FINAL JEE–MAIN EXAMINATION – JANUARY, 2024

(Held On Tuesday 30th January, 2024) **TIME : 3 : 00 PM to 6 : 00 PM**

SECTION-A

61. Which among the following purification methods is based on the principle of "Solubility" in two different solvents?

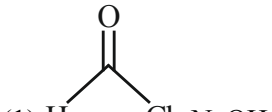
(1) Column Chromatography
(2) Sublimation
(3) Distillation
(4) Differential Extraction

Ans. (4)

Sol. Different Extraction

Different layers are formed which can be separated in funnel. (Theory based).

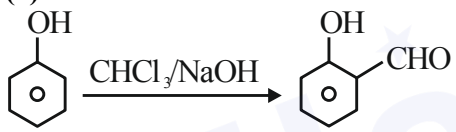
62. Salicylaldehyde is synthesized from phenol, when reacted with



(1) H Cl, NaOH
(2) CO_2, NaOH
(3) CCl_4, NaOH
(4) $HCCl_3$, NaOH

Ans. (4)

Sol.



63. Given below are two statements:

Statement – I: High concentration of strong nucleophilic reagent with secondary alkyl halides which do not have bulky substituents will follow S_N2 mechanism.

Statement – II: A secondary alkyl halide when treated with a large excess of ethanol follows S_N1 mechanism.

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

(1) Statement I is true but Statement II is false.
(3) Statement I is false but Statement II is true.
(3) Both statement I and Statement II are false.
(4) Both statement I and Statement II are true.

Ans. (4)

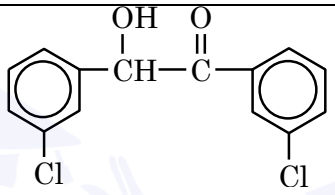
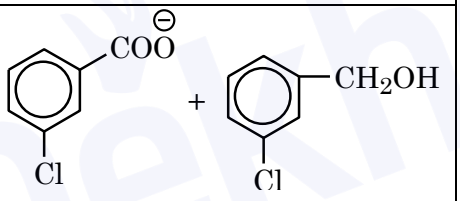
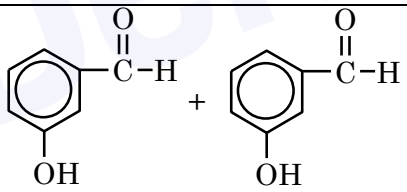
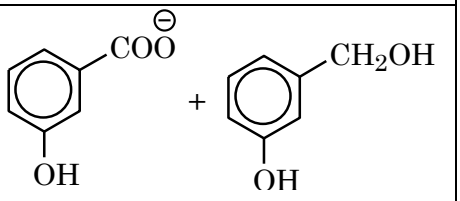
Sol. **Statement – I:** Rate of $S_N2 \propto [R–X][Nu^-]$

S_N2 reaction is favoured by high concentration of nucleophile (Nu^-) & less crowding in the substrate molecule.

Statement – II: Solvolysis follows S_N1 path.

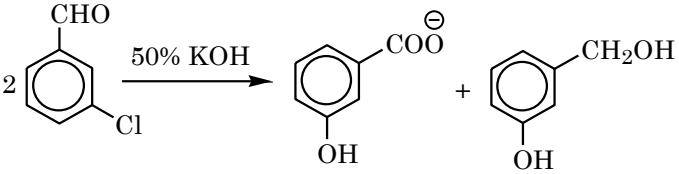
Both are correct Statements.

64. m–chlorobenzaldehyde on treatment with 50% KOH solution yields

(1)	
(2)	
(3)	
(4)	

Ans. (2)

Sol. Meta–chlorobenzaldehyde will undergo Cannizzaro reaction with 50% KOH to give m–chlorobenzoate ion and m–chlorobenzyl alcohol.



65. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : H_2Te is more acidic than H_2S.

Reason R: Bond dissociation enthalpy of H_2Te is lower than H_2S.

In the light of the above statements. Choose the most appropriate from the options given below.

(1) Both A and R are true but R is NOT the correct explanation of A.

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

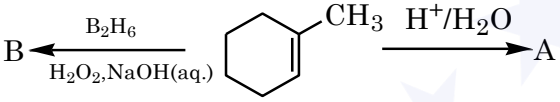
(3) A is false but R is true.

