FINAL JEE–MAIN EXAMINATION – JANUARY, 2024

(Held On Thursday 01st February, 2024) TIME : 3 : 00 PM to 6 : 00 PM

CHEMISTRY | TEST PAPER WITH SOLUTION

SECTION-A

61. The transition metal having highest 3rd ionisation enthalpy is :

(1) Cr (2) Mn

(3) V (4) Fe

Ans. **(2)**

Sol. 3rd Ionisation energy : [NCERT Data]

V : 2833 KJ/mol

Cr : 2990 KJ/mol

Mn : 3260 KJ/mol

Fe : 2962 KJ/mol

alternative

Mn : $3d^5\ 4s^2$

Fe : $3d^6\ 4s^2$

Cr : $3d^5\ 4s^1$

V : $3d^3\ 4s^2$

So Mn has highest 3rd IE among all the given elements due to d^5 configuration.

62. Given below are two statements :

Statement (I) : A π bonding MO has lower electron density above and below the inter-nuclear asix.

Statement (II) : The π* antibonding MO has a node between the nuclei.

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

(1) Both Statement I and Statement II are false

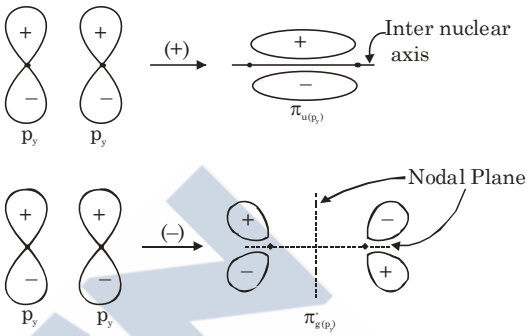
(2) Both Statement I and Statement II are true

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

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

Ans. **(3)**

Sol. A π bonding molecular orbital has higher electron density above and below inter nuclear axis



63. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A) : In aqueous solutions Cr^{2+} is reducing while Mn^{3+} is oxidising in nature.

Reason (R) : Extra stability to half filled electronic configuration is observed than incompletely filled electronic configuration.

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

(1) Both (A) and (R) are true and (R) is the correct explanation of (A)

(2) Both (A) and (R) are true but (R) is not the correct explanation of (A)

(3) (A) is false but (R) is true

(4) (A) is true but (R) is false

Ans. **(1)**

Sol. Cr^{2+} is reducing as it configuration changes from d^4 to d^3 due to formation of Cr^{3+}, which has half filled t_{2g} level, on other hand, the change Mn^{3+} to Mn^{2+} result half filled d^5 configuration which has extra stability.

64. Match List - I with List - II.

List-I (Reactants)	**List-II Products**
(A) Phenol, Zn/Δ	(I) Salicylaldehyde
(B) Phenol, $CHCl_3$, NaOH, HCl	(II) Salicylic acid
(C) Phenol, CO_2, NaOH, HCl	(III) Benzene
(D) Phenol, Conc. HNO_3	(IV) Picric acid

Choose the correct answer from the options given below.

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

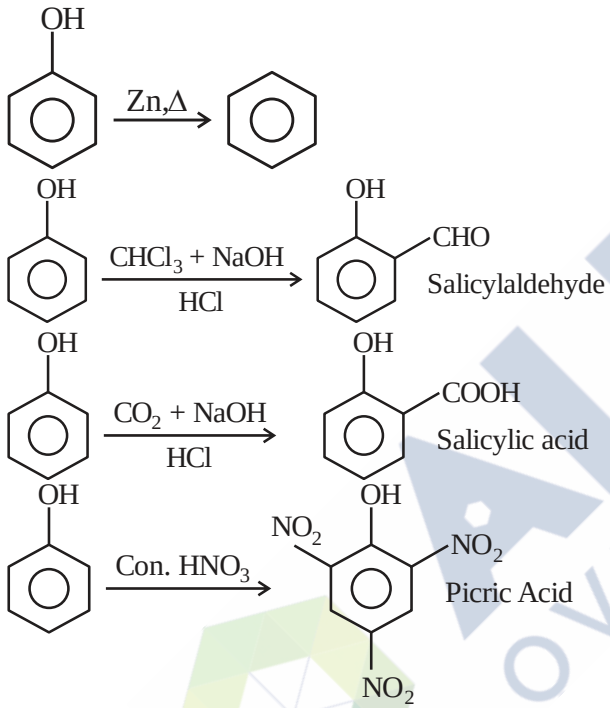
(2) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

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

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

Ans. **(3)**

Sol.



