JEE–MAIN EXAMINATION – JANUARY 2025

(HELD ON WEDNESDAY 22nd JANUARY 2025) **TIME : 9 : 00 AM TO 12 : 00 NOON**

CHEMISTRY

TEST PAPER WITH SOLUTIONS

SECTION-A

51. A solution of aluminium chloride is electrolysed for 30 minutes using a current of 2A. The amount of the aluminium deposited at the cathode is ___ .
[Given : molar mass of aluminium and chlorine are 27 g mol^{-1} and 35.5 g mol^{-1} respectively, Faraday constant = 96500 C mol^{-1}].

(1) 1.660 g (2) 1.007 g

(3) 0.336 g (4) 0.441 g

Ans. **(3)**

Sol. gm equivalent of Al deposited = $\frac{It}{96500}$

$\frac{w}{27}\times 3=\frac{2\times 30\times 60}{96500}$

w = 0.336 g,

52. Which of the following statement is not true for radioactive decay ?

(1) Amount of radioactive substance remained after three half lives is $\frac{1}{8}$th of original amount.

(2) Decay constant does not depend upon temperature.

(3) Decay constant increases with increase in temperature.

(4) Half life is ln 2 times of $\frac{1}{\text{rate constant}}$.

Ans. **(3)**

Sol. Decay constant is independent of temperature.

53. How many different stereoisomers are possible for the given molecule ?

$CH_3-\underset{\underset{OH}{|}}{CH}-CH=CH-CH_3$

(1) 3 (2) 1

(3) 2 (4) 4

Ans. **(4)**

Sol. $CH_3-\underset{\underset{OH}{|}}{CH}-CH=CH-CH_3$

It has 4 stereoisomers $\begin{bmatrix} R\,cis & R\,trans \\ S\,cis & S\,trans \end{bmatrix}$

54. Which of the following electronegativity order is **incorrect**?

(1) Al < Mg < B < N (2) Al < Si < C < N

(3) Mg < Be < B < N (4) S < Cl < O < F

Ans. **(1)**

Sol.

	Li	Be	B	C	N	O	F
(E.N.)= On pauling scale	1	1.5	2	2.5	3	3.5	4.0

	Na	Mg	Al	Si	P	S	Cl
(E.N.)=	0.9	1.2	1.5	1.8	2.1	2.5	3.0

Correct order Mg < Al < B < N

55. Lanthanoid ions with $4f^7$ configuration are :

(A) Eu^{2+} (B) Gd^{3+} (C) Eu^{3+} (D) Tb^{3+}

(E) Sm^{2+}

Choose the correct answer from the options given below :

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

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

Ans. **(1)**

Sol. $_{63}Eu^{2+}$ – [Xe] $4f^7 6s^0$

$_{64}Gd^{3+}$ – [Xe] $4f^7\ 5d^0 6s^0$

$_{63}Eu^{3+}$ – [Xe] $4f^6\ 6s^0$

$_{65}Tb^{3+}$ – [Xe] $4f^8\ 6s^0$

$_{62}Sm^{2+}$ – [Xe] $4f^6\ 6s^0$

Eu^{2+} & Gd^{3+}

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

List-I		List-II	
(A)	$Al^{3+} < Mg^{2+} < Na^{+} < F^{-}$	(I)	Ionisation Enthalpy
(B)	B < C < O < N	(II)	Metallic character
(C)	B < Al < Mg < K	(III)	Electronegativity
(D)	Si < P < S < Cl	(IV)	Ionic radii

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

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

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

Ans. (3)

Sol. Ionic radii – $Al^{3+} < Mg^{2+} < Na^{+} < F^{-}$

Ionisation energy – B < C < O < N

Metallic character – B < Al < Mg < K

Electron negativity – Si < P < S < Cl

57. Which of the following acids is a vitamin ?

(1) Adipic acid (2) Aspartic acid

(3) Ascorbic acid (4) Saccharic acid

Ans. (3)

Sol. Vitamin-C is Ascorbic acid.

58. A liquid when kept inside a thermally insulated closed vessel at 25°C was mechanically stirred from outside. What will be the correct option for the following thermodynamic parameters ?

(1) $\Delta U > 0, q = 0, w > 0$ (2) $\Delta U = 0, q = 0, w = 0$

(3) $\Delta U < 0, q = 0, w > 0$ (4) $\Delta U = 0, q < 0, w > 0$

Ans. (1)

Sol. Thermally insulated $\Rightarrow q = 0$

from I^{st} law

$\Delta U = q + w$

$\Delta U = w$

$w > 0, \Delta U > 0$

59. Radius of the first excited state of Helium ion is given as :

$a_0 \rightarrow$ radius of first stationary state of hydrogen atom.

