ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

Chapter Contents 02

JEE (MAIN) TOPICWISE SOLUTION OF TEST PAPERS JANUARY & SEPTEMBER 2020

CHEMISTRY

PHYSICAL CHEMISTRY

ORGANIC CHEMISTRY

ALLEN

INORGANIC CHEMISTRY

JANUARY & SEPTEMBER 2020 ATTEMPT (PC)

MOLE CONCEPT

1. NTA Ans. (3)

Sol. Option(3) is according to Gaylussac's law of volume combination.

2. NTA Ans. (3)

Sol. $NH_2CONH_2 + 2NaOH \rightarrow Na_2CO_3 + 2NH_3$

10 mmoles 20mmoles

Hence, NH_3 will require 20 meq.

3. NTA Ans. (4.95 to 4.97)

Sol. $FeSO_4.7H_2O$ (M = 277.85)

$$\text{ppm} = \frac{\text{wt. of Fe}}{\text{wt. of wheat}} \times 10^6$$

let the wt. of salt be = w gm

$$\text{moles} = \frac{w}{277.85}$$

$$\text{wt. of Fe} = \left(\frac{W}{277.85} \times 55.85\right)\text{gm}$$

$$10 = \frac{\frac{W}{277.85} \times 55.85}{10^5} \times 10^6$$

$$W = \frac{277.85}{55.85} = 4.97$$

4. NTA Ans. (2120 to 2140)

Sol. Mole of O_2 consumed = $\frac{1 \times 492}{0.082 \times 300}$ = 20

Mole of $NaClO_3$ required = 20

Mass of $NaClO_3$ = 20 × 106.5 = 2130 gm

5. NTA Ans. (1)

Sol. IE values indicate, that the metal belongs to Ist group since second IE is very high

($\because$ only one valence electron)

Metal hydroxide will be of type, MOH.

$MOH + HCl \rightarrow MCl + H_2O$

(1mol) (1mol)

$MOH + \frac{1}{2}H_2SO_4 \rightarrow \frac{1}{2}M_2SO_4 + H_2O$

(1mol) ($\frac{1}{2}$ mol)

So one mole of HCl required to react with one mole MOH.

So $\frac{1}{2}$ mole of H_2SO_4 required to react with one mole MOH.

6. NTA Ans. (4)

Sol. $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

$Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$

The ratio of the volume of H_2 is 1 : 1

7. Official Ans. by NTA (18)

Sol. $\underset{1\,mole}{C_3H_8} + \underset{5\,mole}{5O_2} \rightarrow 3CO_2 + 4H_2O$

For 1 mole propane combustion 5 mole O_2 required

$C_4H_{10} + \frac{13}{2}O_2 \rightarrow 4CO_2 + 5H_2O$

1 mole 6.5 mole

2 mole 13 mole

For 2 moles of butane 13 mole of O_2 is required

total moles = 13 + 5 = 18

8. Official Ans. by NTA (5.00)

Sol. C : H = 4 : 1

C : O = 3 : 4

Mass ratio

C : H : O = 12 : 3 : 16

Mole ratio

C : H : O = 1 : 3 : 1

Empirical formula = CH_3O

Molecular formula = $C_2H_6O_2$

(saturated acyclic organic compound)

$C_2H_6O_2 + \frac{5}{2}O_2 \longrightarrow 2CO_2 + 3H_2O$

2 mole 5 mol

Moles of O_2 required = 5 moles

9. Official Ans. by NTA (50.00)

CONCENTRATION TERMS

1. NTA Ans. (14.00)

Sol. 100 gm soln → 63 gm HNO_3

$\frac{100}{1.4}$ mL → 1 mole HNO_3

$$\text{Molarity} = \frac{1}{\frac{100}{1.4} \times \frac{1}{1000}} = 14M$$

2. NTA Ans. (10)

Sol. ppm = $\dfrac{10.3\times10^{-3}}{1030}\times10^{6}=10$

3. Official Ans. by NTA (100)

Sol. Volume strength of H_2O_2 at 1 atm

273 kelvin = M × 11.2 = 8.9 × 11.2 = 99.68

Ans : 100

4. Official Ans. by NTA (47)

Sol. $X_{C_6H_{12}O_6} = 0.1$

Let total mole is 1 mol then mole of glucose will be 0.1 and mole of water will be 0.9

so mass % of water = $\dfrac{0.9\times18}{0.1\times180+0.9\times18}\times100$

= 47.36

Ans : 47

5. Official Ans. by NTA (25)

Sol. moles = $\dfrac{\text{number of molecules}}{6\times10^{23}}=\dfrac{\text{given mass}}{\text{molar mass}}$

$\Rightarrow$ molar mass = $\dfrac{10\times6.023\times10^{23}}{6.023\times10^{22}}=100\text{g / mol}$

$\Rightarrow$ molarity = $\dfrac{\text{moles of solute}}{\text{volume of sol}^{n}(\ell)}=\dfrac{(5/100)}{2}=0.025$

6. Official Ans. by NTA (2)

Sol. Volume strength = 11.2 × molarity

$\Rightarrow$ molarity = $\dfrac{5.6}{11.2}=0.5$

Assuming 1 litre solution;

mass of solution = 1000 ml × 1 g/ml = 1000 g

mass of solute = moles × molar mass

= 0.5 mol × 34 g/mol

= 17 gm.

$\Rightarrow$ mass% = $\dfrac{17}{1000}\times100=1.7\%$

7. Official Ans. by NTA (4)

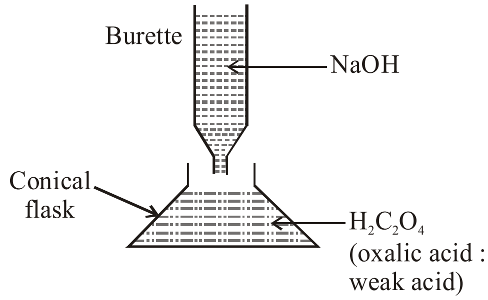
REDOX REACTIONS

1. NTA Ans. (3)

Sol. Potasisum has an oxidation of +1 (only) in combined state.

2. NTA Ans. (4)

Sol.



3. NTA Ans. (4)

Sol. (i) H_2O_2 act as oxidising agent as well as reducing agent depending on condition.

(ii) H_2SO_3 act as oxidising agent as well as reducing agent depending on condition.

(iii) HNO_2 act as oxidising agent as well as reducing agent depending on condition.

(iv) H_3PO_4 can not act both as oxidising and reducing agent.

H_3PO_4 can act as only oxidising agent.

$H_3PO_4 \rightleftharpoons 3H^+ + PO_4^{3-}$

4. NTA Ans. (100)

Sol. 1 Litre has 10^{-3} moles $MgSO_4$

So , 1000 litre has 1 mole $MgSO_4$

= 1 mole $CaCO_3$

= 100 ppm

5. Official Ans. by NTA (19)

Sol. $\left[Fe^{2+}\rightarrow Fe^{3+}+e^{-}\right]\times2$

$$\begin{array}{l} H_2O_2+2e^-\rightarrow 2HO^{\ominus} \\ \hline 2Fe^{2+}+H_2O_2\rightarrow 2Fe^{3+}+2HO^{\ominus}_{(q\omega)} \end{array}$$

x = 2 y = 2

$\left[8H^++MnO_4^-+5e^-\rightarrow Mn^{2+}+4H_2O\right]\times2$

$\left[H_2O_2\rightarrow O_{2(g)}+2H^++2e^-\right]\times5$

$\Rightarrow 16H^++2MnO_4^-+5H_2O_2$

$\rightarrow 2Mn^{2+}+8H_2O+5O_{2(g)}+10H^+$

$\Rightarrow 6H^++2MnO_4^-+5H_2O_2$

$\rightarrow 2Mn^{2+}+8H_2O+5O_{2(g)}$

So x' = 2 y' = 8 z' = 5

so x + y + x' + y' + z'

$\Rightarrow$ 2 + 2 + 2 + 8 + 5

$\Rightarrow$ 19

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6. Official Ans. by NTA (10)

Sol. Molar mass of $Na_2CO_3 \cdot xH_2O$

$\Rightarrow 23 \times 2 + 12 + 48 + 18x$

$\Rightarrow 46 + 12 + 48 + 18x$

$\Rightarrow (106 + 18x)$

$$Eqwt = \frac{M}{2} = (53+9x)$$

As n_{factor} in dissolution will be determined from net cationic or anionic charge; which is 2 so

$$Eqwt = \frac{M}{2} = 53+9x$$

$$Gmeq = \frac{wt}{Eqwt} = \frac{1.43}{53+9x}$$

$$Normality = \frac{Gmeq}{V_{litre}}$$

$$Normality = 0.1 = \frac{\frac{1.43}{53+9x}}{0.1}$$

As volume = 100 ml

= 0.1 Litre

$$So \quad 10^{-2} = \frac{1.43}{53+9x}$$

$53 + 9x = 143$

$9x = 90$

$x = 10.00$

7. Official Ans. by NTA (85)

Sol. Eq of H_2O_2 = Eq of $KMnO_4$

$$x \times 2 = \frac{0.316}{158} \times 5$$

$x = 5 \times 10^{-3}$ mol

$$m_{H_2O_2} = 5 \times 10^{-3} \times 34 = 0.17gm$$

$$\%H_2O_2 = \frac{0.17}{0.2} \times 100 = 85$$

8. Official Ans. by NTA (10)

Sol. $H_3PO_2 + NaOH \rightarrow NaH_2PO_2 + H_2O$

$$\frac{n_{H_3PO_2}\text{ reacted}}{1} = \frac{n_{NaOH}\text{ reacted}}{1}$$

$$\Rightarrow \frac{0.1 \times 10}{1} = 0.1 \times V_{NaOH}$$

$\Rightarrow V_{NaOH} = 10$ ml.