65. Given below are two statements :

Statement (I) : Both metal and non-metal exist in p and d-block elements.

Statement (II) : Non-metals have higher ionisation enthalpy and higher electronegativity than the metals.

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

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

Ans. **(2)**

Sol. **I.** In p-Block both metals and non metals are present but in d-Block only metals are present.

II. EN and IE of non metals are greater than that of metals

I - False, **II-**True

66. The strongest reducing agent amont the following is:

(1) NH_3 (2) SbH_3

(3) BiH_3 (4) PH_3

Ans. **(3)**

Sol. Strongest reducing agent : BiH_3 explained by its low bond dissociation energy.

67. Which of the following compounds show colour due to d-d transition?

(1) $CuSO_4.5H_2O$ (2) $K_2Cr_2O_7$

(3) K_2CrO_4 (4) $KMnO_4$

Ans. **(1)**

Sol. $CuSO_4.5H_2O$

Cu^{2+} : $3d^9\ 4s^0$

unpaired electron present so it show colour due to d-d transition.

68. The set of meta directing functional groups from the following sets is:

(1) –CN, $–NH_2$, –NHR, $–OCH_3$

(2) $–NO_2$, $–NH_2$, –COOH, –COOR

(3) $–NO_2$, –CHO, $–SO_3H$, –COR

(4) –CN, –CHO, $–NHCOCH_3$, –COOR

Ans. **(3)**

Sol. $-N\overset{O}{\underset{O}{\searrow}}$, $-\overset{O}{\overset{\|}{C}}-H$, $-\overset{O}{\overset{\|}{\underset{\underset{O}{\|}}{S}}}-OH$, $-\overset{O}{\overset{\|}{C}}-R$

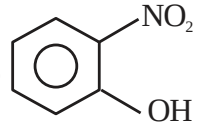
All are –M, Hence meta directing groups.

69. Select the compound from the following that will show intramolecular hydrogen bonding.

(1) H_2O

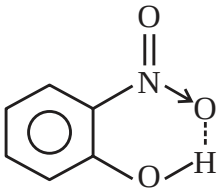
(2) NH_3

(3) C_2H_5OH

(4) 

Ans. **(4)**

Sol. H_2O, NH_3, $C_2H_5OH \Rightarrow$ Intermolecular H-Bonding

 $\Rightarrow$ Intramolecular H-Bonding

70. Lassaigne's test is used for detection of :

(1) Nitrogen and Sulphur only

(2) Nitrogen, Sulphur and Phosphorous Only

(3) Phosphorous and halogens only

(4) Nitrogen, Sulphur, phosphorous and halogens

Ans. **(4)**

Sol. Lassaigne's test is used for detection of all element N, S, P, X.

71. Which among the following has highest boiling point?

(1) $CH_3CH_2CH_2CH_3$

(2) $CH_3CH_2CH_2CH_2$–OH

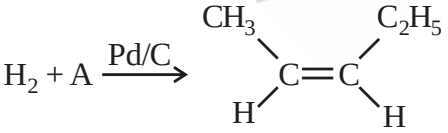
(3) $CH_3CH_2CH_2CHO$

(4) $H_5C_2 - O - C_2H_5$

Ans. **(2)**

Sol. Due to H-bonding boiling point of alcohol is High.

72. In the given reactions identify A and B.



$CH_3 - C \equiv C - CH_3 + H_2 \xrightarrow{Na/Liquid\,NH_3}$ "B"

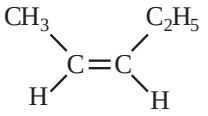
(1) A : 2–Pentyne B : trans – 2 – butene

(2) A : n – Pentane B : trans – 2 – butene

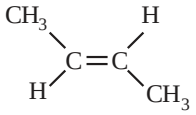
(3) A : 2 – Pentyne B : Cis – 2 – butene

