}}{P}$$

$$\Rightarrow k_P^2 = x^2.\frac{xP}{2}$$

$$x = \sqrt[3]{\frac{2k_P^2}{P}}$$

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

List-I (Structure)		List-II (IUPAC Name)	
(A)	$H_3C{-}CH_2{-}\underset{C_2H_5}{CH}{-}CH_2{-}\underset{CH_3}{CH}{-}C_2H_5$	(I)	4-Methylpent-1-ene
(B)	$(CH_3)_2C(C_3H_7)_2$	(II)	3-Ethyl-5-methylheptane
(C)		(III)	4,4-Dimethylheptane
(D)		(IV)	2-Methyl-1,3-pentadiene

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

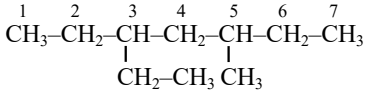
(1) (A)-(III), (B)-(II), (C)-(IV), (D)-(I)

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

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

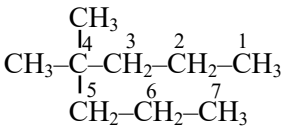
(4) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

Ans. (3)

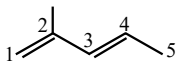
Sol. (A) 

3-Ethyl-5-methylheptane

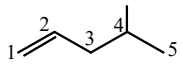
(B) $(CH_3)_2C(C_3H_7)_2$



4, 4-Dimethylheptane

(C) 

2-Methyl-1, 3-pentadiene

(D) 

4-Methylpent-1-ene

56. Choose the **correct** statements.

(A) Weight of a substance is the amount of matter present in it.

(B) Mass is the force exerted by gravity on an object.

(C) Volume is the amount of space occupied by a substance.

(D) Temperatures below 0°C are possible in Celsius scale, but in Kelvin scale negative temperature is not possible.

(E) Precision refers to the closeness of various measurements for the same quantity.

(1) (B), (C) and (D) Only

(2) (A), (B) and (C) Only

(3) (A), (D) and (E) Only

(4) (C), (D) and (E) Only

Ans. (4)

Sol. Theory based

57. The correct increasing order of stability of the complexes based on Δ_o value is :

(I) $[Mn(CN)_6]^{3-}$ (II) $[Co(CN)_6]^{4-}$

(III) $[Fe(CN)_6]^{4-}$ (IV) $[Fe(CN)_6]^{3-}$

(1) II < III < I < IV (2) IV < III < II < I

(3) I < II < IV < III (4) III < II < IV < I

Ans. (3)

Sol. (I) $[Mn(CN)_6]^{3-}$ $-1.6\ \Delta_o$

(II) $[Co(CN)_6]^{4-}$ $-1.8\ \Delta_o$

(III) $[Fe(CN)_6]^{4-}$ $-2.4\ \Delta_o$

(IV) $[Fe(CN)_6]^{3-}$ $-2.0\ \Delta_o$

I < II < IV < III

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

List-I (Complex)		**List-II (Hybridisation & Magnetic characters)**	
(A)	$[MnBr_4]^{2-}$	(I)	d^2sp^3 & diamagnetic
(B)	$[FeF_6]^{3-}$	(II)	sp^3d^2 & paramagnetic
(C)	$[Co(C_2O_4)_3]^{3-}$	(III)	sp^3 & diamagnetic
(D)	$[Ni(CO)_4]$	(IV)	sp^3 & paramagnetic

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

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

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

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

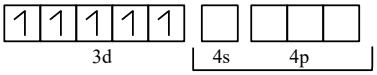
(4) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)

Ans. (4)

Sol. **(A) $[MnBr_4]^{2-}$**

$Mn^{+2} \Rightarrow [Ar]\ 3d^5$

In presence of ligand field

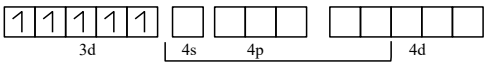
$\Rightarrow$ [Ar] 

