FINAL JEE–MAIN EXAMINATION – APRIL, 2024

(Held On Monday 08th April, 2024) **TIME : 3 : 00 PM to 6 : 00 PM**

CHEMISTRY — TEST PAPER WITH SOLUTION

SECTION-A

61. In qualitative test for identification of presence of phosphorous, the compound is heated with an oxidising agent. Which is further treated with nitric acid and ammonium molybdate respectively. The yellow coloured precipitate obtained is :

(1) $Na_3PO_4.12MoO_3$

(2) $(NH_4)_3PO_4.12(NH_4)_2MoO_4$

(3) $(NH_4)_3PO_4.12MoO_3$

(4) $MoPO_4.21NH_4NO_3$

Ans. **(3)**

Sol. $\underset{\text{Or } HPO_4^-}{PO_4^{3-}} + \underset{\text{Ammonium Molybdate}}{(NH_4)_2MoO_4} \xrightarrow{H^+} \underset{\text{Canary yellow ppt. (Ammonium phopho molybdate)}}{(NH_4)_3PO_4.12MoO_3\downarrow}$

62. For a reaction $A \xrightarrow{K_1} B \xrightarrow{K_2} C$

If the rate of formation of B is set to be zero then the concentration of B is given by :

(1) $K_1K_2[A]$ (2) $(K_1 - K_2)[A]$

(3) $(K_1 + K_2)[A]$ (4) $(K_1/K_2)[A]$

Ans. **(4)**

Sol. Rate of formation of B is

$$\frac{d[B]}{dt} = k_1[A] - k_2[B]$$

$$0 = k_1[A] - k_2[B]$$

$$\left(\frac{k_1}{k_2}\right)[A] = [B]$$

63. When ψ_A and Ψ_B are the wave functions of atomic orbitals, then σ^* is represented by :

(1) $\psi_A - 2\psi_B$ (2) $\psi_A - \psi_B$

(3) $\psi_A + 2\psi_B$ (4) $\psi_A + \psi_B$

Ans. **(2)**

Sol. Antibonding molecular orbitals are formed by destructive interference of wave functions.

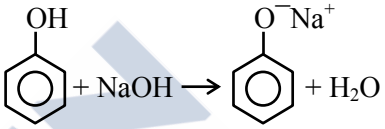
(ABMO) $\sigma^* = \psi_A - \psi_B$

64. Which one the following compounds will readily react with dilute NaOH?

(1) $C_6H_5CH_2OH$ (2) C_2H_5OH

(3) $(CH_3)_3COH$ (4) C_6H_5OH

Ans. **(4)**

Sol. 

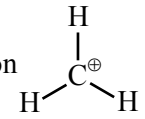
Stronger ACID than H_2O

65. The shape of carbocation is :

(1) trigonal planar (2) diagonal pyramidal

(3) tetrahedral (4) diagonal

Ans. **(1)**

Sol. Carbocation 

Trigonal planar

66. Given below are two statements :

Statement (I) : S_N2 reactions are 'stereospecific', indicating that they result in the formation only one stereo-isomers as the product.

Statement (II) : S_N1 reactions generally result in formation of product as racemic mixtures. 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) **Statement I** is false but **Statement II** is true

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

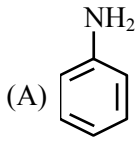
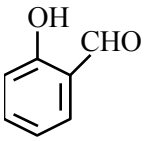
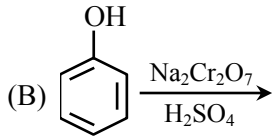
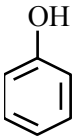
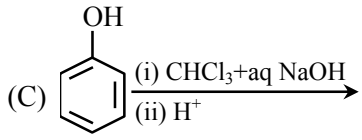
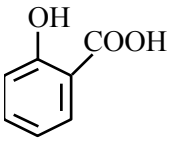
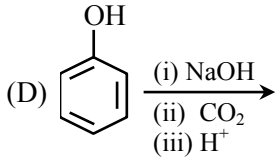
(4) Both **Statement I** and **Statement II** is false

Ans. **(3)**

Sol. $SN^2 \rightarrow$ Inversion

$SN^1 \rightarrow$ Racemisation

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

List-I (Reactions)	**List-II (Products)**
(A) 	(I) 
(B) 	(II) 
(C) 	(III) 
(D) 	(IV) 

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

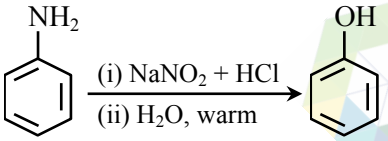
(1) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