(4) A : n – Pentane B : Cis – 2 – butene

Ans. **(1)**

Sol. $H_2 + CH_3 - C \equiv C - C_2H_5 \xrightarrow{Pd/C}$ 

2-pentyne

$CH_3 - C \equiv C - CH_3 + H_2 \xrightarrow[Liquid\,NH_3]{Na}$ 

Trans-2-butene

73. The number of radial node/s for 3p orbital is:

(1) 1 (2) 4

(3) 2 (4) 3

Ans. **(1)**

Sol. For 3p : n = 3, ℓ = 1

Number of radial node = $n - \ell - 1$

$= 3 - 1 - 1 = 1$

74. Match List - I with List - II.

List - I Compound	**List - II Use**
(A) Carbon tetrachloride	(I) Paint remover
(B) Methylene chloride	(II) Refrigerators and air conditioners
(C) DDT	(III) Fire extinguisher
(D) Freons	(IV) Non Biodegradable insecticide

Choose the correct answer from the options given below :

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

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

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

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

Ans. **(2)**

Sol. CCl_4 used in fire extinguisher. CH_2Cl_2 used as paint remover. Freons used in refrigerator and AC. DDT used as non Biodegradable insecticide.

75. The functional group that shows negative resonance effect is:

(1) $-NH_2$ (2) –OH

(3) –COOH (4) –OR

Ans. **(3)**

Sol. $-\overset{\overset{O}{\|}}{C}-OH$ shows –R effect, while rest 3 groups shows +R effect via lone pair.

76. $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$ are respectively known as:

(1) Spin free Complex, Spin paired Complex

(2) Spin paired Complex, Spin free Complex

(3) Outer orbital Complex, Inner orbital Complex

(4) Inner orbital Complex, Spin paired Complex

Ans. (2)

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

Co^{3+} (strong field ligand) $\Rightarrow 3d^6\left(t_{2g}^6, e_g^0\right)$,

Hybridisation : d^2sp^3

Inner obital complex(spin paired complex)

Pairing will take place.

$[CoF_6]^{3-}$

Co^{3+} (weak field ligand) $\Rightarrow 3d^6\left(t_{2g}^4, e_g^2\right)$

Hybridisation : sp^3d^2

Outer orbital complex (spin free complex)

no pairing will take place

77. Given below are two statements :

Statement (I) : SiO_2 and GeO_2 are acidic while SnO and PbO are amphoteric in nature.

Statement (II) : Allotropic forms of carbon are due to property of catenation and pπ-dπ bond formation.

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

(1) Both Statement I and Statement II are false

(2) Both Statement I and Statement II are true

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

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

Ans. (3)

Sol. SiO_2 and GeO_2 are acidic and SnO, PbO are amphoteric.

Carbon does not have d-orbitals so can not form pπ-dπ Bond with itself. Due to properties of catenation and pπ-pπ bond formation. carbon is able to show allotropic forms.

78. $C_2H_5Br \xrightarrow{\text{alc. KOH}} A \xrightarrow[CCl_4]{Br_2} B \xrightarrow[\text{Excess}]{KCN} C \xrightarrow[\text{Excess}]{H_3O^+} D$

Acid D formed in above reaction is :

(1) Gluconic acid

(2) Succinic acid

(3) Oxalic acid

(4) Malonic acid

Ans. (2)

Sol.

$$C_2H_5Br \xrightarrow{\text{alc. KOH}} \underset{(A)}{CH_2=CH_2} \xrightarrow[CCl_4]{Br_2} \underset{(B)}{CH_2(Br)-CH_2(Br)} \xrightarrow{KCN,\ \text{Excess}} \underset{(C)}{CH_2(CN)-CH_2(CN)} \xrightarrow{H_3O^+} \underset{\text{Succinic Acid}}{\underset{(D)}{CH_2(COOH)-CH_2(COOH)}}$$

79. Solubility of calcium phosphate (molecular mass, M) in water is W_g per 100 mL at 25° C. Its solubility product at 25°C will be approximately.

(1) $10^7\left(\frac{W}{M}\right)^3$ (2) $10^7\left(\frac{W}{M}\right)^5$

(3) $10^3\left(\frac{W}{M}\right)^5$ (4) $10^5\left(\frac{W}{M}\right)^5$

Ans. (2)

Sol. $S=\frac{W\times 10}{M}$

$$Ca_3(PO_4)_2(s) \rightleftharpoons \underset{3s}{3Ca^{2+}(aq.)} + \underset{2s}{2PO_4^{3-}(aq.)}$$

$$S=\frac{W\times 1000}{M\times 100}=\frac{W\times 10}{M}$$

$K_{sp} = (3s)^3\,(2s)^2$

$= 108\ s^5$

$=108\times 10^5\times\left(\frac{W}{M}\right)^5$

$= 1.08 \times 10^7\left(\frac{W}{M}\right)^5$

80. Given below are two statements :

Statement (I) : Dimethyl glyoxime forms a six-membered covalent chelate when treated with $NiCl_2$ solution in presence of NH_4OH.