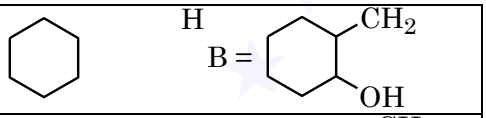
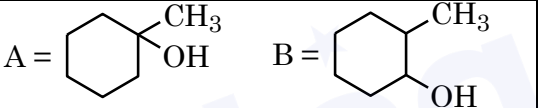
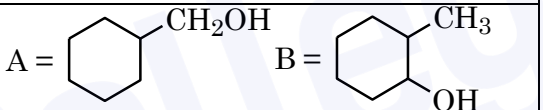
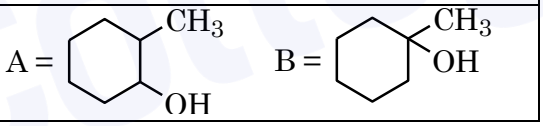
(4) A is true but R is false.

Ans. **(2)**

Sol. Due to lower Bond dissociation enthalpy of H_2Te it ionizes to give H^+ more easily than H_2S.

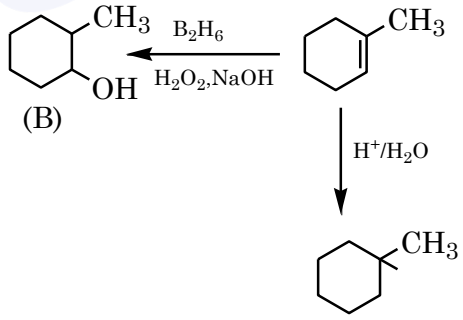
66. Product A and B formed in the following set of reactions are:



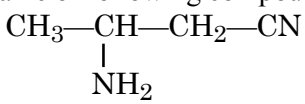
(1)	
(2)	
(3)	
(4)	

Ans. **(2)**

Sol.



67. IUPAC name of following compound is



(1) 2–Aminopentanenitrile

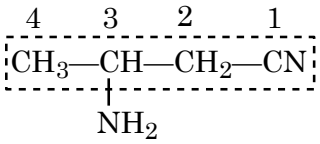
(2) 2–Aminobutanenitrile

(3) 3–Aminobutanenitrile

(4) 3–Aminopropanenitrile

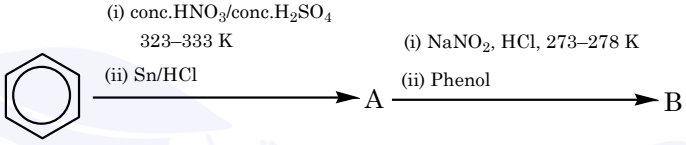
Ans. **(3)**

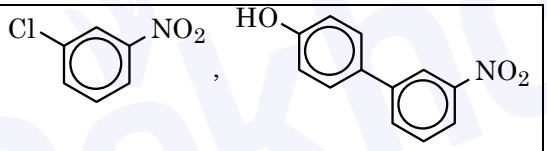
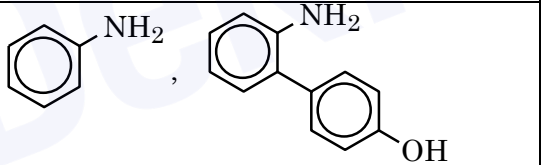
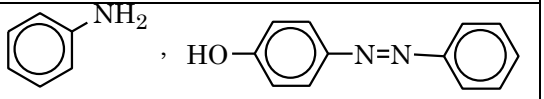
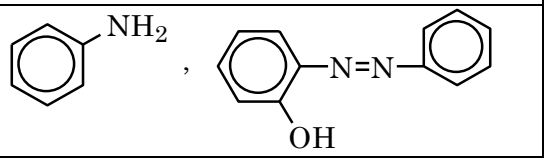
Sol.



3–Aminobutanenitrile

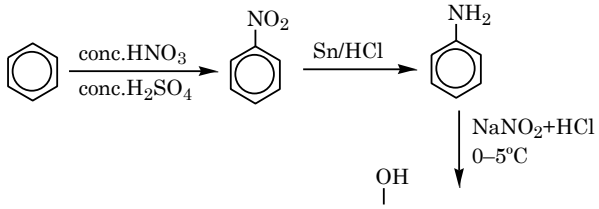
68. The products A and B formed in the following reaction scheme are respectively



(1)	
(2)	
(3)	
(4)	

Ans. **(3)**

Sol.