$\Rightarrow sp^3$ hybridization, paramagnetic in nature

(B) $[FeF_6]^{3-}$

$Fe^{+3} \Rightarrow [Ar]\ 3d^5$

In presence of ligand field

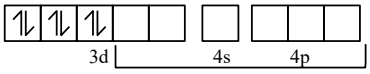
$\Rightarrow$ [Ar] 

$\Rightarrow sp^3d^2$ hybridization, paramagnetic in nature

(C) $[Co(C_2O_4)_3]^{3-}$

$Co^{+3} \Rightarrow [Ar]\ 3d^6$

In presence of ligand field

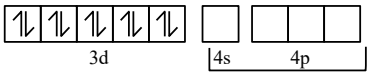
$\Rightarrow$ [Ar] 

$\Rightarrow d^2sp^3$ hybridization, diamagnetic in nature

(D) $[Ni(CO)_4]$

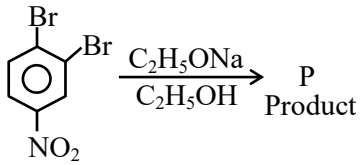
$Ni^0 \Rightarrow [Ar]\ 3d^8 4s^2$

In presence of ligand field

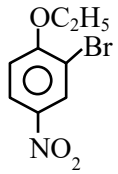
$\Rightarrow$ [Ar] 

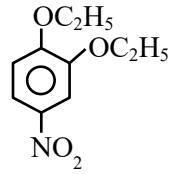
$\Rightarrow sp^3$ hybridization, diamagnetic in nature

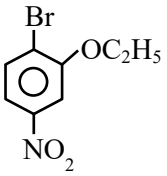
59. In the following substitution reaction :

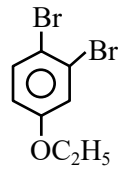


Product 'P' formed is :

(1) 

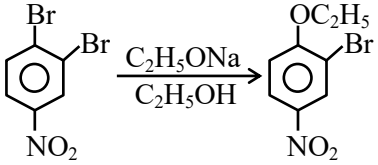
(2) 

(3) 

(4) 

Ans. (1)

Sol. It is an example of nucleophillic Aromatic substitution reaction.



60. For a Mg | Mg^{2+} (aq) || Ag^+(aq) | Ag the correct Nernst Equation is :

(1) $E_{cell} = E^o_{cell} - \frac{RT}{2F} \ln \frac{[Ag^+]}{[Mg^{2+}]}$

(2) $E_{cell} = E^o_{cell} + \frac{RT}{2F} \ln \frac{[Ag^+]^2}{[Mg^{2+}]}$

(3) $E_{cell} = E^o_{cell} - \frac{RT}{2F} \ln \frac{[Mg^{2+}]}{[Ag^+]}$

(4) $E_{cell} = E^o_{cell} - \frac{RT}{2F} \ln \frac{[Ag^+]^2}{[Mg^{2+}]}$

Ans. (2)

Sol. According to Nernst equation :-

$$E = E° - \frac{RT}{nF} \ln Q.$$

Cell reaction :-

$$Mg_{(s)} + 2Ag^+_{(aq)} \rightleftharpoons 2Ag_{(s)} + Mg^{+2}_{(aq)}$$

$$\Rightarrow Q = \frac{[Mg^{+2}]}{[Ag^+]^2}$$

$$\Rightarrow E = E^o_{Cell} - \frac{RT}{2F} \ln \left[\frac{[Mg^{+2}]}{[Ag^+]^2}\right]$$

61. The correct option with order of melting points of the pairs (Mn, Fe), (Tc, Ru) and (Re, Os) is :

(1) Fe < Mn, Ru < Tc and Re < Os

(2) Mn < Fe, Tc < Ru and Re < Os

(3) Mn < Fe, Tc < Ru and Os < Re

(4) Fe < Mn, Ru < Tc and Os < Re

Ans. (3)

Sol. M.P. $\Rightarrow$ Mn < Fe, Tc < Ru, Os < Re

NCERT based

62. 1.24 g of AX_2 (molar mass 124 g mol^{-1}) is dissolved in 1 kg of water to form a solution with boiling point of 100.0156°C, while 25.4 g of AY_2 (molar mass 250 g mol^{-1}) in 2 kg of water constitutes a solution with a boiling point of 100.0260°C.