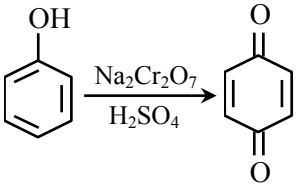
(2) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

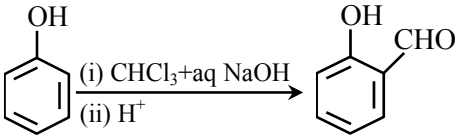
(3) (A)-(I), (B)-(IV), (C)-(II), (D)-(III)

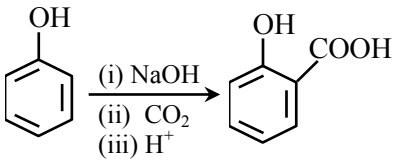
(4) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)

Ans. **(4)**

Sol. 







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

List-I (Test)	**List-II (Identification)**
(A) Bayer's test	(I) Phenol
(B) Ceric ammonium nitrate test	(II) Aldehyde
(C) Phthalein dye test	(III) Alcoholic-OH group
(D) Schiff's test	(IV) Unsaturation

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

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

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

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

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

Ans. **(4)**

Sol. (A) Bayer's test → Unsaturation

(B) Ceric ammonium nitrate test → Alcoholic-OH group

(C) Phthalein dye test → Phenol

(D) Schiff's test → Aldehyde

69. Identify the **incorrect** statements about group 15 elements :

(A) Dinitrogen is a diatomic gas which acts like an inert gas at room temperature.

(B) The common oxidation states of these elements are –3, +3 and +5.

(C) Nitrogen has unique ability to form pπ–pπ multiple bonds.

(D) The stability of +5 oxidation states increases down the group.

(E) Nitrogen shows a maximum covalency of 6.

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

(1) (A), (B), (D) only (2) (A), (C), (E) only

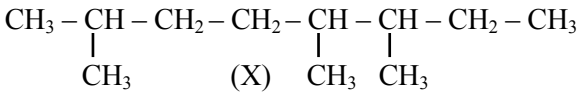
(3) (B), (D), (E) only (4) (D) and (E) only

Ans. **(4)**

Sol. (D) Due to inert pair effect lower oxidation state is more stable.

(E) Nitrogen belongs to 2nd period and cannot expand its octet.

70. IUPAC name of following hydrocarbon (X) is :



(1) 2-Ethyl-3,6-dimethylheptane

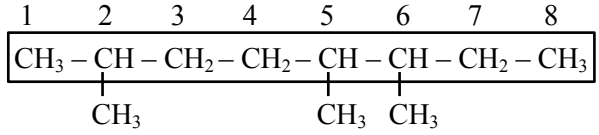
(2) 2-Ethyl-2,6-diethylheptane

(3) 2,5,6-Trimethyloctane

(4) 3,4,7-Trimethyloctane

Ans. **(3)**

Sol.



2,5,6-Trimethyloctane

71. The equilibrium $Cr_2O_7^{2-} \rightleftharpoons 2CrO_4^{2-}$ is shifted to the right in :

(1) an acidic medium

(2) a basic medium

(3) a weakly acidic medium

(4) a neutral medium

Ans. **(2)**

Sol. $Cr_2O_7^{2-} \underset{H^+}{\overset{OH^-}{\rightleftharpoons}} 2CrO_4^{2-}$

72. Given below are two statements :

Statement (I) : A Buffer solution is the mixture of a salt and an acid or a base mixed in any particular quantities.

Statement (II) : Blood is naturally occurring buffer solution whose pH is maintained by H_2CO_3 / $HCO_3^{\ominus}$ concentrations.

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** is true

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

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

Ans. **(1)**

Sol. Buffer solution is a mixture of either weak acid / weak base and its respective conjugate.

Blood is a buffer solution of carbonic acid H_2CO_3 and bicarbonate HCO_3^-

Statement 1 is false but Statement II is true.

73. The correct sequence of acidic strength of the following aliphatic acids in their decreasing order is :

CH_3CH_2COOH, CH_3COOH, $CH_3CH_2CH_2COOH$, HCOOH

(1) HCOOH > CH_3COOH > CH_3CH_2COOH > $CH_3CH_2CH_2COOH$

(2) HCOOH > $CH_3CH_2CH_2COOH$ > CH_3CH_2COOH > CH_3COOH

(3) $CH_3CH_2CH_2COOH$ > CH_3CH_2COOH > CH_3COOH > HCOOH

(4) CH_3COOH > CH_3CH_2COOH > $CH_3CH_2CH_2COOH$ > HCOOH

Ans. **(1)**

Sol. CH_3CH_2COOH, CH_3COOH, $CH_3CH_2CH_2COOH$, HCOOH

The correct order is :

HCOOH > CH_3COOH > CH_3CH_2COOH > $CH_3CH_2CH_2COOH$

74. Given below are two statements :

Statement (I) : All the following compounds react with p-toluenesulfonyl chloride.