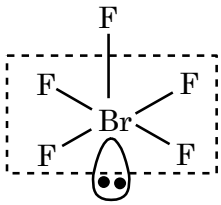
69. The molecule/ion with square pyramidal shape is:

(1) $[Ni(CN)_4]^{2-}$ (2) PCl_5

(3) BrF_5 (4) PF_5

Ans. **(3)**

Sol. BrF_5



Square Pyramidal.

70. The orange colour of $K_2Cr_2O_7$ and purple colour of $KMnO_4$ is due to

(1) Charge transfer transition in both.

(2) d→d transition in $KMnO_4$ and charge transfer transitions in $K_2Cr_2O_7$.

(3) d→d transition in $K_2Cr_2O_7$ and charge transfer transitions in $KMnO_4$.

(4) d→d transition in both.

Ans. **(1)**

Sol. $\left.\begin{matrix} K_2Cr_2O_7 \rightarrow Cr^{+6} \rightarrow \text{No d} - \text{d transition} \\ KMnO_4 \rightarrow Mn^{7+} \rightarrow \text{No d} - \text{d transition} \end{matrix}\right\} \text{Charge transfer}$

71. Alkaline oxidative fusion of MnO_2 gives "A" which on electrolytic oxidation in alkaline solution produces B. A and B respectively are:

(1) Mn_2O_7 and MnO_4^-

(2) MnO_4^{2-} and MnO_4^-

(3) Mn_2O_3 and MnO_4^{2-}

(4) MnO_4^{2-} and Mn_2O_7

Ans. **(2)**

Sol. Alkaline oxidative fusion of MnO_2:

$$2MnO_2 + 4OH^- + O_2 \rightarrow 2MnO_4^{2-} + 2H_2O$$

Electrolytic oxidation of MnO_4^{2-} in alkaline medium.

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

72. If a substance 'A' dissolves in solution of a mixture of 'B' and 'C' with their respective number of moles as n_A, n_B and n_C, mole fraction of C in the solution is:

(1) $\frac{n_C}{n_A \times n_B \times n_C}$ (2) $\frac{n_C}{n_A + n_B + n_C}$

(3) $\frac{n_C}{n_A - n_B - n_C}$ (4) $\frac{n_B}{n_A + n_B}$

Ans. **(2)**

Sol. Mole fraction of C = $\frac{n_C}{n_A + n_B + n_C}$

73. Given below are two statements:

Statement – I: Along the period, the chemical reactivity of the element gradually increases from group 1 to group 18.

Statement – II: The nature of oxides formed by group 1 element is basic while that of group 17 elements is acidic.

In the the light above statements, choose the most appropriate from the questions given below:

(1) Both statement I and Statement II are true.

(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 false.

Ans. **(3)**

Sol. Chemical reactivity of elements decreases along the period therefore statement – I is false.

Group – 1 elements from basic nature oxides while group – 17 elements form acidic oxides therefore statement – II is true.

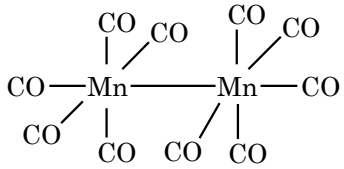
74. The coordination geometry around the manganese in decacarbonyldimanganese(0)

(1) Octahedral (2) Trigonal bipyramidal

(3) Square pyramidal (4) Square planar

Ans. **(1)**

Sol. $Mn_2(CO)_{10}$



Octahedral around Mn

75. Given below are two statements:

Statement-I: Since fluorine is more electronegative than nitrogen, the net dipole moment of NF_3 is greater than NH_3.

Statement-II: In NH_3, the orbital dipole due to lone pair and the dipole moment of NH bonds are in opposite direction, but in NF_3 the orbital dipole due to lone pair and dipole moments of N-F bonds are in same direction.

In the light of the above statements. Choose the most appropriate from the options given below.