9. Official Ans. by NTA (50.00)

Sol. $K_2Cr_2O_7 + FeC_2O_4 \longrightarrow Cr^{+3} + Fe^{+3} + CO_2$

n = 6 n = 3

$$\frac{0.02 \times 6 \times V(mL)}{1000} = \frac{0.288}{144} \times 3$$

$$\Rightarrow \boxed{V = 50mL}$$

10. Official Ans. by NTA (19.00)

Sol. $K_2Cr_2O_7$

$2(+1) + 2x + 7(-2) = 0$

$x = +6$

In $K_2Cr_2O_7$, Transition metal (Cr) present in +6 oxidation state.

$KMnO_4$

$(+1) + y + 4(-2) = 0$

$x = +7$

In $KMnO_4$, transition metal (Mn) present in +7 oxidation state

K_2FeO_4

$2(+1) + z + 4(-2) = 0$

$x = +6$

In K_2FeO_4, transition metal (Fe) present in +6 oxidation state

So, $x = +6$

$y = +7$

$z = +6$

$x + y + z = 19$

IDEAL GAS

1. NTA Ans. (4)

Sol. $V_{mp}\left(=\sqrt{\frac{2RT}{M}}\right) < V_{av}\left(=\sqrt{\frac{8RT}{\pi M}}\right) < V_{rms}\left(=\sqrt{\frac{3RT}{M}}\right)$

2. Official Ans. by NTA (3)

Sol. According to Dalton's law of partial pressure

$p_i = x_i \times P_T$

p_i = partial pressure of the i^{th} component

x_i = mole fraction of the i^{th} component

p_T = total pressure of mixture

$$\Rightarrow 2 \text{ atm} = \left(\frac{n_{H_2}}{n_{H_2} + n_{H_e} + n_{O_2}}\right) \times p_T$$

$$\Rightarrow p_T = 2 \text{ atm} \times \frac{3}{1} = 6 \text{ atm}$$

3. Official Ans. by NTA (1)

Sol. $PM = dRT \Rightarrow d \propto \frac{1}{T}$

4. Official Ans. by NTA (750.00)

ATOMIC STRUCTURE

1. NTA Ans. (2)

Sol. No. of orbitals = $n^2 = 5^2 = 25$

For n = 5, no. of orbitals = n^2 = 25

Total number of orbitals is equal to no. of electrons having $m_s = \frac{1}{2}$

2. NTA Ans. (2)

Sol. For balmer : $n_1 = 2$, $n_2 = 3, 4, 5, \ldots \infty$

$$\bar{\nu} = \frac{1}{\lambda} = R_H\left[\frac{1}{2^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda_{longest}} = R_H\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$

Ans.(2)

3. NTA Ans. (4)

Sol. $r_n = \frac{n^2 \times a_0}{z}$

For 2^{nd} Bohr orbit of Li^{+2}

n = 2

z = 3

$$\Rightarrow r_n = \frac{2^2 \times a_0}{3} = \frac{4a_0}{3}$$

4. NTA Ans. (1)

Sol. $2\pi r = n\lambda$

for $n = 1, r = a_0$

$n = 4, r = 16a_0$

So, $2\pi \times 16a_0 = 4 \times \lambda$

$\lambda = 8\pi a_0$

5. Official Ans. by NTA (3)

Sol. As we know $\Delta E = \frac{hc}{\lambda}$

So $\lambda = \frac{hc}{\Delta E}$ for λ minimum i.e.

shortest; ΔE = maximum

for Lyman series n = 1 & for ΔE_{max}

Transition must be form $n = \infty$ to n = 1

So $\frac{1}{\lambda} = R_H Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$$\frac{1}{\lambda} = R_H Z^2(1-0)$$

$$\frac{1}{\lambda} = R \times (1)^2 \Rightarrow \lambda_1 = \frac{1}{R}$$

For longest wavelength ΔE = minimum for Balmer series n = 3 to n = 2 will have ΔE minimum

for He^+ Z = 2

So $\frac{1}{\lambda_2} = R_H \times Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$$\frac{1}{\lambda_2} = R_H \times 4\left(\frac{1}{4} - \frac{1}{9}\right)$$

$$\frac{1}{\lambda_2} = R_H \times \frac{5}{9}$$

$$\lambda_2 = \lambda_1 \times \frac{9}{5}$$

6. **Official Ans. by NTA (4)**

Sol. $\frac{\Delta R_1}{\Delta R_2} = \frac{(r_4 - r_3)_{4^{2+}}}{(r_4 - r_3)_{He^+}} = \frac{\frac{4^2}{3} - \frac{3^2}{3}}{\frac{4^2}{2} - \frac{3^2}{2}} = \frac{7/3}{7/2} = \frac{2}{3}$

7. **Official Ans. by NTA (1)**

8. **Official Ans. by NTA (222.00)**

Sol. $E = W + K{\cdot}E_{max}$

$K{\cdot}E_{max} = E - W$

$= \frac{hc}{\lambda} - 4.41 \times 10^{-19}$

$= \frac{6.63\times10^{-34}\times3\times10^{8}}{300\times10^{-9}} - 4.41 \times 10^{-19}$

$= 2.22 \times 10^{-19}$ J

$= 222 \times 10^{-21}$ J

CHEMICAL EQUILIBRIUM

1. **NTA Ans. (1)**

ALLEN Ans. (1 or Bonus)

Sol. Bonus (no reaction is given)

$A \rightleftharpoons B$ (Assume reaction)

$K = \frac{[B]}{[A]} = \frac{11}{6} \simeq 2$

2. **Official Ans. by NTA (1)**

Sol. $\Delta H^o > 0$ $T\downarrow$ equation shifts back ward.

N_2 is treated as inert gas in this case hence no effect on equilibrium.

3. **Official Ans. by NTA (2)**

Sol. $N_2 + 3H_2 \rightleftharpoons 2NH_3 \rightarrow K_C = 64$

$2NH_3 \rightleftharpoons N_2 + 3H_2 \rightarrow K_C = \frac{1}{64}$

$NH_3 \rightleftharpoons \frac{1}{2}N_2 + \frac{3}{2}H_2 \rightarrow K_C = \left(\frac{1}{64}\right)^{1/2} = \frac{1}{8}$

IONIC EQUILIBRIUM

1. **NTA Ans. (10.60)**

Sol. 4 gm of NaOH in 100 L sol. $\Rightarrow 10^{-3}$ M sol.

9.8 gm of H_2SO_4 in 100 L sol. $\Rightarrow 10^{-3}$ M sol.

Mixture : 40L of 10^{-3} M NaOH and 10 L of 10^{-3} M H_2SO_4 sol.

Final Conc. of OH^-

$= \frac{10^{-3}(40\times1-10\times1\times2)}{40+10} = 6\times10^{-4}M$

pOH = – log (6×10^{-4})

= 4 – log 6 = 4 – 0.60 = 3.40

pH = 14 – 3.40 = 10.60

2. **NTA Ans. (5.22 to 5.24)**

Sol. 3gm Acetic Acid + 250 ml 0.1 M HCl + Water

$\longrightarrow$ made to 500 ml solution.

$\Rightarrow$ 500 ml solution has 25 meq of HCl

50 meq of CH_3COOH

$\therefore$ 20ml solution has 1 meq of HCl

2 meq of CH_3COOH

We have added 2.5 meq. of NaOH $\left(5M, \frac{1}{2} ml\right)$

Finally , NaOH & HCl are completely consumed and we are left with 0.5 meq of CH_3COOH

and 1.5 meq of CH_3COONa

$pH = pKa + \log\frac{1.5}{0.5}$

$= 4.75 + \log 3 = 4.75 + 0.4771$

$= 5.2271$

3. **NTA Ans. (3)**

Sol. From the graph & dimensions salt is : XY_2

$[X] = 1 \times 10^{-3}M$

$[Y] = 2 \times 10^{-3}M$

$XY_2(s) \rightleftharpoons X^{2+}_{(aq.)} + 2Y^-_{(aq.)}$

ksp = $[X^{2+}][Y^-]^2$

$= (10^{-3})(2 \times 10^{-3})^2$

$= 4 \times 10^{-9}$ M^3

4. NTA Ans. (2)

Sol. $H_2O(\ell) \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)}$

For ionization of H_2O : $\Delta H > O$

$\Rightarrow$ ENDOTHERMIC

On temperature increase reaction shifts forward

$\Rightarrow$ both $[H^+]$ and $[OH^-]$ increase

$\Rightarrow$ pH & pOH decreases.

5. NTA Ans. (2)

Sol. $\left[Pb^{2+}\right] = \frac{300 \times 0.134}{400} = 1.005 \times 10^{-1}$ M

$\left[Cl^-\right] = \frac{100 \times 0.4}{400} = 10^{-1}$ M

$PbCl_{2(s)} \rightleftharpoons Pb^{+2}_{(aq.)} + 2Cl^-_{(aq.)}$

$Q = [Pb^{2+}] \times [Cl^-]^2 = 1.005 \times 10^{-3} > k_{sp}$

6. NTA Ans. (1)

Sol. $Cr(OH)_3(s) \rightleftharpoons Cr^{3+}(aq.) + 3OH^-(aq.)$

(s) (3s)

$k_{sp} = 27(s)^4 = 6 \times 10^{-31}$

$\Rightarrow [3(s)]^4 = 18 \times 10^{-31}$

$[OH^-] = 3(s) = [18 \times 10^{-31}]^{1/4}$

7. Official Ans. by NTA (3)

Sol. $\underset{\substack{10 \text{ milli mol} \\ -}}{HCl} + \underset{\substack{20 \text{ milli mol} \\ 10 \text{ milli mol}}}{CH_3COONa} \rightarrow \underset{\substack{- \\ 10 \text{ milli mol}}}{CH_3COOH} + \underset{\substack{- \\ 10 \text{ milli mol}}}{NaCl}$

So finally we get mixture of $CH_3COOH + CH_3COONa$ that will work like acidic buffer solution.