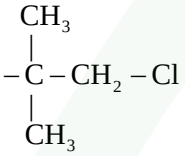
(1) $r = \frac{a_0}{2}$ (2) $r = \frac{a_0}{4}$ (3) $r = 4a_0$ (4) $r = 2a_0$

Ans. (4)

Sol. $r = a_0 \frac{n^2}{Z} = a_0 . \frac{(2)^2}{2} = 2a_0.$

60. Given below are two statements :

Statement I : $CH_3 - O - CH_2 - Cl$ will undergo S_N1 reaction though it is a primary halide.

Statement II :  will not undergo S_N2 reaction very easily though it is a primary halide.

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.

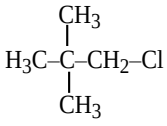
(2) Both **Statement I** and **Statement II** are incorrect

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

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

Ans. (4)

Sol. $CH_3–O–CH_2–Cl$ will undergo S_N1 mechanism because $CH_3 - O - \overset{+}{C}H_2$ is highly stable.



(Neopentyl chloride) will undergo S_N2 mechanism at a slow rate because it's sterically crowded

61. Given below are two statements :

Statement I : One mole of propyne reacts with excess of sodium to liberate half a mole of H_2 gas.

Statement II : Four g of propyne reacts with $NaNH_2$ to liberate NH_3 gas which occupies 224 mL at STP.

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

(1) **Statement I** is correct but **Statement II** is incorrect.
(2) Both **Statement I** and **Statement II** are incorrect
(3) **Statement I** is incorrect but **Statement II** is correct
(4) Both **Statement I** and **Statement II** are correct.

Ans. (1)

Sol.

$$\underset{1\text{mole}}{CH_3-C\equiv CH}+\underset{(\text{excess})}{Na}\rightarrow CH_3-C\equiv C^{-}\overset{+}{N}a+\underset{\frac{1}{2}\text{mole}\,H_2}{\frac{1}{2}H_2}\uparrow$$

$$CH_3-C\equiv CH+NaNH_2\rightarrow CH_3C\equiv C^{-}\overset{+}{N}a+NH_3$$

4 gm

$$\frac{4}{40}=0.1\text{mole}\qquad\qquad\frac{0.1\text{mole}}{2240\,\text{mole}}$$

Statement I is correct but **Statement II** is incorrect

62. A vessel at 1000 K contains CO_2 with a pressure of 0.5 atm. Some of CO_2 is converted into CO on addition of graphite. If total pressure at equilibrium is 0.8 atm, then K_P is :

(1) 0.18 atm (2) 1.8 atm (3) 0.3 atm (4) 3 atm.

Ans. (2)

Sol. $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$

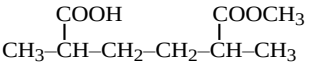
0.5	–
0.5–x	2x

$P_{total} = 0.5 + x = 0.8$

$x = 0.3$

$$K_p=\frac{(0.6)^2}{0.2}=1.8$$

63. The IUPAC name of the following compound is :



(1) 2-Carboxy-5-methoxycarbonylhexane.

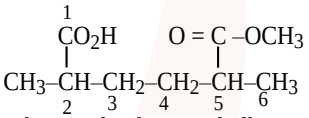
(2) Methyl-6-carboxy-2,5-dimethylhexanoate.

(3) Methyl-5-carboxy-2-methylhexanoate.

(4) 6-Methoxycarbonyl-2,5-dimethylhexanoic acid.

NTA Ans. (4)

Sol.



5-Methoxycarbonly-2-methylhexanoic acid

64. Which of the following electrolyte can be sued to obtain $H_2S_2O_8$ by the process of electrolysis?

(1) Dilute solution of sodium sulphate

(2) Dilute solution of sulphuric acid

(3) Concentrated solution of sulphuric acid

(4) Acidified dilute solution of sodium sulphate.

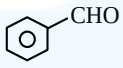
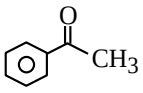
Ans. (3)

Sol. Theory based.

