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.

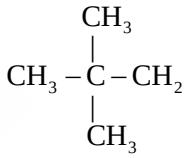
(1) $r = \frac{a_0}{2}$ (2) $r = \frac{a_0}{4}$ (3) $r = 4a_0$ (4) $r = 2a_0$

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.

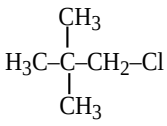
(2) Both **Statement I** and **Statement II** are incorrect

(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

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

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

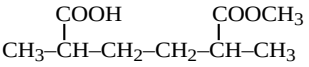
0.5	–
0.5–x	2x

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

$x = 0.3$

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

63. The IUPAC name of the following compound is :



(1) 2-Carboxy-5-methoxycarbonylhexane.

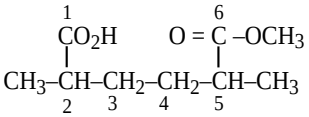
(2) Methyl-6-carboxy-2,5-dimethylhexanoate.

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

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

Ans. **(4)**

Sol.



6-Methoxycarbonly-2,5-dimethylhexanoic 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.

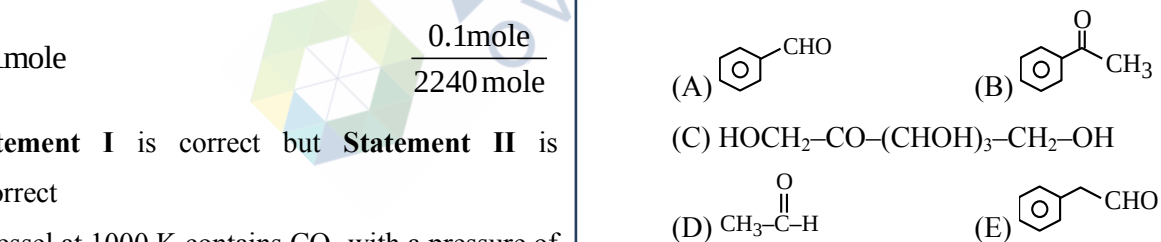
Ans. **(3)**

Sol. Theory based.

At anode :

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

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



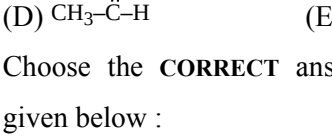
Choose the **CORRECT** answer from the options given below :

(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) $[Fe(en)_3]Cl_3$

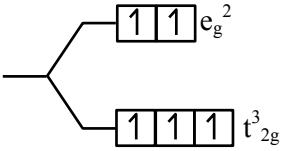
(3) $K_4[Fe(CN)_6]$ (4) $K_3[Fe(SCN)_6]$

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.

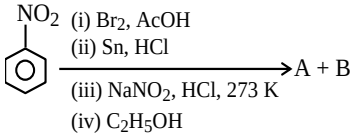
where C = concentration

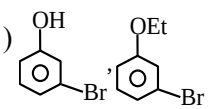
Options	i.C.
(i)	2×10^{-4}
(ii)	1×10^{-4}
(iii)	2×10^{-3}
(iv)	2×10^{-2}

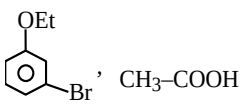
B.P. order :

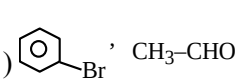
(ii) < (i) < (iii) < (iv)

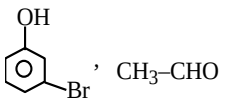
68. The products formed in the following reaction sequence are :



(1) 

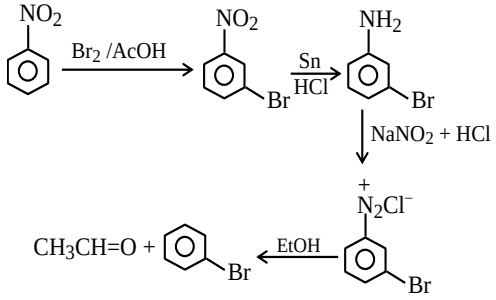
(2) 

(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 :

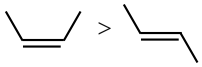
(1) (A), (D) and (E) only (2) (C), (D) and (E) only

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

Ans. (1)

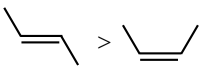
Sol. (A) $CH_3–CH=CH_2$. GI is not possible

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

(C)  (dipole moment only)

(D) $H_3C–\underset{\underset{CH_3}{|}}{C}=CH–CH_3$ (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 _____ .

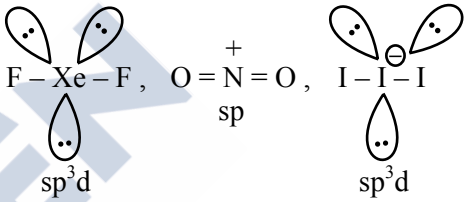
SO_2, $BeCl_2$, CO_2, N_3^-, NO_2, F_2O, XeF_2, NO_2^+, I_3^-, O_3

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

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

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

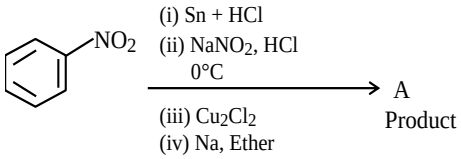
$$= 10^{20} \times e^{-23.031} = 10^{20} \times -e^{\ln 10 \times 10}$$

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

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

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

75. Consider the following sequence of reactions :



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

Ans. (154)

Sol.