$K_b(H_2O) = 0.52$ K kg mol^{-1}

Which of the following is **correct** ?

(1) AX_2 and AY_2 (both) are completely unionised.

(2) AX_2 and AY_2 (both) are fully ionised.

(3) AX_2 is completely unionised while AY_2 is fully ionised.

(4) AX_2 is fully ionised while AY_2 is completely unionised.

Ans. (4)

Sol. For AX_2 :- $\Delta T_b = K_b \times m \times i$

$$0.0156 = 0.52 \times \frac{0.01}{1} \times i_{AX_2}$$

$$\Rightarrow i_{AX_2} = 3 \quad \Rightarrow \text{complete ionisation}$$

For AY_2 :- $\Delta T_b = K_b \times m \times i$

$$0.026 = 0.52 \times 0.0508 \times i_{AY_2}$$

$$\Rightarrow i_{AY_2} \backsimeq 1 \ \therefore \text{complete unionisation}$$

63. 500 J of energy is transferred as heat to 0.5 mol of Argon gas at 298 K and 1.00 atm. The final temperature and the change in internal energy respectively are :

Given : $R = 8.3\ J\ K^{-1}\ mol^{-1}$

(1) 348 K and 300 J (2) 378 K and 300 J

(3) 368 K and 500 J (4) 378 K and 500 J

NTA Ans. (4)

Sol. $q_p = n \times c_p \times \Delta T$

$$\Rightarrow 500 = 0.5 \times \frac{5}{2} \times 8.3\ (T_f - 298)$$

$$\Rightarrow T_f \backsimeq 346.2K$$

$$\frac{\Delta H}{\Delta U} = \frac{C_p}{C_v} = \left(\frac{5}{3}\right)$$

$$\Rightarrow \Delta U = \frac{3}{5} \times 500 = 300\ J$$

64. The reaction $A_2 + B_2 \rightarrow 2\ AB$ follows the mechanism

$$A_2 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} A + A(\text{fast})$$

$$A + B_2 \xrightarrow{k_2} AB + B\ (\text{slow})$$

$$A + B \rightarrow AB\ (\text{fast})$$

The overall order of the reaction is :

(1) 1.5 (2) 3

(3) 2.5 (4) 2

Ans. (1)

Sol. $\text{rate} = k_2[A][B_2]$ .....(1)

$$\left(\frac{k_1}{k_{-1}}\right) = \left(\frac{[A]^2}{[A_2]}\right)$$

$$\Rightarrow [A] = \sqrt{\frac{k_1}{k_{-1}}} . \sqrt{[A_2]}$$

Substituting in (1) ; we get

$$\text{Rate} = k_2 \sqrt{\frac{k_1}{k_{-1}}} . [A_2]^{\frac{1}{2}} . [B_2]$$

$$\therefore \text{order} = \left(\frac{3}{2}\right) = 1.5$$

65. If a_0 is denoted as the Bohr radius of hydrogen atom, then what is the de-Broglie wavelength (λ) of the electron present in the second orbit of hydrogen atom ? [n : any integer]

(1) $\frac{2a_0}{n\pi}$ (2) $\frac{8\pi a_0}{n}$

(3) $\frac{4\pi a_0}{n}$ (4) $\frac{4n}{\pi a_0}$

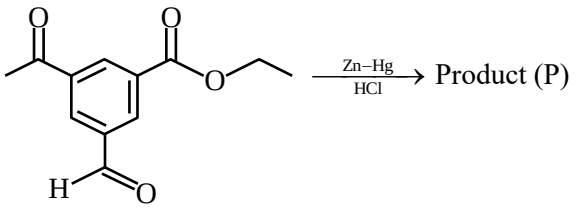
Ans. (2)