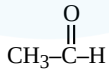
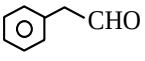
At anode :

$2HSO_4^- \rightarrow H_2S_2O_8 + 2e^-$

65. The compounds which give positive Fehling's test are :

(A)  (B) 

(C) $HOCH_2–CO–(CHOH)_3–CH_2–OH$

(D)  (E) 

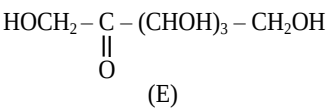
Choose the **CORRECT** answer from the options given below :

(1) (A),(C) and (D) Only (2) (A),(D) and (E) Only

(3) (C), (D) and (E) Only (4) (A), (B) and (C) Only

Ans. (3)

Sol. $\underset{(C)}{CH_3CH=O}$, $\underset{(D)}{PhCH_2CH=O}$,



(E)

All gives positive Fehling test

66. In which of the following complexes the CFSE, Δ_0 will be equal to zero?

(1) $[Fe(NH_3)_6]Br_2$ (2) $[Fe(en)_3]Cl_3$

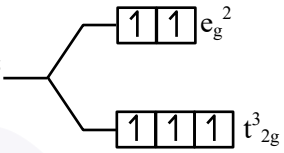
(3) $K_4[Fe(CN)_6]$ (4) $K_3[Fe(SCN)_6]$

Ans. **(4)**

Sol. For complex $K_3[Fe(SCN)_6]$

E.C. of Fe^{3+} – $[Ar]3d^5$

W.F.L.



Calculation of CFSE

$= (-0.4 \times 3 + 0.6 \times 2)\ \Delta_0$

$= 0\ \Delta_0$

67. Arrange the following solutions in order of their increasing boiling points.

(i) 10^{-4} M NaCl (ii) 10^{-4} M Urea

(iii) 10^{-3} M NaCl (iv) 10^{-2} M NaCl

(1) (ii) < (i) < (iii) < (iv) (2) (ii) < (i) ≅ (iii) < (iv)

(3) (i) < (ii) < (iii) < (iv) (4) (iv) < (iii) < (i) < (ii)

Ans. **(1)**

Sol. $\Delta T_b = i\ K_b\ .\ m\ .\propto i.C.$

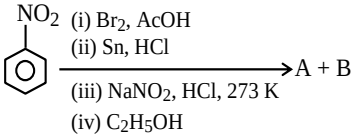
where C = concentration

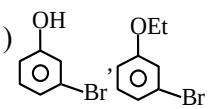
Options	i.C.
(i)	2×10^{-4}
(ii)	1×10^{-4}
(iii)	2×10^{-3}
(iv)	2×10^{-2}

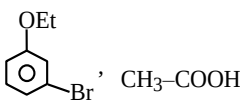
B.P. order :

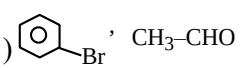
(ii) < (i) < (iii) < (iv)

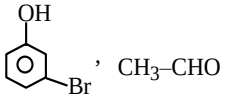
68. The products formed in the following reaction sequence are :



(1) 

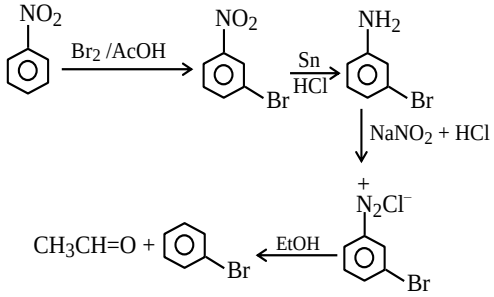
(2) 

(3) 

(4) 

Ans. **(3)**

Sol.



69. From the magnetic behaviour of $[NiCl_4]^{2-}$ (paramagnetic) and $[Ni(CO)_4]$ (diamagnetic), choose the correct geometry and oxidation state.

(1) $[NiCl_4]^{2-}$: Ni^{II}, square planar

$[Ni(CO)_4]$: Ni(0), square planar

(2) $[NiCl_4]^{2-}$: Ni^{II}, tetrahedral

$[Ni(CO)_4]$: Ni(0), tetrahedral

(3) $[NiCl_4]^{2-}$: Ni^{II}, tetrahedral

$[Ni(CO)_4]$: Ni^{II}, square planar

(4) $[NiCl_4]^{2-}$: Ni(0), tetrahedral

$[Ni(CO)_4]$: Ni(0), square planar

Ans. **(2)**

Sol. $[NiCl_4]^{2-}$

Ni^{+2} – [Ar] $3d^8\ 4s^0 \rightarrow sp^3$, Tetrahedral

Number of unpaired electron = 2 paramagentic

$[Ni(CO)_4]$,

Ni(0) → [Ar] $3d^{10}\ 4s^0$ (After rearrangement)

No unpaired electron

sp^3, Tetrahedral, Diamagnetic

70. The **incorrect** statements regarding geometrical isomerism are :

(A) Propene shows geometrical isomerism.

(B) Trans isomer has identical atoms/groups on the opposite sides of the double bond.