8. Official Ans. by NTA (3)

Sol. Steep rise in pH around the equivalence point for titration of strong acid with strong base.

9. Official Ans. by NTA (37)

Sol. $P_{CO_2} = K_H \times CO_2$

$\frac{3}{30} = \frac{K_H . n_{CO_2}}{K_H 1} \Rightarrow n_{CO_2 = 0.1} mol$

$pH = \frac{1}{2}(pka_1 - \log c) = \frac{1}{2}(6.4 \times 1) = 3.7$

$pH = 37 \times 10^{-1}$

10. Official Ans. by NTA (2.00)

Sol. $AB_2(s) \rightleftharpoons \underset{S}{A^{+2}_{(aq.)}} + \underset{2S}{2B^-_{(aq.)}} : K_{sp}$

$K_{SP} = S^1 \times (2s)^2 = 4s^3$

$3.2 \times 10^{-11} = 4 \times S^3$

$S = 2 \times 10^{-4}$ M/L

11. Official Ans. by NTA (4)

THERMODYNAMICS

1. NTA Ans. (–2.70 to –2.71)

Sol. $A(\ell) \longrightarrow 2B(g)$

$\Delta U = 2.1$ Kcal , $\Delta S = 20$ cal K^{-1} at 300 K

$\Delta H = \Delta U + \Delta n_g RT$

$\Delta G = \Delta H - T\Delta S$

$\Delta G = \Delta U + \Delta n_g RT - T\Delta S$

$= 2.1 + \frac{2 \times 2 \times 300}{1000} - \frac{300 \times 20}{1000}$

($R = 2$ cal K^{-1} mol^{-1})

$= 2.1 + 1.2 - 6 = -2.70$ Kcal/mol

2. NTA Ans. (48.00)

Sol. Area enclosed under

P V curve = 48 = 48 Joule

3. NTA Ans. (6.25)

Sol. For ideal gas :

$\Delta U = nC_V[T_2 - T_1]$

$\Rightarrow 5000 = 4 \times C_V[500 - 300]$

$\Rightarrow C_V = \frac{5000}{800} = 6.25$ J $mole^{-1}$ K^{-1}

4. NTA Ans. (1)

Sol. $ds = \int \frac{q_{rev.}}{T}$

5. NTA Ans. (2.17 to 2.23)

Sol. $0 - T_f' = 2 \times 0.5 = 1$

$T_f' = -1°C = 272$ K

for gas $P = \frac{0.1 \times 0.08 \times 272}{1}$

$P = 2.176$ atm

$P_1V_1 = P_2V_2$

$2.176 \times 1 = 1 \times V_2$

$V_2 = 2.176$ litre

6. Official Ans. by NTA (4)

Sol. As the expansion is done in vaccum that is in absence of p_{ext} so

W = zero

7. Official Ans. by NTA (1)

Sol. For ideal Gas

U = f(T), H = f(T)

Z = 1

$C_P - C_V = R$

$dU = C_V\, dT$

8. Official Ans. by NTA (–13538.00)
Official Ans. by ALLEN (–13537.57)

Sol. $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

$= (\Delta U^\circ + \Delta n_g RT) - T\Delta S^\circ$

$= \left[\left\{-20+(-1))\frac{8.314}{1000}\times 298\right\}-\frac{298}{1000}\times(-30)\right]$ kJ

$= -13.537572$ kJ

$= -13537.57$ Joule

9. Official Ans. by NTA (189494.00)
Official Ans. by ALLEN (189494.39)

Sol. $H_2O(\ell) \rightleftharpoons H_2O(g)$ 90 gm of H_2O

$\Delta H = \Delta U + \Delta n_g RT$ $\Rightarrow$ 5 moles of H_2O

5×41000 J $= \Delta U + 1 \times 8.314 \times 373 \times 5$

$\Delta U = 189494.39$ Joule

10. Official Ans. by NTA (96500.00)

Sol. $\Delta G = \Delta G^o + RT \ln\left[\frac{Sn^{+2}}{Cu^{+2}}\right]$

$= -2 \times 96500\ [(-0.16) - 0.34] + RT \ln\left(\frac{1}{1}\right)$

$= 96500$ J

11. Official Ans. by NTA (3)

THERMOCHEMISTRY

1. NTA Ans. (–192.50 or –85.00)

Sol. $2C(\text{graphite}) + 3H_2(g) \longrightarrow C_2H_6(g)$

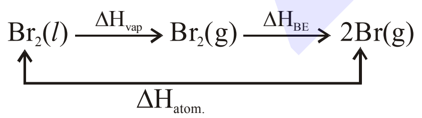
$\Delta_f H\ (C_2H_6) = 2\Delta H_{comb}\ (C_{graphite}) + 3\ \Delta H_{comb}(H_2) - \Delta H_{comb}\ (C_2H_6)$

$= -(286\times 2)-(393.5\times 3)-(-1560)$

$= -572 - 1180.5 + 1560 = -192.5$ kJ/mole

2. NTA Ans. (4)

Sol. Enthalpy of atomisation of $Br_2(l)$



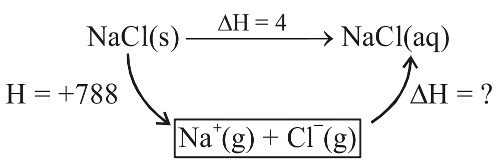
$\Delta H_{atom} = \Delta H_{vap} + \Delta H_{BE}$

$x = \Delta H_{vap} + y$

So, $x > y$

3. Official Ans. by NTA (2)

Sol.



$4 = 788 + \Delta H$

$\Delta H = -784$ kJ

4. Official Ans. by NTA (–326400.00)
Official Ans. by ALLEN (326400.00)

Sol. $C_2H_5OH_{(\ell)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(\ell)}$

$\Delta n_g = 2 - 3 = -1$

$\Delta_c H = \Delta_c U + (\Delta n_g)\ RT$

$\Delta_c H = \Delta_c U - RT$

$\Delta_c U = \Delta_c H + RT$

$= -327 \times 10^3 + 2 \times 300$

$= -326400$ cal.

$\therefore$ Heat evolved

$= 326400$ cal.

SOLID STATE

1. NTA Ans. (1)

Sol. Since AgBr has intermediate radius ratio

$\therefore$ it shows both schottky & Frenkel defects

ZnS $\rightarrow$ Frenkel defects

KBr, CsCl $\rightarrow$ Schottky defects

2. Official Ans. by NTA (143)

Sol. $d = \frac{z\left(\frac{M}{N_A}\right)}{a^3}$

$2.7\times 10^3 = z\frac{\left(\frac{2.7\times 10^{-2}}{6\times 10^{23}}\right)}{\left(405\times 10^{-12}\right)^3}$

$2.7\times 10^3 = z\frac{\left(2.7\times 10^{-2}\right)}{6\times 10^{23}\left(4.05\times 10^{-10}\right)^3}$

$2.7\times 10^3 = z\frac{\left(2.7\times 10^{-2}\right)}{6\times 10^{23}\times 66.43\times 10^{-30}}$

$3.98 = z$

$z \approx 4$ structure is fcc

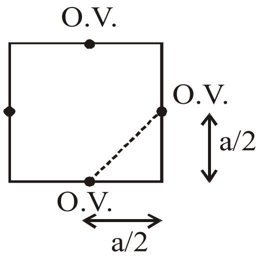
$\frac{a}{\sqrt{2}} = 2r$

$r = \frac{a}{2\sqrt{2}} = \frac{\sqrt{2}a}{4} = \frac{1.414\times 405\times 10^{-12}}{4}$

$r = 143.16 \times 10^{-12}$

3. Official Ans. by NTA (3)

Sol.



distance between nearest octahedral voids(O.V.)

$= \sqrt{\left(\frac{a}{2}\right)^2 + \left(\frac{a}{2}\right)^2} \quad \Rightarrow \quad = \frac{a}{\sqrt{2}}$

4. Official Ans. by NTA (1)

Sol. O^{-2} ions form ccp. O_4 ↓ (–8 charge)

M_1 = 50% of O.V. $\Rightarrow \frac{50}{100} \times 4 = 2 : (M_1)_2$

M_2 = 12.5% of T.V. $\Rightarrow \frac{12.5}{100} \times 8 = 1 : (M_2)_1$

So formula is : $(M_1)_2\ (M_2)_1 O_4$

This must be neutral. Both metals must have +8 charge in total.

From given options : $\left\{ \begin{array}{l} \text{O.N. of } M_1 = +2 \\ \qquad\qquad M_2 = +4 \end{array} \right\}$

CHEMICAL KINETICS

1. NTA Ans. (4)

Sol. $K_{eq} = \frac{k_f}{k_b} = \frac{[N_2][H_2O]^2}{[H_2]^2[NO]^2}$

At equilibrium $r_f = r_b$

$k_f \underset{[\text{Given}]}{[H_2][NO]^2} = k_b \frac{[N_2][H_2O]^2}{[H_2]}$

Hence, rate expression for reverse reaction.