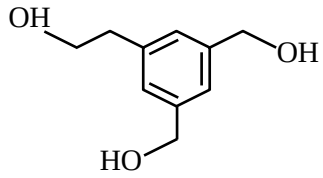
Sol. $2\pi r_n = n\lambda$

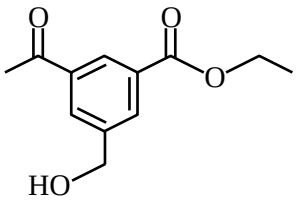
$$2\pi . (4a_0) = n\lambda$$

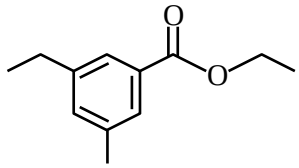
$$= \lambda = \frac{8\pi a_0}{n}$$

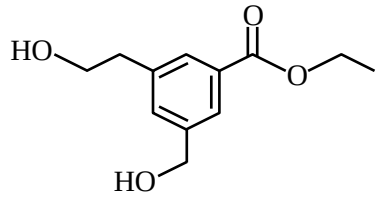
66. The product (P) formed in the following reaction is :



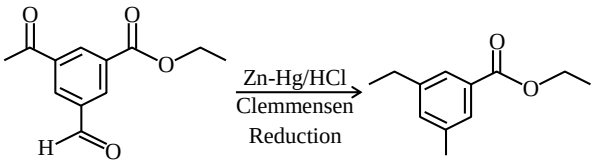
(1) 

(2) 

(3) 

(4) 

Ans. **(3)**

Sol. 

67. An element 'E' has the ionisation enthalpy value of 374 kJ mol^{-1}. 'E' reacts with elements A, B, C and D with electron gain enthalpy values of –328, –349, –325 and –295 kJ mol^{-1}, respectively.

The correct order of the products EA, EB, EC and ED in terms of ionic character is :

(1) EB > EA > EC > ED

(2) ED > EC > EA > EB

(3) EA > EB > EC > ED

(4) ED > EC > EB > EA

Ans. **(1)**

Sol. Difference between I.E. & E.G.E increases, ionic character increases.

68. Match **List – I** with **List – II**.

	List – I (Carbohydrate)		**List – II (Linkage Source)**
(A)	Amylose	(I)	β-C_1-C_4, plant
(B)	Cellulose	(II)	α-C_1-C_4, animal
(C)	Glycogen	(III)	α-C_1-C_4, α-C_1-C_6, plant
(D)	Amylopectin	(IV)	α-C_1-C_4, plant

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

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

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

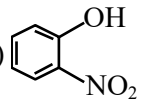
(3) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

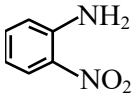
(4) (A)-(IV), (B)-(I), (C)-(III), (D)-(II)

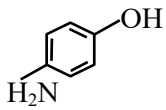
Ans. **(2)**

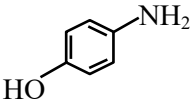
Sol. Informative

69. The steam volatile compounds among the following are :

(A) 

(B) 

(C) 

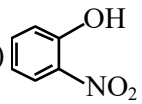
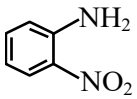
(D) 

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

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

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

Ans. **(3)**

Sol. (A)  & (B)  are steam volatile due to intramolecular hydrogen bonding.

70. Given below are two statements :

Statement (I) : The radii of isoelectronic species increases in the order.

$Mg^{2+} < Na^{+} < F^{-} < O^{2-}$

Statement (II) : The magnitude of electron gain enthalpy of halogen decreases in the order.