(C) Cis-but-2-ene has higher dipole moment than trans-but-2-ene.

(D) 2-methylbut-2-ene shows two geometrical isomers.

(E) Trans-isomer has lower melting point that cis isomer.

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

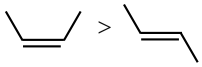
(1) (A), (D) and (E) only (2) (C), (D) and (E) only

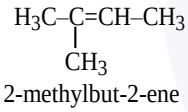
(3) (B) and (C) only (4) (A) and (E) only

Ans. (1)

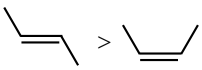
Sol. (A) $CH_3–CH=CH_2$. GI is not possible

(B) Trans isomer has identical atoms/groups on the opposite side of double bond.

(C)  (dipole moment only)

(D)  (does not show GI)

2-methylbut-2-ene

(E)  (Melting point)

SECTION-B

71. Some CO_2 gas was kept in a sealed container at a pressure of 1 atm and at 273 K. This entire amount of CO_2 gas was later passed through an aqueous solution of $Ca(OH)_2$. The excess unreacted $Ca(OH)_2$ was later neutralized with 0.1 M of 40 mL HCl. If the volume of the sealed container of CO_2 was x, then x is _____ cm^3 (nearest integer).

[Given : The entire amount of $CO_2(g)$ reacted with exactly half the initial amount of $Ca(OH)_2$ present in the aqueous solution.]

Ans. (45)

Sol. Let moles of CO_2 = n

moles of $Ca(OH)_2$ total initially = 2n

excess $Ca(OH)_2$ = n

gm equivalent of $Ca(OH)_2$ = gm equivalent of HCl

$$n \times 2 = 0.1 \times \frac{40}{1000} \times 1$$

$$n = 2 \times 10^{-3}$$

Volume of $CO_2 = 2 \times 10^{-3} \times 22400 = 44.8\ cm^3$

72. In Carius method for estimation of halogens, 180 mg of an organic compound produced 143.5 mg of AgCl. The percentage composition of chlorine in the compound is _____ %.

[Given : molar mass in g mol^{-1} of Ag : 108, Cl = 35.5]

Ans. (20)

Sol. $$n_{Cl} = n_{AgCl} = \frac{143.5 \times 10^{-3}}{143.5} = 10^{-3}$$

$$\%\ Cl = \frac{10^{-3} \times 35.5}{180 \times 10^{-3}} \times 100 = 19.72$$

73. The number of molecules/ions that show linear geometry among the following is _____ .

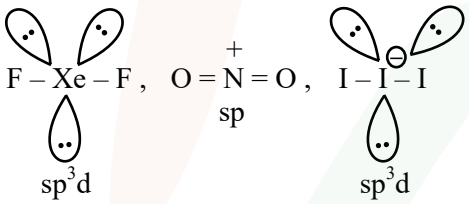
SO_2, $BeCl_2$, CO_2, N_3^-, NO_2, F_2O, XeF_2, NO_2^+, I_3^-, O_3

Ans. (6)

Sol. Linear species are

$Cl – Be – Cl$, $O = C = O$, $N^- = N^+ = N^-$

(sp) (sp) (sp)



74. $A \rightarrow B$

The molecule A changes into its isomeric form B by following a first order kinetics at a temperature of 1000 K. If the energy barrier with respect to reactant energy for such isomeric transformation is 191.48 kJ mol^{-1} and the frequency factor is 10^{20}, the time required for 50%, molecules of A to become B is _____ picoseconds (nearest integer).

[R = 8.314 J K^{-1} mol^{-1}]

Ans. (69)

Sol. $$t_{1/2} = \frac{0.693}{K}$$

$$K = Ae^{-Ea/RT}$$

$$= 10^{20} \times e^{-\frac{191.48 \times 10^3}{8.314 \times 1000}}$$

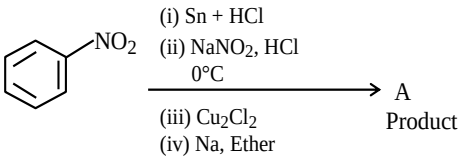
$$= 10^{20} \times e^{-23.031} = 10^{20} \times -e^{\ln 10 \times 10}$$

$$= \frac{10^{20}}{10^{10}} = 10^{10}\ \text{sec.}$$

$$t_{1/2} = \frac{0.693}{10^{10}} = 6.93 \times 10^{-11}$$

$$= 69.3 \times 10^{-12}\ \text{sec.}$$

75. Consider the following sequence of reactions :



Molar mass of the product formed (A) is _____g mol^{-1} .

Ans. (154)

Sol.