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

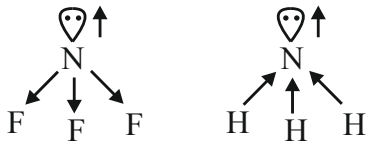
(2) Both Statement I and Statement II are false.

(3) Both statement I and Statement II is are true.

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

Ans. **(2)**

Sol.



76. The correct stability order of carbocations is

(1) $(CH_3)_3C^+ > CH_3-\overset{+}{C}H_2 > (CH_3)_2\overset{+}{C}H > \overset{+}{C}H_3$

(2) $\overset{+}{C}H_3 > (CH_3)_2\overset{+}{C}H > CH_3-\overset{+}{C}H_2 > (CH_3)_3\overset{+}{C}$

(3) $(CH_3)_3\overset{+}{C} > (CH_3)_2\overset{+}{C}H > CH_3-\overset{+}{C}H_2 > \overset{+}{C}H_3$

(4) $\overset{+}{C}H_3 > CH_3-\overset{+}{C}H_2 > CH_3-\underset{CH_3}{\overset{+}{C}H} > (CH_3)C^+$

Ans. **(3)**

Sol. More no. of hyperconjugable Hydrogens, more stable is the carbocations.

77. The solution from the following with highest depression in freezing point/lowest freezing point is

(1) 180 g of acetic acid dissolved in water

(2) 180 g of acetic acid dissolved in benzene

(3) 180 g of benzoic acid dissolved in benzene

(4) 180 g of glucose dissolved in water

Ans. **(1)**

Sol. ΔT_f is maximum when i × m is maximum.

1) $m_1 = \frac{180}{60} = 3$, $i = 1 + \alpha$

Hence

$$\Delta T_f = (1+\alpha)\cdot k_f = 3\times 1.86 = 5.58\,^\circ C\ (\alpha << 1)$$

2) $m_2 = \frac{180}{60} = 3,\ i = 0.5,\ \Delta T_f = \frac{3}{2}\times k_f' = 7.68^\circ C$

3) $m_3 = \frac{180}{122} = 1.48,\ i = 0.5,\ \Delta T_f = \frac{1.48}{2}\times k_f' = 3.8^\circ C$

4) $m_4 = \frac{180}{180} = 1,\ i = 1,\ \Delta T_f = 1\cdot k_f' = 1.86^\circ C$

As per NCERT, $k_f'(H_2O) = 1.86\ k\cdot kg\ mol^{-1}$

$k_f'(\text{Benzene}) = 5.12\ k\cdot kg\ mol^{-1}$

78. A and B formed in the following reactions are:

$$CrO_2Cl_2 + 4NaOH \rightarrow A + 2NaCl + 2H_2O$$

$$A + 2HCl + 2H_2O_2 \rightarrow B + 3H_2O$$

(1) $A = Na_2CrO_4$, $B = CrO_5$

(2) $A = Na_2Cr_2O_4$, $B = CrO_4$

(3) $A = Na_2Cr_2O_7$, $B = CrO_3$

(4) $A = Na_2Cr_2O_7$, $B = CrO_5$

Ans. **(1)**

Sol. $CrO_2Cl_2 + 4NaOH \rightarrow \underset{(A)}{Na_2CrO_4} + 2NaCl + 2H_2O$

$$Na_2CrO_4 + 2H_2O_2 + 2HCl \rightarrow \underset{(B)}{CrO_5} + \underset{\text{Missing from balanced eqaution}}{2NaCl} + 3H_2O$$

79. Choose the correct statements about the hydrides of group 15 elements.

A. The stability of the hydrides decreases in the order $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

B. The reducing ability of the hydrides increases in the order $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$

C. Among the hydrides, NH_3 is strong reducing agent while BiH_3 is mild reducing agent.

D. The basicity of the hydrides increases in the order $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$

Choose the most appropriate from the option given below:

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

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

Ans. **(3)**

Sol. On moving down the group, bond strength of M–H bond decreases, which reduces the thermal stability but increases reducing nature of hydrides, hence A and B are correct statements.