Statement (II) : Prussian blue precipitate contains iron both in (+2) and (+3) oxidation states. In the light of the above statements, choose the most appropriate answer from the options given below:

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

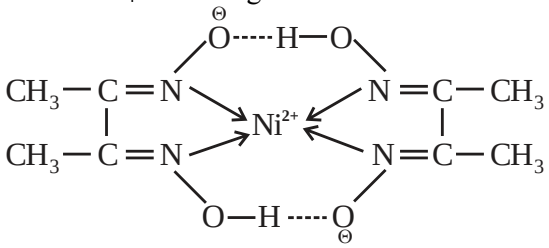
(2) Both Statement I and Statement II are true

(3) Both Statement I and Statement II are false

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

Ans. **(1)**

Sol. $Ni^{2+} + NH_4OH + dmg \rightarrow$



2 Five member ring

III II

$Fe_4[Fe(CN)_6]_3$

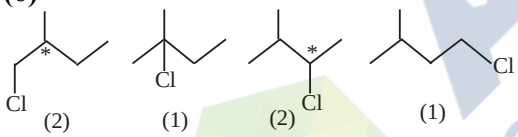
Prussian Blue

SECTION-B

81. Total number of isomeric compounds (including stereoisomers) formed by monochlorination of 2-methylbutane is_____.

Ans. **(6)**

Sol.



82. The following data were obtained during the first order thermal decomposition of a gas A at constant volume:

$A(g) \rightarrow 2B(g) + C(g)$

S.No	Time/s	Total pressure/(atm)
1.	0	0.1
2.	115	0.28

The rate constant of the reaction is_____$\times 10^{-2} s^{-1}$ (nearest integer)

Ans. **(2)**

Sol.

	A(g)	$\rightarrow$	2B(g)	+	C(g)
t = 0	0.1				
t = 115 sec.	0.1 – x		2x		x

$0.1 + 2x = 0.28$

$2x = 0.18$

$x = 0.09$

$$K = \frac{1}{115} \ell n \frac{0.1}{0.1 - 0.09}$$

$= 0.0200 \text{ sec}^{-1}$

$= 2 \times 10^{-2} \text{ sec}^{-1}$

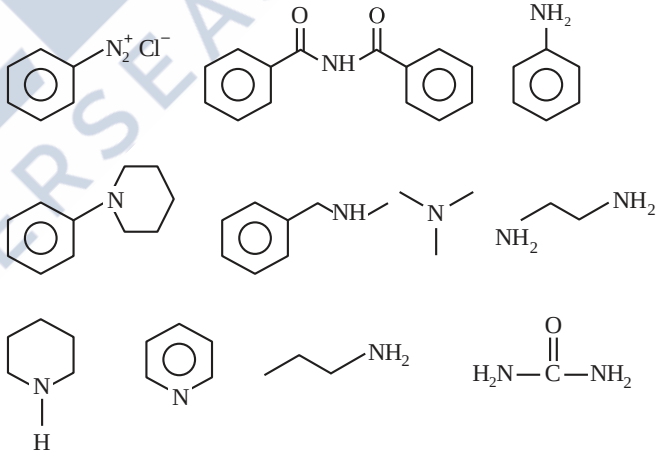
83. The number of tripeptides formed by three different amino acids using each amino acid once is _____.

Ans. **(6)**

Sol. Let 3 different amino acid are A, B, C then following combination of tripeptides can be formed-

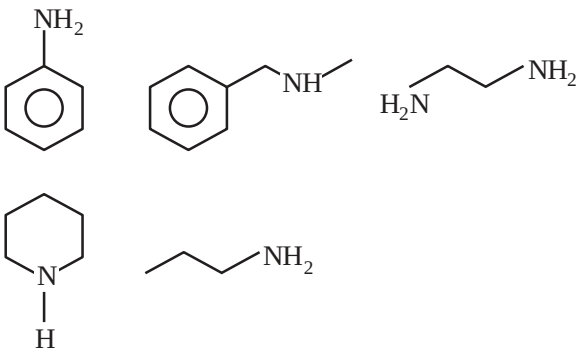
ABC, ACB, BAC, BCA, CAB, CBA

84. Number of compounds which give reaction with Hinsberg's reagent is_____.



Ans. **(5)**

Sol.