$= k_b \frac{[N_2][H_2O]^2}{[H_2]}$

2. NTA Ans. (4)

Sol. $K = Ae^{\frac{-E_a}{RT}}$

$K' = Ae^{\frac{-E_a'}{RT}} = 10^6 K$

$Ae^{\frac{-E'}{RT}} = 10^6 \times Ae^{\frac{-E_a}{RT}}$

$\frac{-E_a'}{RT} = \frac{-E_a}{RT} + \ln 10^6$

$E_a' = E_a - RT \ln 10^6$

$E_a' - E_a = - RT \ln 10^6 = - 6RT \times 2.303$

3. NTA Ans. (3)

Sol. $\log K = \frac{-Ea}{2.303RT} + \log A$

Acrroding to Arrhenius equation plot of 'log K' Vs. $\frac{1}{T}$ is linear with.

Slope = $\frac{-Ea}{2.303R}$

From plot we conclude :

$\underset{(\text{magnitude})}{|\text{slope}|}$: c > a > d > b

$\therefore\ E_c > E_a > E_d > E_b$

4. NTA Ans. (4)

Sol. $K_1 = Ae^{-\frac{Ea}{R \times 700}}$

$K_2 = A \times e^{-\frac{(Ea-30)}{R \times 500}}$

For same rate

$K_1 = K_2$

$e^{-\frac{Ea}{700R}} = e^{-\frac{(Ea-30)}{R \times 500}}$

$\frac{Ea}{700R} = \frac{Ea - 30}{R \times 500}$

5Ea = 7Ea – 210

210 = 2Ea

E_a = 105 kJ/mole

E_a – 30 = 75

5. NTA Ans. (3.98 to 4.00 or –3.98 to –4.00)

Sol. $\ln\left(\frac{t_1}{t_2}\right) = \frac{-Ea}{R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$

$\ln\left(\frac{60}{40}\right) = \frac{-Ea}{8.3}\left[\frac{1}{400} - \frac{1}{300}\right]$

E = 0.4 × 1200 × 8.3

= 3.984 kJ/mole

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6. Official Ans. by NTA (84297)

Official Ans. by ALLEN (84297.47 or 84297.48)

Sol. $T_1 = 300K \qquad T_2 = 315K$

As per question $K_{T_2} = 5K_{T_1}$ as molecules activated are increased five times so k will increases 5 times

Now

$$\ln\left(\frac{K_{T_2}}{K_{T_1}}\right) = \frac{Ea}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\ln 5 = \frac{Ea}{R}\left(\frac{15}{300 \times 315}\right)$$

So $\quad Ea = \dfrac{1.6094 \times 8.314 \times 300 \times 315}{15}$

Ea = 84297.47 Joules/mole

7. Official Ans. by NTA (60)

Sol. $t_{0.75} = 2 \times \dfrac{\ln 2}{k} = 90$

$$k = \frac{\ln 2}{45}\min^{-1}$$

$$kt = \ln\frac{1}{1-0.6} = \ln 2.5$$

$$\frac{\ln 2}{45} \times t = \ln 2.5$$

$$t = 45 \times \frac{\log 2.5}{\log 2} = 45 \times \frac{0.4}{0.3} = 60\,\text{min}$$

8. Official Ans. by NTA (4)

Sol. Zero order reaction is multiple step reaction.

9. Official Ans. by NTA (4)

Sol. For aA + bB $\rightarrow$ cC;

$$\frac{-1}{a}\frac{d[A]}{dt} = \frac{-1}{b}\frac{d[B]}{dt} = \frac{1}{c}\frac{d[C]}{dt}$$

$$\therefore \quad \frac{-1}{2}\frac{d[A]}{dt} = \frac{-1}{3}\frac{d[B]}{dt} = \frac{-2}{3}\frac{d[C]}{dt} = \frac{1}{3}\frac{d[P]}{dt}$$

10. Official Ans. by NTA (4)

Sol. $[A]_t = 4[B]_t$

$$[A]_0\ e^{-(\ln^2/300)^t} = 4[B]_0 e^{(-\ln 2/180)t}$$

$$e^{\left(\frac{\ln^2}{180} - \frac{\ln^2}{300}\right)} = 4$$

$$\left(\frac{\ln^2}{180} - \frac{\ln^2}{300}\right)t = \ln 4$$

$$\left(\frac{1}{180} - \frac{1}{300}\right)t = 2 \Rightarrow t = \frac{2 \times 180 \times 300}{120} = 900\,\text{sec}.$$

11. Official Ans. by NTA (1)

Sol. Slope $= -\dfrac{E_a}{R}$

$$-\frac{10}{5} = -\frac{E_a}{R}$$

$E_a = 2R$

12. Official Ans. by NTA (1)

Sol. From rate law

$$r = -\frac{1}{2}\frac{d[A]}{dt} = \frac{-d[B]}{dt}$$

$= K[A]^x\ [B]^y$

$6 \times 10^{-3} = K(0.1)^x\ (0.1)^y$ ......(1)

$2.4 \times 10^{-2} = K(0.1)^x\ (0.2)^y$ ......(2)

$1.2 \times 10^{-2} = K(0.2)^x\ (0.1)^y$ ......(3)

(3) $\div$ (1) $\Rightarrow$ x = 1

(2) $\div$ (3) $\Rightarrow$ x = 2

So, order with respect to A = 1

Order with respect to B = 2

(4) $\div$ (3)

$$\left(\frac{x}{0.2}\right) \times \left(\frac{0.2}{0.1}\right)^2 = \frac{7.2 \times 10^{-2}}{1.2 \times 10^{-2}}$$

$$x = \frac{6 \times 0.2}{4}$$

x = 0.3 M

(5) $\div$ (4)

$$\left(\frac{y}{0.2}\right)^2 = \frac{2.88 \times 10^{-1}}{7.2 \times 10^{-2}}$$

$y^2 = 4 \times 0.2^2$

y = 0.4 M

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13. Official Ans. by NTA (3)

14. Official Ans. by NTA (100.00)

Official Ans. by ALLEN (99.98)

Sol. $\ell n\left(\frac{K_{T_2}}{K_{T_1}}\right)=\frac{E_a}{R}\left[\frac{1}{T_1}-\frac{1}{T_2}\right]$

$T_1 = 303$ K ; $T_2 = 313$ K

$\frac{K_{T_2}}{K_{T_1}}=3.555$

$\ell n(3.555)=\frac{E_a}{8.314}\left[\frac{1}{303}-\frac{1}{313}\right]$

$E_a = 99980.715$

$E_a = 99.98\ \frac{kJ}{mole}$

RADIOACTIVITY

1. NTA Ans. (23 to 23.03)

Sol. All nuclear decays follow first order kinetics

$t=\frac{1}{k}\ell n\frac{[A_0]}{[A]}$

$=\frac{(t_{1/2})}{0.693}\times 2.303\ \ \log_{10}10\ \ = 10 \times 2.303 \times 1$

$= 23.03$ years

SURFACE CHEMISTRY

1. NTA Ans. (0.36 to 0.38)

Sol. 1 L solution requires 30 m.mol HCl

250 ml sol. will require 7.5 m.mol HCl

or 3.75 m.mol H_2SO_4

$\Rightarrow \frac{3.75\times 98}{1000}$ gm H_2SO_4

$= 0.3675$ gm H_2SO_4

2. NTA Ans. (4)

Sol. Since, $Fe(OH)_3$ is positively charged sol, hence, anionic charge will flocculate

As per Hardy Schulze rules coagulation power of anion follows the order :

$Fe(CN)_6^{3-} > CrO_4^{2-} > Cl^- = Br^- = NO_3^-$

Higher the coagulation power lower will be its flocculation value

therefore order will be :

$Fe(CN)_6^{3-} < CrO_4^{2-} < Cl^- = Br^- = NO_3^-$

3. NTA Ans. (4)

4. NTA Ans. (4)

Sol. Adsorption of Gases will decreases

5. Official Ans. by NTA (3)

Sol. Foam - Froth

Gel $\rightarrow$ Jellies

Aerosol $\rightarrow$ Smoke

Sol $\rightarrow$ Cell fluids

Solid sol $\rightarrow$ rubber

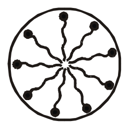
6. Official Ans. by NTA (3)

Sol. The diameter of disperseed particles is similar to wavelength of light used.

7. Official Ans. by NTA (3)

Sol. 

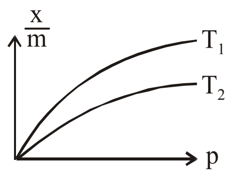
Polar head
more compatible
with polar aq. solution



Micelles formed at CMC.

8. Official Ans. by NTA (3)

Sol. $\frac{x}{m}=K.P.^{1/n}$



$(T_2 > T_1)$

9. Official Ans. by NTA (6.00)
Official Ans. by ALLEN (48.00)

Sol. $\frac{x}{m}=k\,p^{x}$ ...(1)

$\Rightarrow \underbrace{\log\frac{x}{m}}_{y}=\underbrace{\log k}_{c}+\underbrace{x}_{m}\underbrace{\log p}_{x}$

Given c = log k = 0.4771 or k = 3

slope x = 2

put in eq. (1) $\frac{x}{m} = 3 \times (4)^2 \Rightarrow 48$

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10. Official Ans. by NTA (2)

Sol.(a) Since adsorption is exothermic process, as adsorption proceeds number of active sites present over adsorbent decreases, so less heat is evolved.