80. Reduction potential of ions are given below:

ClO_4^-	IO_4^-	BrO_4^-
$E° = 1.19V$	$E° = 1.65V$	$E° = 1.74V$

The correct order of their oxidising power is:

(1) $ClO_4^- > IO_4^- > BrO_4^-$

(2) $BrO_4^- > IO_4^- > ClO_4^-$

(3) $BrO_4^- > ClO_4^- > IO_4^-$

(4) $IO_4^- > BrO_4^- > ClO_4^-$

Ans. (2)

Sol. Higher the value of ⊕ve SRP (Std. reduction potential) more is tendency to undergo reduction, so better is oxidising power of reactant.

Hence, ox. Power:- $BrO_4^- > IO_4^- > ClO_4^-$

SECTION-B

81. Number of complexes which show optical isomerism among the following is _____.

$cis-[Cr(ox)_2Cl_2]^{3-}$, $[Co(en)_3]^{3+}$,

$cis-[Pt(en)_2Cl_2]^{2+}$, $cis-[Co(en)_2Cl_2]^{+}$,

$trans-[Pt(en)_2Cl_2]^{2+}$, $trans-[Cr(ox)_2Cl_2]^{3-}$

Ans. (4)

Sol. $cis-[Cr(ox)_2Cl_2]^{3-}$ → can show optical isomerism (no POS & COS)

$[Co(en)_3]^{3+}$ → can show (no POS & COS)

$cis-[Pt(en)_2Cl_2]^{2+}$ → can show (no POS & COS)

$cis-[Co(en)_2Cl_2]^{+}$ → can show (no POS & COS)

→ can't show (contains POS & COS)

$trans-[Cr(ox)_2Cl_2]^{3-}$ → can't show (contains POS & COS)

82. NO_2 required for a reaction is produced by decomposition of N_2O_5 in CCl_4 as by equation $2N_2O_{5(g)} \rightarrow 4NO_{2(g)} + O_{2(g)}$

The initial concentration of N_2O_5 is 3 mol L^{-1} and it is 2.75 mol L^{-1} after 30 minutes.

The rate of formation of NO_2 is x × 10^{-3} mol L^{-1} min^{-1}, value of x is _____.

Ans. (17)

Sol. Rate of reaction (ROR)

$$= -\frac{1}{2}\frac{\Delta[N_2O_5]}{\Delta t} = \frac{1}{4}\frac{[NO_2]}{\Delta t} = \frac{\Delta[O_2]}{\Delta t}$$

$$ROR = -\frac{1}{2}\frac{\Delta[N_2O_5]}{\Delta t} = -\frac{1}{2}\frac{(2.75-3)}{30}\,mol\,L^{-1}\,min^{-1}$$

$$ROR = -\frac{1}{2}\frac{(-0.25)}{30}\,mol\,L^{-1}\,min^{-1}$$

$$ROR = \frac{1}{240}\,mol\,L^{-1}\,min^{-1}$$

$$\text{Rate of formation of } NO_2 = \frac{\Delta[NO_2]}{\Delta t} = 4 \times ROR$$

$$= \frac{4}{240} = 16.66 \times 10^{-3}\ mol L^{-1}\ min^{-1} \simeq 17 \times 10^{-3}.$$

83. Two reactions are given below:

$$2Fe_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow Fe_2O_{3(s)}, \Delta H° = -822\,kJ/mol$$

$$C_{(s)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{(g)}, \Delta H° = -110\,kJ/mol$$

Then enthalpy change for following reaction

$3C_{(s)} + Fe_2O_{3(s)} \rightarrow 2Fe_{(s)} + 3CO_{(g)}$

Ans. (492)

Sol. $2Fe_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow Fe_2O_{3(s)}, \Delta H° = -822\,kJ/mol$ **.....(1)**

$C_{(s)} + \frac{1}{2}O_{2(g)} \rightarrow CO_{(g)}, \Delta H° = -110\,kJ/mol$ **.....(2)**

$3C_{(s)} + Fe_2O_{3(s)} \rightarrow 2Fe_{(s)} + 3CO_{(g)}$, $\Delta H_3 = ?$

(3) = 3 × (2) – (1)

$\Delta H_3 = 3 \times \Delta H_2 - \Delta H_1$

= 3(–110) + 822

= 492 kJ/mole

84. The total number of correct statements, regarding the nucleic acids is_____.

A. RNA is regarded as the reserve of genetic information.

B. DNA molecule self-duplicates during cell division

C. DNA synthesizes proteins in the cell.

D. The message for the synthesis of particular proteins is present in DNA

E. Identical DNA strands are transferred to daughter cells.

Ans. (3)