85. Mass of ethylene glycol (antifreeze) to be added to 18.6 kg of water to protect the freezing point at –24°C is_____ kg (Molar mass in g mol^{-1} for ethylene glycol 62, K_f of water = 1.86 K kg mol^{-1})

Ans. (15)

Sol. $\Delta T_f = iK_f \times$ molality

$$24 = (1) \times 1.86 \times \frac{W}{62 \times 18.6}$$

W = 14880 gm

= 14.880 kg

86. Following Kjeldahl's method, 1g of organic compound released ammonia, that neutralised 10 mL of 2M H_2SO_4. The percentage of nitrogen in the compound is _____%.

Ans. (56)

Sol. $H_2SO_4 + 2NH_3 \rightarrow (NH_4)_2\,SO_4$

Millimole of $H_2SO_4 \rightarrow 10 \times 2$

So Millimole of $NH_3 = 20 \times 2 = 40$

Organic → NH_3

Compound 40 Millimole

$$\therefore \text{Mole of N} = \frac{40}{1000}$$

$$\text{wt. of N} = \frac{40}{1000} \times 14$$

% composition of N in organic compound

$$= \frac{40 \times 14}{1000 \times 1} \times 100$$

= 56%

87. The amount of electricity in Coulomb required for the oxidation of 1 mol of H_2O to O_2 is ____$\times 10^5$C.

Ans. (2)

Sol. $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$

$$\frac{W}{E} = \frac{Q}{96500}$$

$$\text{mole} \times \text{n-factor} = \frac{Q}{96500}$$

$$1 \times 2 = \frac{Q}{96500}$$

$Q = 2 \times 96500$ C

$= 1.93 \times 10^5$ C

88. For a certain reaction at 300K, K = 10, then $\Delta G°$ for the same reaction is –_____$\times 10^{-1}$ kJ mol^{-1}. (Given R = 8.314 JK^{-1} mol^{-1})

Ans. (57)

Sol. $\Delta G° = -RT\,\ell n\,K$

$= -8.314 \times 300\ \ell n\ (10)$

= 5744.14 J/mole

$= 57.44 \times 10^{-1}$ kJ/mole

89. Consider the following redox reaction :

$$MnO_4^- + H^+ + H_2C_2O_4 \rightleftharpoons Mn^{2+} + H_2O + CO_2$$

The standard reduction potentials are given as below $\left(E^\circ_{red}\right)$

$E^\circ_{MnO_4^-/Mn^{2+}} = +1.51V$

$E^\circ_{CO_2/H_2C_2O_4} = -0.49V$

If the equilibrium constant of the above reaction is given as $K_{eq} = 10^x$, then the value of x = _____ (nearest integer)

Ans. (338 OR 339)

Sol. Cell Rx^n ; $MnO_4^- + H_2C_2O_4 \rightarrow Mn^{2+} + CO_2$

$E^\circ_{cell} = E^\circ_{op}$ of anode + E°_{RP} of cathode

$= 0.49 + 1.51 = 2.00V$

At equilibrium

$E_{cell} = 0,$

$E^\circ_{cell} = \frac{0.059}{n}\log K$

(As per NCERT $\frac{RT}{F} = 0.059$ But $\frac{RT}{F} = 0.0591$

can also be taken.)

$2 = \frac{0.059}{10}\log K$

$\log K = 338.98$

90. 10 mL of gaseous hydrocarbon on combustion gives 40 mL of $CO_2(g)$ and 50 mL of water vapour. Total number of carbon and hydrogen atoms in the hydrocarbon is _____.

Ans. **(14)**

Sol. $\boxed{\begin{matrix}CxHy\\10ml\end{matrix}} + O_2 \rightarrow CO_2 + H_2O$

$$CxHy + \left(x + \frac{y}{4}\right)O_2 \rightarrow \underset{10x}{xCO_2} + \underset{5y}{\frac{y}{2}H_2O}$$

$10x = 40$

$x = 4$

$5y = 50$

$y = 10$

C_4H_{10}