(b) Since NH_3 has higher force of attraction on adsorbent due to its polar nature (high value of 'a').

(c) As the adsorption increases, residual forces over surface decreases.

(d) Since process is exothermic, on increasing temperature it shift to backward direction, so concentration of adsorbate particle decreases.

11. Official Ans. by NTA (48.00)

Sol. $\frac{x}{m} = KP^{1/n}$

$$\log\left(\frac{x}{m}\right) = \frac{1}{n}\log P + \log K$$

$$\text{slope} = \frac{1}{n} = 2$$

intercept = log K = 0.4771

K = 3

mass of gas adsorbed per gm of adsorbent = $\frac{x}{m}$

$$\frac{x}{m} = 3\times(0.04)^2 = 48\times10^{-4}$$

ELECTROCHEMISTRY

1. NTA Ans. (1)

Sol.

	E^0	ΔG^0
$Cu^{2\oplus} + 2e^{\oplus} \longrightarrow Cu$	0.34	= – 2F (0.34)
$Cu^{\oplus} + e^{\oplus} \longrightarrow Cu$	0.522	= –F (0.522)

$$Cu^{2\oplus} + e^{\oplus} \longrightarrow Cu^{+}$$

ΔG^0 = –2F (0.34) – (– F(0.522) = –F (0.68 – 0.522) = – F (0.158)

$$E^0 = \frac{-F(0.158)}{-F} = 0.158V$$

2. NTA Ans. (1)

Sol. Option (1) is incorrect.

According to Kohlrausch's law correct expression is

$$(\Lambda_m^0)_{NaBr} - (\Lambda_m^0)_{NaI} = (\Lambda_m^0)_{KBr} - (\Lambda_m^0)_{KI}$$

The other statements are correct.

3. NTA Ans. (–0.93 to –0.94)

Sol. $2H_2O(l) \rightarrow O_2(g) + 4H^+ + 4e^-$; $E^0_{red.} = 1.23V$

From nernst equation

$$E_{cell} = E^0_{cell} - \frac{RT}{nF}\ln Q$$

at 1 bar & 298 K

$$\frac{2.303RT}{F} = 0.059$$

pH = 5 ⇒ $[H^+] = 10^{-5}$ M

$E^\circ_{oxidation}$ = – 1.23 volt

$$E_{cell} = -1.23 - \frac{0.059}{4}\log[H^+]^4$$

$$E_{cell} = -1.23 - \frac{0.059}{4}\log(10^{-5})^4$$

= –1.23 + 0.059 × 5 = – 0.935 V

4. NTA Ans. (2.13 to 2.17)

Sol. Cell reaction is :

$Sn(s) + Pb^{+2}(aq) \longrightarrow Sn^{+2}(aq) + Pb(s)$

Apply Nernst equation :

$$E_{cell} = E^0_{cell} - \frac{0.06}{2}\log\frac{[Sn^{+2}]}{[Pb^{+2}]} \quad ...(1)$$

E^0_{cell} = –0.13 + 0.14 = 0.01 V

At equilibrium : E_{cell} = 0

Substituting in (1)

$$0 = 0.01 - \frac{0.06}{2}\log\frac{[Sn^{+2}]}{[Pb^{+2}]}$$

$$\Rightarrow \frac{1}{3} = \log\frac{[Sn^{+2}]}{[Pb^{+2}]}$$

$$\Rightarrow \frac{[Sn^{+2}]}{[Pb^{+2}]} = 2.15$$

5. NTA Ans. (5.66 to 5.68)

Sol. gm eq. of Ag = $\frac{108}{108}$ = 1

gm eq. of $O_2(g) = 1$

Volume of $O_2(g) = 22.7 \times \frac{1}{4}$ = 5.675 litre

6. NTA Ans. (1)

Sol. Distilled water have lowest ionic conductance.

7. Official Ans. by NTA (4)

Sol. As voltage is '2V' so both Ag^+ & Au^+ will reduce and their equal gm equivalent will reduce so

gmeq Ag = gmeq of Au

$$\frac{Wt_{Ag}}{E_{qwt_{Ag}}} = \frac{Wt_{Au}}{E_{qwt_{Au}}}$$

So $\frac{wt_{Ag}}{wt_{Au}} = \frac{E_{qwt_{Ag}}}{E_{qwt_{Au}}} = \frac{At\,wt_{Ag}}{Atwt_{Au}}$

8. Official Ans. by NTA (1)

Sol. $E^o_{cell} = 0.34 - (-0.76)$

= 1.10 volt

If E_{ext} > 1.10 volt

Cu → Anode

Zn → Cathode

If E_{ext} = 1.10 volt

Zn → Anode

Cu → Cathode

9. Official Ans. by NTA (58)

Official Ans. by ALLEN (142)

Sol.

$$\frac{1}{2}H_2 \rightarrow H^+ + e^{\ominus}$$

$$e^{\ominus} + AgCl_{(s)} \rightarrow Ag_{(s)} + Cl^{\ominus}$$

$$\frac{1}{2}H_2 + AgCl_{(s)} \rightarrow H^+_{(aq)} + Ag_{(s)} + Cl^{\ominus}_{(aq)}$$

$$E = \varepsilon^0 - \frac{.06}{1}\log\frac{[H^+][Cl^{\ominus}]}{P_{H_2}^{\frac{1}{2}}}$$

$$E = 0.22 - .06\log\frac{(10^{-1})(10^{-1})}{1^{\frac{1}{2}}}$$

E = 0.22 + .12 = .34 volt

⇒ total energy of photon will be (for Na)

= 2.3 + 0.34 = 2.64 eV

10. Official Ans. by NTA (60)

Sol. Moles of $e^{\ominus} = \left(\frac{8 \times 60 \times 2}{96000}\right)$

Using stoichiometry; theoritically

$$\frac{n_{e^{\ominus}}\text{ used}}{6} = \frac{n_{cr^{+3}}\text{ produced}}{2}$$

$$\Rightarrow n_{cr^{+3}}\text{ produced} = \frac{2}{6} \times \frac{8 \times 60 \times 2}{96000}$$

$$= \frac{0.02}{6}$$

$$\Rightarrow wt_{cr^{+3}}\text{ theoritically produced}$$

$$= \left(\frac{0.02}{6} \times 52\right)g$$

$$\Rightarrow \%\text{ efficiency} = \frac{0.104g}{\left(\frac{0.02 \times 52}{6}\right)g} \times 100$$

= 60%

11. Official Ans. by NTA (6)

Sol. $\Delta G^\circ = -AFE^\circ = -3 \times 96500 \times E^\circ$

$\Rightarrow E^\circ = -6 \times 10^{-2}$ V

12. Official Ans. by NTA (1)

Sol. Its a weak electrolyte hence : CH_3COOH

13. Official Ans. by NTA (144.00)

Sol.

$$Cu^+ \longrightarrow Cu^{2+} + e^-$$

$$Cu^+ + e^- \longrightarrow Cu(s)$$

$$2Cu^+ \longrightarrow Cu^{2+} + Cu$$

$E^o_{cell} = E^o_{Cu^+/Cu} - E^o_{Cu^{2+}/Cu^+}$

= 0.52 – 0.16

= 0.36 V

At equilibrium → E_{cell} = 0

$$E^o_{cell} = \frac{RT}{nF}\ln K$$

$$\ln K = \frac{E^o_{cell} \times nF}{RT}$$

$$\ln K = \frac{0.36 \times 1}{0.025}$$

= 14.4 = 144 × 10^{-1}

14. Official Ans. by NTA (11.00)

15. Official Ans. by NTA (4)

Sol. $\Delta G = -nFE_{cell}$

ΔG is negative, if E_{cell} is positive

Anode : $Cu(s) \longrightarrow Cu^{+2}(C_1) + 2e^- : E°$

Cathode : $Cu^{+2}(C_2) + 2e^- \longrightarrow Cu(S) : -E°$

Cell reaction : $Cu^{+2}(C_2) \longrightarrow Cu^{+2}(C_1)\ E^\circ_{cell} = 0$

$$E_{cell} = E^\circ_{cell} - \frac{2.303RT}{nF}\log Q$$

$$E_{cell} = 0 - \frac{2.303RT}{nF}\log\left(\frac{C_1}{C_2}\right)$$

$$E_{cell} > 0 : \text{ if } \frac{C_1}{C_2} < 1 \Rightarrow C_1 < C_2$$

LIQUID SOLUTION

1. NTA Ans. (3)

Sol. The vapour pressure of mixture (= 600 mm Hg) is greater than the individual vapour pressure of its constituents (Vapour pressure of CS_2 = 512 mm Hg, acetone = 344 mm Hg). Hence, the solution formed shows positive deviation from Raoult's law.

$\Rightarrow (1)\Delta_{Sol}H > 0$, (2) Raoult's law is not obeyed

(3) $\Delta_{sol.}$ Volume > 0

(4) CS_2 and Acetone are less attracted to each ether than to themselves.

2. NTA Ans. (3)

Sol. The pure solvent solution will try to maintain higher vapour pressure in the sealed container and in return the solvent vapour molecules will condense in the solution of non-volatile solute as it maintains an equilibrium with lower vapour pressure. (Lowering of vapour pressure is observed when a non volatile solute is mixed in a volatile solvent)

This will eventually lead to increase in the volume of solution and decrease in the volume of solvent.

3. NTA Ans. (3)

Sol. Order of B.P. is : Z > Y > X

Order of vapour pressure : Z < Y < X

order of intermolecular interaction : Z > Y > X.