$C_6H_5NH_2$ $(C_6H_5)_2NH$ $(C_6H_5)_3N$

Statement (II) : Their products in the above reaction are soluble in aqueous NaOH.

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

(1) Both **Statement I** and **Statement II** is false

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

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

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

Ans. **(1)**

Sol. Hinsberg test given by 1° amine only.

75. The emf of cell $Tl\left|\underset{(0.001M)}{Tl^+}\right\|\left|\underset{(0.01M)}{Cu^{2+}}\right|Cu$ is 0.83 V at 298 K. It could be increased by :

(1) increasing concentration of Tl^+ ions

(2) increasing concentration of both Tl^+ and Cu^{2+} ions

(3) decreasing concentration of both Tl^+ and Cu^{2+} ions

(4) increasing concentration of Cu^{2+} ions

Ans. (4)

Sol.

Anodic Reaction	$\left[T\ell_{(s)} \rightarrow T\ell^{+}_{(aq)} + e^{-}\right]2$
Cathodic Reaction	$Cu^{+2}_{(aq)} + 2e^{-} \rightarrow Cu_{(s)}$
Overall Redox Reaction	$2T\ell_{(s)} + Cu^{+2}_{(aq)} \rightarrow 2T\ell^{+}_{(aq)} + Cu_{(s)}$

$$E_{cell} = E^{o}_{cell} - \frac{0.0591}{2}\log\frac{\left[T\ell^{+}\right]^2}{\left[Cu^{+2}\right]}$$

E_{cell} increases by increasing concentration of $[Cu^{+2}]$ ions.

76. Identify the correct statements about p-block elements and their compounds.

(A) Non metals have higher electronegativity than metals.

(B) Non metals have lower ionisation enthalpy than metals.

(C) Compounds formed between highly reactive nonmetals and highly reactive metals are generally ionic.

(D) The non-metal oxides are generally basic in nature.

(E) The metal oxides are generally acidic or neutral in nature.

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

(3) (B) and (E) only (4) (B) and (D) only

Ans. (2)

Sol. As electronegativity increases non-metallic nature increases.

Along the period ionisation energy increases.

High electronegativity difference results in ionic bond formation.

Oxides of metals are generally basic and that of non-metals are acidic in nature.

77. Given below are two statements :

Statement (I) : Kjeldahl method is applicable to estimate nitrogen in pyridine.

Statement (II) : The nitrogen present in pyridine can easily be converted into ammonium sulphate in Kjeldahl method.

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

(1) Both **Statement I** and **Statement II** is false

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

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

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

Ans. (1)

Sol. Nitrogen present in pyridine can not be estimated by Kjeldahl method as the nitrogen present in pyridine can not be easily converted into ammonium sulphate.

78. The reaction ;

$$\frac{1}{2}H_{2(g)} + AgCl_{(s)} \rightarrow H^{+}_{(aq)} + Cl^{-}_{(aq)} + Ag_{(s)}$$

occurs in which of the following galvanic cell :

(1) $Pt\left|H_{2(g)}\right|HCl_{(soln.)}\left|AgCl_{(s)}\right|Ag$

(2) $Pt\left|H_{2(g)}\right|HCl_{(soln.)}\left|AgNO_{3(aq)}\right|Ag$

(3) $Pt\left|H_{2(g)}\right|KCl_{(soln.)}\left|AgCl_{(s)}\right|Ag$

(4) $Ag\left|AgCl_{(s)}\right|KCl_{(soln.)}\left|AgNO_{3(aq.)}\right|Ag$

Ans. (3)

Sol. Anodic half cell

Gas – gas ion electrode

$$\frac{1}{2}H_{2(g)} \rightarrow H^{+}_{(aq)} + e^{-}$$

Cathodic Reaction

Metal-metal insoluble salt anion electrode

$$Ag^{+}_{(aq)} + e^{-} \rightarrow Ag_{(s)}$$

$$AgCl_{(s)} \rightleftharpoons Ag^{+}_{(aq)} + Cl^{-}_{(aq)}$$

$$AgCl_{(s)} + e^{-} \rightarrow Ag_{(s)} + Cl^{-}_{(aq)}$$

Overall redox reaction

$$\frac{1}{2}H_{2(g)} + AgCl_{(s)} \rightarrow H^{+}_{(aq)} + Cl^{-}_{(aq)} + Ag_{(s)}$$

Cell Representation

$$Pt\,|\,H_{2(g)}\,|\,kCl_{(sol)}\,|\,AgCl_{(s)}\,|\,Ag$$

79. Given below are two statements :

Statement (I) : Fusion of MnO_2 with KOH and an oxidising agent gives dark green K_2MnO_4.