Sol. A. RNA is regarded as the reserve of genetic information. (False)

B. DNA molecule self-duplicates during cell division. (True)

C. DNA synthesizes proteins in the cell. (False)

D. The message for the synthesis of particular proteins is present in DNA. (True)

E. Identical DNA strands are transferred to daughter cells. (True)

85. The pH of an aqueous solution containing 1M benzoic acid ($pK_a = 4.20$) and 1M sodium benzoate is 4.5. The volume of benzoic acid solution in 300 mL of this buffer solution is _____ mL.

Ans. (100)

Sol.

	1M Benzoic acid (V_a ml)	+	1M Sodium Benzoate (V_s ml)
Millimole	$V_a \times 1$		$V_s \times 1$

$pH = 4.5$

$$pH = pka + \log\frac{[salt]}{[acid]}$$

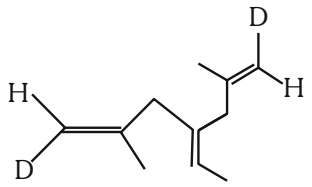
$$4.5 = 4.2 + \log\left(\frac{V_s}{V_a}\right)$$

$$\frac{V_s}{V_a} = 2 \qquad \ldots\ldots(1)$$

$$V_s + V_a = 300 \qquad \ldots\ldots (2)$$

$V_a = 100$ ml

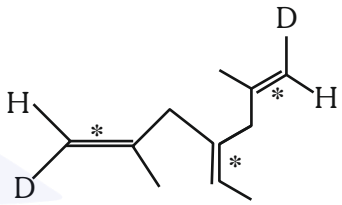
86. Number of geometrical isomers possible for the given structure is/are _____.



Ans. (4)

Sol. 3 stereocenteres, symmetrical

Total Geometrical isomers $\rightarrow$ 4. EE, ZZ, EZ (two isomers)



87. Total number of species from the following which can undergo disproportionation reaction _____.

$H_2O_2, ClO_3^-, P_4, Cl_2, Ag, Cu^{+1}, F_2, NO_2, K^+$

Ans. (6)

Sol. Intermediate oxidation state of element can undergo disproportionation.

$H_2O_2, ClO_3^-, P_4, Cl_2, Cu^{+1}, NO_2$

88. Number of metal ions characterized by flame test among the following is _____.

$Sr^{2+}, Ba^{2+}, Ca^{2+}, Cu^{2+}, Zn^{2+}, Co^{2+}, Fe^{2+}$

Ans. (4)

Sol. All the following metal ions will respond to flame test.

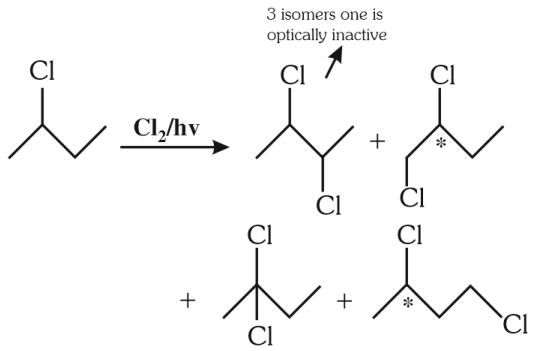
$Sr^{2+}, Ba^{2+}, Ca^{2+}, Cu^{2+}$

89. 2-chlorobutane + $Cl_2 \rightarrow C_4H_8Cl_2$(isomers)

Total number of optically active isomers shown by $C_4H_8Cl_2$, obtained in the above reaction is_____.

Ans. **(6)**

Sol.



90. Number of spectral lines obtained in He^+ spectra, when an electron makes transition from fifth excited state to first excited state will be

Ans. **(10)**

Sol. 5^{th} excited state $\Rightarrow n_1 = 6$

1^{st} excited state $\Rightarrow n_2 = 2$

$\Delta n = n_1 - n_2 = 6 - 2 = 4$

Maximum number of spectral lines

$$= \frac{\Delta n(\Delta n + 1)}{2} = \frac{4(4+1)}{2} = 10$$