4. NTA Ans. (1.74 to 1.76 or 0.03)

Sol. $\Delta T_f = i \times m \times K_f$

$$0.2 = 2 \times 2 \times \frac{w/58.5}{600/1000}$$

w = 1.755 gm

5. Official Ans. by NTA (167)

Sol. Osmotic pressure = $\pi = i \times C \times RT$

For NaCl i = 2 so

$\pi_{NaCl} = i \times C_{NaCl} \times RT$ $\quad C_{NaCl}$ = conc. of NaCl

$0.1 = 2 \times C_{NaCl} \times RT$

$C_{NaCl} = \frac{0.05}{RT}$ $\quad C_{glucose}$ = conc. of glucose

For glucose i = 1 so

$\pi_{Glucose} = i \times C_{glucose} \times RT$

$0.2 = 1 \times C_{glucose} \times RT$

$C_{Glucose} = \frac{0.2}{RT}$ $\quad \eta_{NaCl}$ = No. of moles NaCl

η_{NaCl} in 1 L = $C_{NaCl} \times V_{Litre}$

$= \frac{0.05}{RT}$ $\quad \eta_{glucose}$ = No. of moles glucose

$\eta_{glucose}$ in 2 L = $C_{glucose} \times V_{Litre}$

$= \frac{0.4}{RT}$

$V_{Total} = 1 + 2 = 3L$

so Final conc. NaCl = $\frac{0.05}{3RT}$

Final conc. glucose = $\frac{0.4}{3RT}$

$\pi_{Total} = \pi_{NaCl} + \pi_{glucose}$

$= \left[i \times C_{NaCl} + C_{glucose}\right] \times RT$

$= \left(\frac{2 \times 0.05}{3RT} + \frac{0.4}{3RT}\right) \times RT$

$= \frac{0.5}{3}$ atm

= 0.1666 atm

= 166.6×10^{-3} atm

$\Rightarrow 167.00 \times 10^{-3}$ atm

so x = 167.00

6. Official Ans. by NTA (600)

Sol. $550 = P_A^o \times \frac{1}{4} + P_B^o \times \frac{3}{4}$

$2200 = P_A^o + 3P_B^o$ .....(i)

$2800 = P_A^o + 4P_B^o$ ....(ii)

$560 = P_A^o \times \frac{1}{5} + P_B^o \times \frac{4}{5}$

$P_B^o = 600, P_A^o = 400$

7. Official Ans. by NTA (2)

Sol. (1) $P_\gamma = K_H X_Y$

$$P_\gamma = 2 \times 10^{-15} \times \frac{55.5}{55.5 + \frac{1000}{18}} = 2 \times 10^{-5} \text{K bar}$$

$= 2 \times 10^{-2}$ bar

(2) $P_\delta = K_H X_\delta$

$$P_\delta = 0.5 \times \frac{55.5}{55.5 + \frac{1000}{18}} = .249 \text{ K bar} = 249 \text{ bar}$$

(3) On increasing temperature solubility of gases decreases

(4) $K_H \downarrow$ solubility $\uparrow$ and lowest K_H is for γ.

8. Official Ans. by NTA (177)

9. Official Ans. by NTA (1)

Sol. Relative lowering of V.P. = $\frac{\Delta P}{P^0} = x_{solute}$

$$\left(\frac{\Delta P}{P^0}\right)_A = \frac{\frac{10}{100}}{\frac{10}{100} + \frac{180}{18}} : \left(\frac{\Delta P}{P^0}\right)_B = \frac{\frac{10}{200}}{\frac{10}{200} + \frac{180}{18}}$$

$$\left(\frac{\Delta P}{P^0}\right)_C = \frac{\frac{10}{10,000}}{\frac{10}{10,000} + \frac{180}{18}} : \left(\frac{\Delta P}{P^0}\right)_A > \left(\frac{\Delta P}{P^0}\right)_B > \left(\frac{\Delta P}{P^0}\right)_C$$

CHEMICAL EQUILIBRIUM

1. Official Ans. by NTA (2)

Sol. $A \rightleftharpoons B + C \quad K_{eq}^{(1)} = \frac{[B][C]}{[A]}$ .....(1)

$B + C \rightleftharpoons P \quad K_{eq}^{(2)} = \frac{[P]}{[B][C]}$ .....(2)

For

$A \rightleftharpoons P \quad K_{eq} = \frac{[P]}{[A]}$

Multiplying equation (1) & (2)

$K_{eq}^{(1)} \times K_{eq}^{(2)} = \frac{[P]}{[A]} = K_{eq}$

2. Official Ans. by NTA (3)

Sol. at equilibrium

$r_a = r_b$

3. Official Ans. by NTA (16)

Sol.

	X	+	Y	=	2Z
t = 0	1		1.5		0.5
At eq.	0.75		1.25		1

;

$$K_{eq.} = \frac{1^2}{\frac{3}{4} \times \frac{5}{4}} = \frac{16}{15}$$

4. Official Ans. by NTA (2)

Sol. $N_2 + 3H_2 \rightleftharpoons 2NH_3 \rightarrow K_C = 64$

$2NH_3 \rightleftharpoons N_2 + 3H_2 \rightarrow K_C = \frac{1}{64}$

$NH_3 \rightleftharpoons \frac{1}{2} N_2 + \frac{3}{2} H_2 \rightarrow K_C = \left(\frac{1}{64}\right)^{1/2} = \frac{1}{8}$

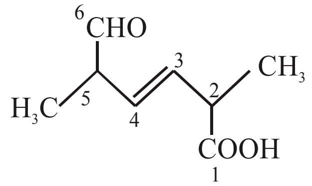
5. Official Ans. by NTA (4)

JANUARY & SEPTEMBER 2020 ATTEMPT (OC)

NOMENCLATURE

1. Official Ans. by NTA (4)

Soll.

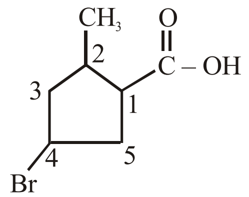


IUPAC name

2, 5-dimethyl-6-oxo-hex-3-enoic acid

2. Official Ans. by NTA (1)

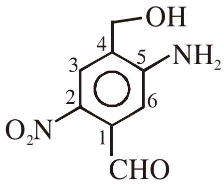
Sol.



4-bromo-2-methyl cyclopentane carboxylic Acid

3. Official Ans. by NTA (4)

Sol.



5-amino-4-hydroxymethyl-2-nitrobenzaldehyde

ACIDITY & BASICITY

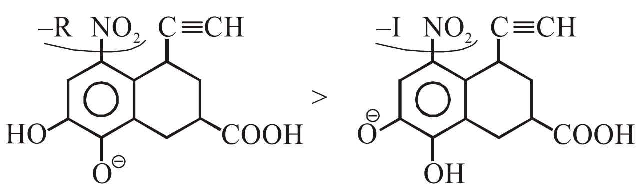
1. Official Ans. by NTA (1)

Sol. Acidic strength order :

$$R-\overset{O}{\overset{\|}{C}}-OH > R-OH > R-C\equiv CH$$

Reason : $R-\overset{O}{\overset{\|}{C}}-O^{\ominus}$ stable by equivalent resonance.

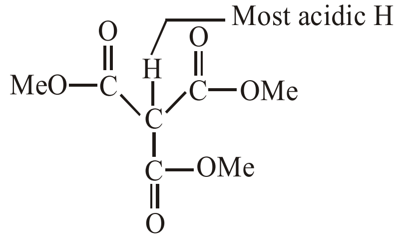
Stable :



So answer is b > c > d > a.

2. Official Ans. by NTA (4)

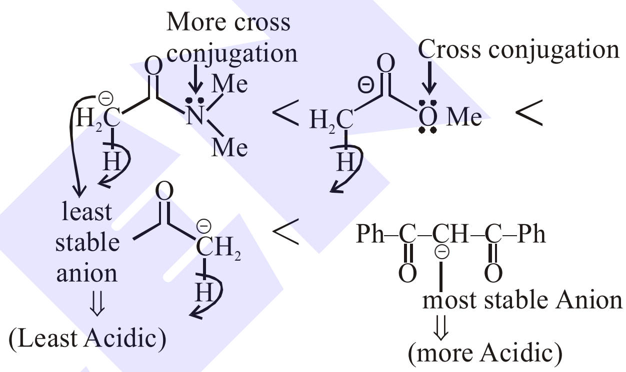
Sol.



Due to presence of 3 (–R) groups

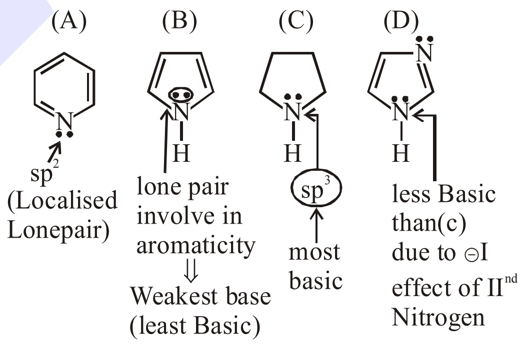
3. Official Ans. by NTA (4)

Sol. D < C < A < B



4. Official Ans. by NTA (4)

Sol.