Statement (II) : Manganate ion on electrolytic oxidation in alkaline medium gives permanganate ion.

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

(1) Both **Statement I** and **Statement II** is true

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

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

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

Ans. (1)

Sol. $MnO_2 + 4KOH + O_2 \xrightarrow{\text{fused}} 2K_2MnO_4 + 2H_2O$

Dark green

Electrolytic oxidation in alkaline medium :

At anode :

$$MnO_4^{2-} \rightarrow MnO_4^{-} + e^{-}$$

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

	List-I (Complex ion)	**List-II (Spin only magnetic moment in B.M.)**
(A)	$[Cr(NH_3)_6]^{3+}$	(I) 4.90
(B)	$[NiCl_4]^{2-}$	(II) 3.87
(C)	$[CoF_6]^{3-}$	(III) 0.0
(D)	$[Ni(CN)_4]^{2-}$	(IV) 2.83

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

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

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

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

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

Ans. (3)

Sol. (A) $[Cr(NH_3)_6]^{3+}$

$Cr^{3+} : 3d^3$

n = 3 (unpaired electrons)

$\mu \simeq 3.87$ B.M. (II)

(B) $[NiCl_4]^{2-}$

$Ni^{2+} : 3d^8$

n = 2

$\mu \simeq 2.83$ B.M. (IV)

(C) $[CoF_6]^{3-}$

$Co^{3+} : 3d^6$

n = 4

$\mu \simeq 4.90$ B.M. (I)

(D) $[Ni(CN)_4]^{2-}$

$Ni^{2+} : 3d^8$

n = 0

$\mu = 0$ B.M. (III)

SECTION-B

81. $\Delta_{vap}H^{\ominus}$ for water is +40.49 kJ mol^{-1} at 1 bar and 100°C. Change in internal energy for this vapourisation under same condition is _____ kJ mol^{-1}. (Integer answer)

(Given R = 8.3 JK^{-1} mol^{-1})

Ans. (38)

Sol. $H_2O(\ell) \rightleftharpoons H_2O(g) \qquad \Delta H^0_{vap} = 40.79\,kJ/mole$

$\Delta H^0_{vap} = \Delta U^0_{vap} + \Delta n_g RT$

$40.79 = \Delta U^0_{vap} + \frac{1\times 8.3\times 373.15}{1000}$

$\Delta U^0_{vap} = 40.79 - 3.0971$

$= 37.6929$

$\Delta U^0_{vap} \simeq 38$

82. Number of molecules having bond order 2 from the following molecule is _____.

C_2, O_2, Be_2, Li_2, Ne_2, N_2, He_2

Ans. (2)

Sol. C_2

$(12e^-) : \sigma1s^2,\sigma^*1s^2,\sigma2s^2,\sigma^*2s^2\left[\pi2p_x^2 = \pi2p_y^2\right]$

$B.O. = \frac{8-4}{2} = 2$

O_2

$(16e^-) : \sigma1s^2,\sigma^*1s^2,\sigma2s^2,\sigma^*2s^2,\sigma2pz^2$

$\left[\pi2p_x^2 = \pi2p_y^2\right]\left[\pi^*2p_x^1 = \pi^*2p_y^1\right]$

$B.O. = \frac{10-6}{2} = 2$

Be_2

$(8e^-) : \sigma1s^2,\sigma^*1s^2,\sigma2s^2,\sigma^*2s^2$

$B.O. = \frac{4-4}{2} = 0$

Li_2

$(6e^-) : \sigma1s^2,\sigma^*1s^2,\sigma2s^2$

$B.O. = \frac{4-2}{2} = 1$

Ne_2

$(20e^-) : \sigma1s^2,\sigma^*1s^2,\sigma2s^2,\sigma^*2s^2,\sigma2pz^2$

$\left[\pi2p_x^2 = \pi2p_y^2\right]\left[\pi^*2p_x^2 = \pi^*2p_y^2\right]\sigma^*2p_z^2$