Cl > F > Br > I

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

(1) **Statement I** is incorrect but **Statement II** is correct

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

(3) **Statement I** is correct but **Statement II** is incorrect

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

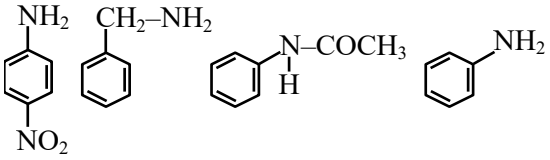
Ans. (4)

Sol. (i) For isoelectronic species –ve charge increases, radii increases.

(ii) Magnitude of E.G.E : Cl > F > Br > I

SECTION-B

71. Given below are some nitrogen containing compounds.

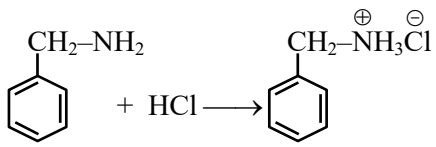


Each of them is treated with HCl separately. 1.0 g of the most basic compound will consume _____mg of HCl.

(Given molar mass in g mol^{-1} C:12, H : 1, O : 16, Cl : 35.5)

Ans. (341)

Sol. Benzyl Amine is most basic due to localised lone pair.



(Benzyl Amine)

Mole of benzyl Amine $\Rightarrow \frac{1}{107} = 0.00934$ mole

1 Mole of Benzyl amine consumed 1 mole of HCl

So, Mole of HCl consumed $\rightarrow$ 0.00934 mole

Mass of HCl consumed $\rightarrow$ 0.00934 × molar mass of HCl

= 0.00934 × 36.5

= 0.341 gm

= 341 mg

72. The molar mass of the water insoluble product formed from the fusion of chromite ore ($FeCr_2O_4$) with Na_2CO_3 in presence of O_2 is _____g mol^{-1}.

Ans. (160)

Sol. $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$

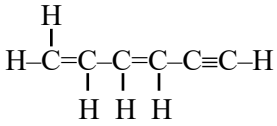
Fe_2O_3 is water insoluble, so its molar mass

$\Rightarrow [2 \times 56 + 3 \times 16] \Rightarrow 160$ g/mol

73. The sum of sigma (σ) and pi(π) bonds in Hex-1,3-dien-5-yne is _____.

Ans. (15)

Sol.



Number of σ bond = 11

Number of π bond = 4

σ + π = 11 + 4 = 15

74. If A_2B is 30% ionised in an aqueous solution, then the value of van't Hoff factor (i) is _____$\times 10^{-1}$.

Ans. (16)

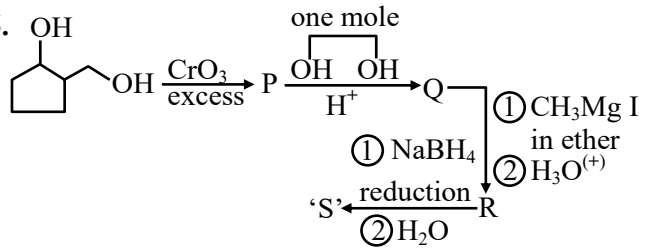
Sol. $A_2B \rightarrow 2A^+ + B^{-2}$; y = 3

$\alpha = 0.3$

$i = 1 + (y - 1)\alpha$

$= 1 + (3 - 1)\ (0.3) = 1.6 = 16 \times 10^{-1}$

75.

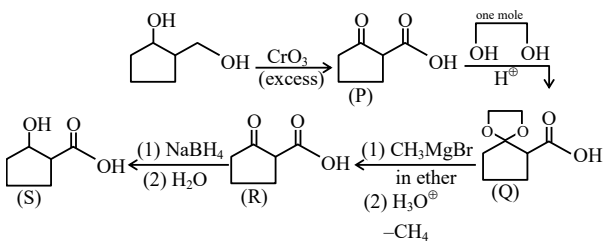


0.1 mole of compound 'S' will weigh_____g.

(Given molar mass in g mol^{-1} C:12, H:1, O:16)

Ans. (13)

Sol.



0.1 mole of compound (S) weight in gm

= 0.1 × molar mass of compound (S)

= 0.1 × 130 = 13 gm