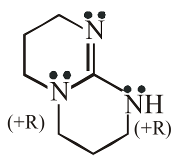


5. Official Ans. by NTA (1)

ELECTRONIC DISPLACEMENT EFFECT

1. NTA Ans. (3)

Sol. Base strength order



$> \ddot{N}H_2 - CH = \ddot{N}H > CH_3 - \ddot{N}H - CH_3$ (+R)

(B) (A) (C)

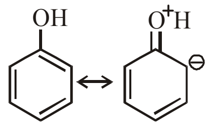
pk_b order (C > A > B)

2. NTA Ans. (1)

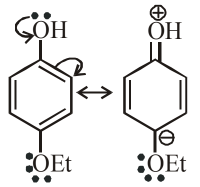
Sol. (C) > (B) > (A)

3. NTA Ans. (2)

Sol. $H_3C - OH$ (100% single bond)

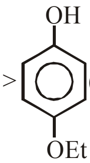
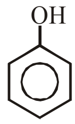


C–OH bond has partial double bond character

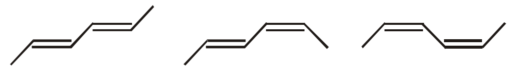


(+M)

(C–OH bond has some double bond character but double bond character is less)

Ans. CH_3OH >  (p-ethoxyphenol) > 

4. NTA Ans. (1)

Sol. 

(a) (Trans, Trans) (b) (Trans, Cis) (c) (Cis, Cis)

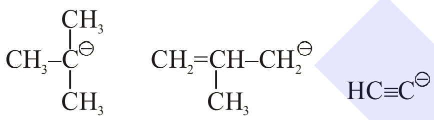
∴ Generally trans is more stable then cis form.

Heat of combustion (HOC) $\propto \frac{1}{\text{Stability}}$

Stability : a > b > c

HOC : c > b > a

5. NTA Ans. (3)

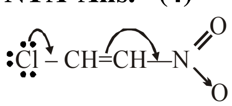
Sol. 

(i) (ii) (iii)

$CH_3^{\ominus}$ (iv) $\overset{\ominus}{C}\equiv N$ (v)

Basic strength order : (i) > (iv) > (ii) > (iii) > (v)

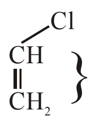
6. NTA Ans. (4)

Sol. 

Due to –M effect of $-NO_2$ and + M effect of Cl more D.B. character between C – Cl bond. So shortest bond length.

7. NTA Ans. (3)

8. Official Ans. by NTA (3)

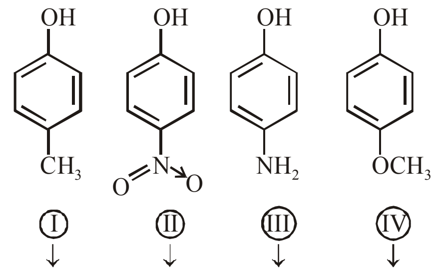
Sol. 

In option (3) C—Cl bond is shortest due to resonance of lone pair of –Cl.

Due to resonance C—Cl bond acquire partial double bond character.

Hence C—Cl bond length is least.

9. Official Ans. by NTA (1)

Sol. 

	(I)	(II)	(III)	(IV)
BP value from net	≃202°C	≃279°	≃284°C	≃243°C

BP ∝ dipolemoment (μ)

Alter

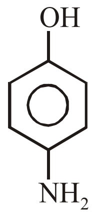
Increasing order of boiling point is :

I. 

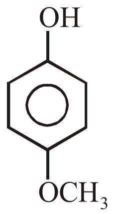
⇒ Shows hydrogen bonding from –O–H group only

II. 

⇒ Shows strongest hydrogen bonding from both sides of –OH group as well as $-NO_2$ group.

III. 

⇒ Shows stronger hydrogen from both side of –OH group as well as $-NH_2$ group.

IV. 

⇒ Shows stronger hydrogen bonding from one side –OH–group and another side of $-OCH_3$ group shows only dipole-dipole interaction.

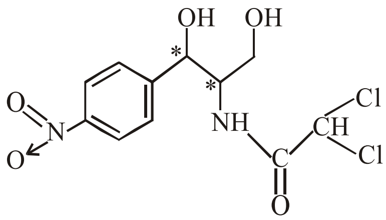
⇒ Hence correct order of boiling point is:

(I) < (IV) < (III) < (II)

ISOMERISM

1. NTA Ans. (2)

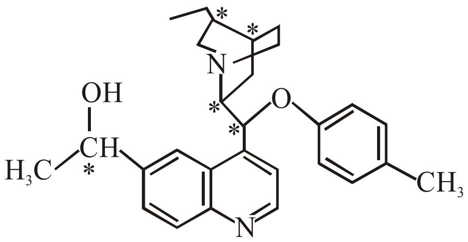
Sol.



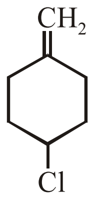
Chloramphenicol

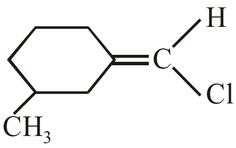
2. Official Ans. by NTA (5.00)

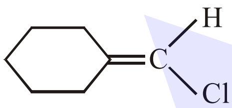
Sol. No. of chiral centres

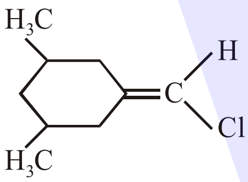


3. Official Ans. by NTA (2)
Official Ans. by ALLEN (2 & 4)

Sol. (1)  Not show GI

(2)  Show GI

(3)  Not show GI

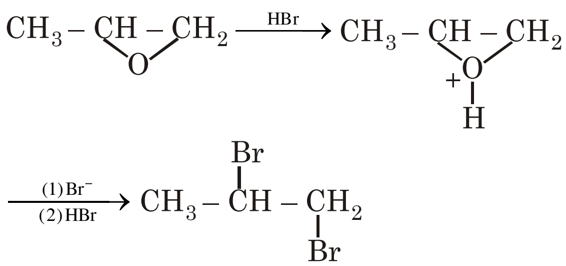
(4)  Show GI

4. Official Ans. by NTA (3)

HALOGEN DERIVATIVE

1. NTA Ans. (4)

Sol.



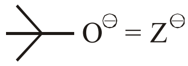
2. NTA Ans. (3)

Sol.

$$CH_3–CH_2–CH_2–Br + Z^{\ominus} \xrightarrow{K_s} CH_3–CH_2–CH_2–Z$$

$$CH_3–CH_2–CH_2–Br + Z^{\ominus} \xrightarrow{K_e} CH_3–CH=CH_2 + HZ + Br^-$$

(A) $CH_3–CH_2–O^- = Z^{\ominus} \longrightarrow$

(B) 

(B) with more steric crowding forms elimination product compared to substitution.

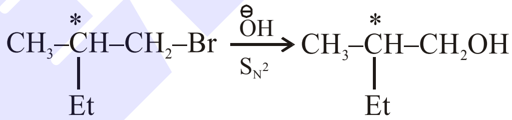
$K_e(B) > K_e(A)$

$$\mu_B = \frac{K_s(B)}{K_e(A)} < \mu_A = \frac{K_s(A)}{K_e(A)}$$

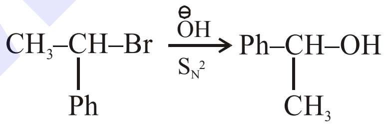
3. NTA Ans. (3)

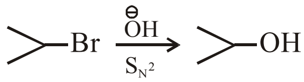
Sol. Reactivity D > B > C > A
Carbocation formed from D is most stable
Carbocation formed from A is least stable

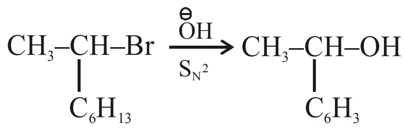
4. Official Ans. by NTA (1)

Sol. (1) 

* (NCERT)

(2) 

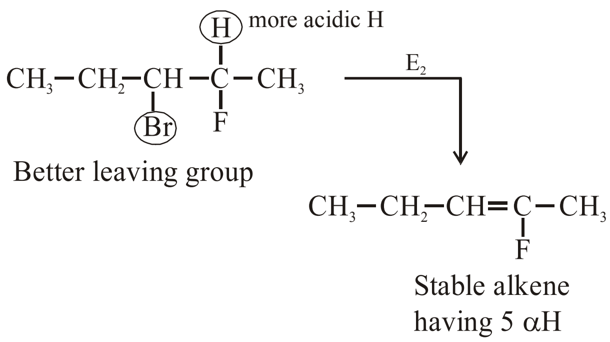
(3) 

(4) 

As language given, we have to go with option (1) as stereochemistry of chiral centre is not distorted.

5. Official Ans. by NTA (4)

Sol.



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6. Official Ans. by NTA (1)

Sol. Reaction 1 : SN_1

Reaction 2 : E_2

SN_1 is independent of concentration of nucleophile/base

7. Official Ans. by NTA (2)

Sol. $S_N{}^1$ favours

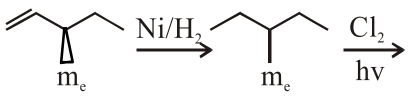
(a) The reaction is favoured by weak nucleophiles

(b) $R^{\oplus}$ would be easily formed if the substituents are bulky

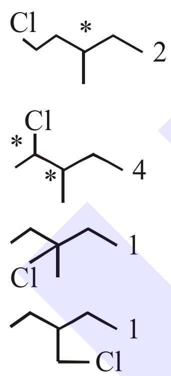
(c) The reaction is accompained by recemization

8. Official Ans. by NTA (8)

Sol.