$B.O. = \frac{10-10}{2} = 0$

N_2

$(14e^-) : \sigma1s^2,\sigma^*1s^2,\sigma2s^2,\sigma^*2s^2\left[\pi2p_x^2 = \pi2p_y^2\right]\sigma2p_z^2$

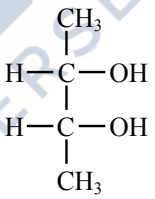
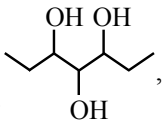
$B.O. = \frac{10-4}{2} = 6$

He_2

$(4e^-) : \sigma1s^2,\sigma^*1s^2$

$B.O. = \frac{2-2}{2} = 0$

83. Total number of optically active compounds from the following is _____.

$CH_3-CH_2-CH_2-CH_2-OH$,

$CH_3-CH_2-\underset{\underset{Cl}{|}}{CH}-CH_3$

$CH_3-CH_2-CH_2-CH_2-Cl$,

$(CH_3)_2CH-CH_2-CH_2-Cl$

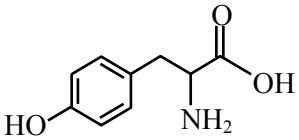
Ans. (1)

Sol. $CH_3-CH_2-\underset{\underset{Cl}{|}}{CH}-CH_3$

84. The total number of carbon atoms present in tyrosine, an amino acid, is _____.

Ans. (9)

Sol. Tyrosine

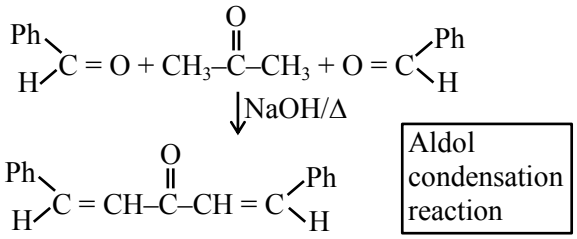


Number of carbon atoms = 9

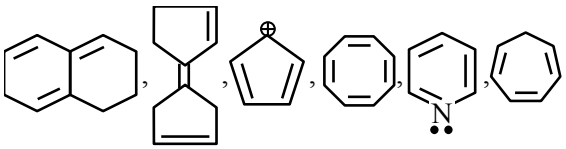
85. Two moles of benzaldehyde and one mole of acetone under alkaline conditions using aqueous NaOH after heating gives x as the major product. The number of π bonds in the product x is

Ans. **(9)**

Sol.

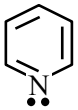


86. Total number of aromatic compounds among the following compounds is _____.



Ans. **(1)**

Sol.



87. Molality of an aqueous solution of urea is 4.44 m. Mole fraction of urea in solution is $x \times 10^{-3}$. Value of x is _____. (integer answer)

Ans. **(74)**

Sol. Molality of urea is 4.44 m, that means 4.44 moles of urea present in 1000 gm of water.

$$\therefore X_{urea} = \frac{4.44}{4.44 + \frac{1000}{18}}$$

$= 0.0740$

OR

74×10^{-3}

$X = 74$

88. Total number of unpaired electrons in the complex ion $[Co(NH_3)_6]^{3+}$ and $[NiCl_4]^{2-}$ is

Ans. **(2)**

Sol. $Co^{+3} : 3d^6 \quad t_{2g}^{2,2,2}\ e_g^{0,0}$

Unpaired $e^- = 0$

$Ni^{+2} : 3d^8 \quad e^{2,2}\ t_2^{2,1,1}$

Unpaired $e^- = 2$

89. Wavenumber for a radiation having 5800 Å wavelength is $x \times 10\ cm^{-1}$. The value of x is _____.

Ans. **(1724)**

Sol. $\bar{\nu}$ (wave no.) $= \frac{1}{\lambda} = \frac{1}{5800 \times 10^{-8}\ cm} = 17241$

OR

$1724 \times 10\,cm^{-1} \Rightarrow x = 1724$

90. A solution is prepared by adding 1 mole ethyl alcohol in 9 mole water. The mass percent of solute in the solution is _____ (Integer Answer) (Given : Molar mass in g mol^{-1} Ethyl alcohol : 46, water : 18)

Ans. **(22)**

Sol. Mass percent of Alcohol

$$= \frac{\text{Mass of ethyl alcohol}}{\text{Total mass of solution}} \times 100$$

$$= \frac{1 \times 46}{1 \times 46 + 9 \times 18} \times 100 = \frac{4600}{208}$$

$= 22.11$ Or 22