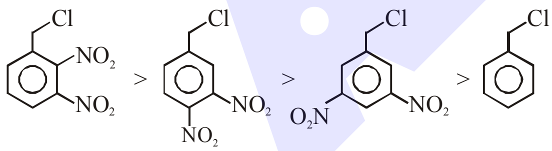


Simplest
O.A. Alkene



9. Official Ans. by NTA (2)

Sol.

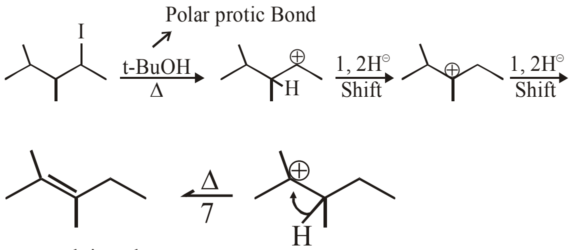


–I & –R   less –I & –R   Only 2 – I

rate of SN^2 reaction

10. Official Ans. by NTA (4)

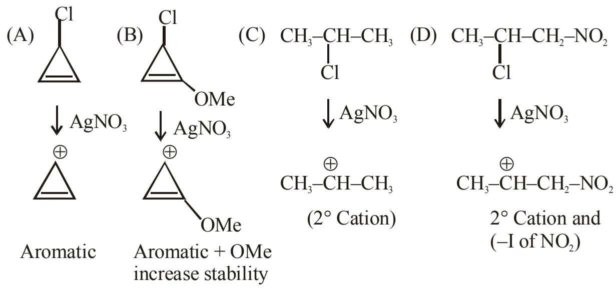
Sol.



more subtituted
Alkene (major)

11. Official Ans. by NTA (4)

Sol.



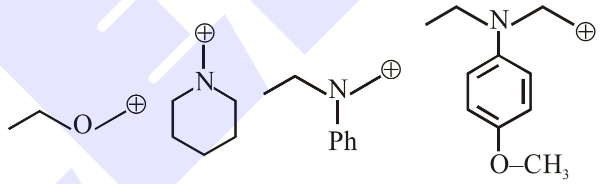
∴ Stability Cation B > A > C > D

12. Official Ans. by NTA (2)

Sol. $R-x + aq.AgNO_3 \xrightarrow{R.D.S} R^{\oplus} + \underset{(PPT)}{Agx}$ (1)

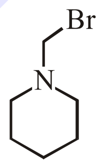
So rate of P.P.T formation of Agx depend's on stability of carbocation (R^+)

In given question formed carbocation will be



(a) (b) (c) (d)

Most stable carbocation is (b) so

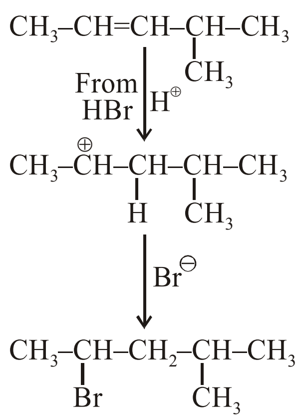


give fastest P.P.T of AgBr with aq $AgNO_3$

13. Official Ans. by NTA (1)

Official Ans. by ALLEN (4)

Sol.



Addition of HBr according to M.R.

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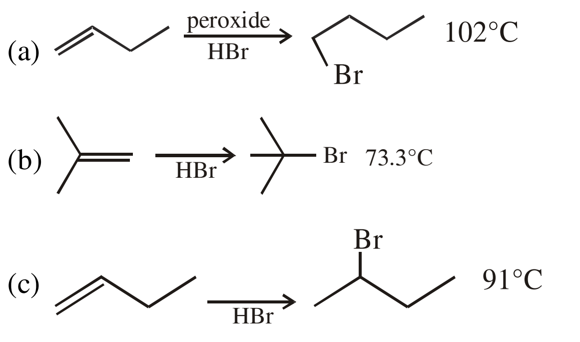
14. Official Ans. by NTA (2)

Sol.



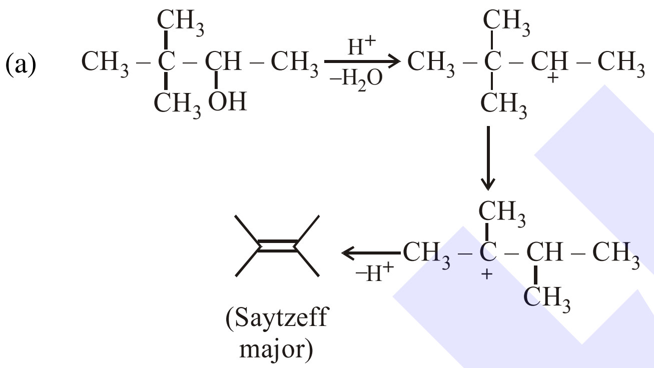
$$\text{B.P.} \propto \frac{1}{\text{Branching}} \qquad \therefore\ a > c > b \text{ (order of B.P.)}$$

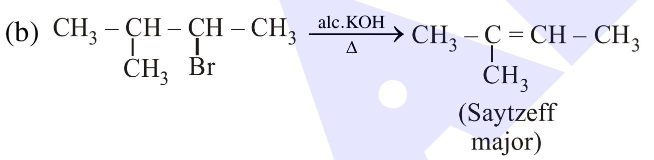
15. Official Ans. by NTA (2)

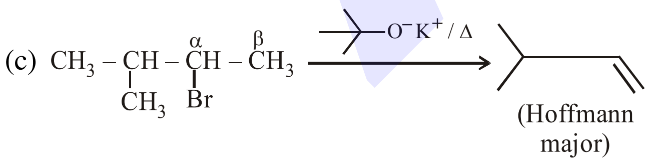
ALCOHOL & ETHER

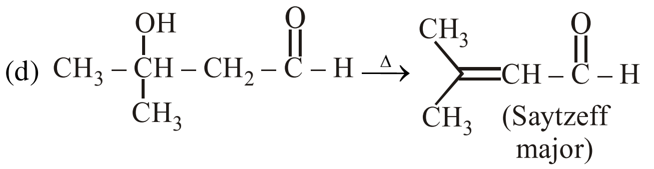
1. NTA Ans. (1)

Sol.







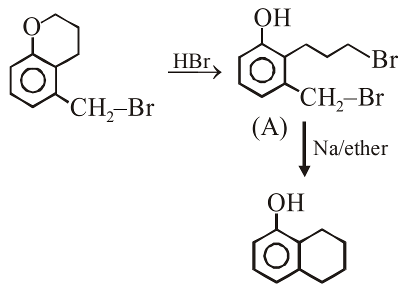


$(CH_3)_3O^-K^+$ is incorrect representation of potassium tert-butoxide $[(CH_3)_3CO^-K^+]$.

So it is possible that it can be given as **Bonus**

2. NTA Ans. (4)

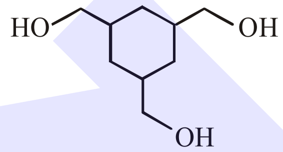
Sol.



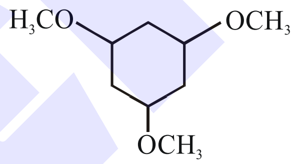
3. NTA Ans. (1)

Sol. Alcohol has more boiling point than ether (due to hydrogen bonding).

So,

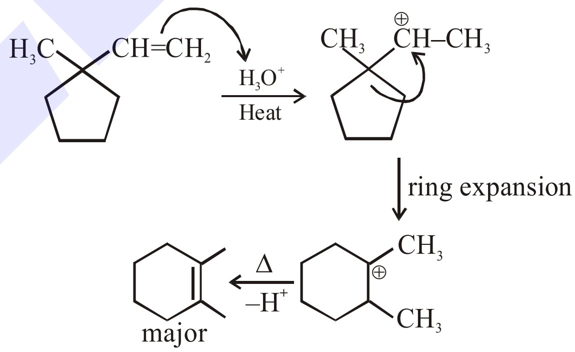


has more boiling point than



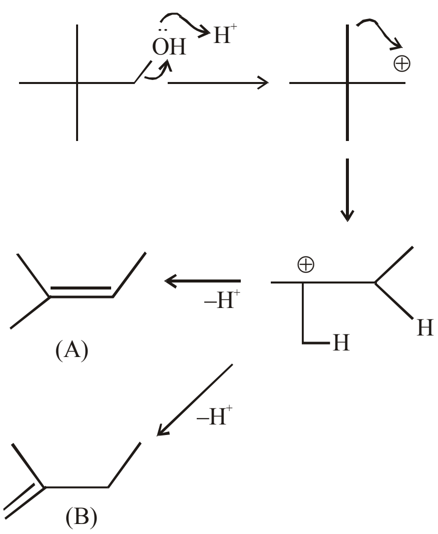
4. Official Ans. by NTA (3)

Sol.



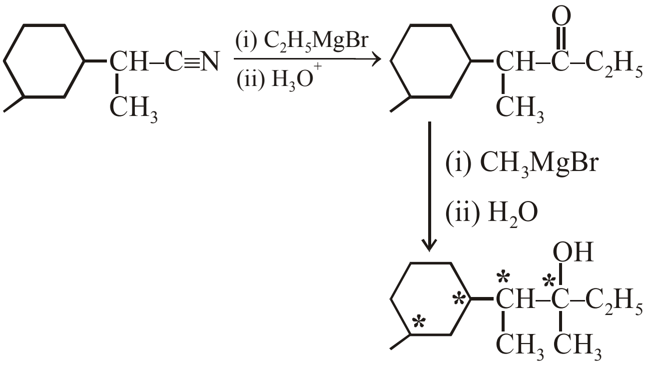
5. Official Ans. by NTA (4)

Sol.



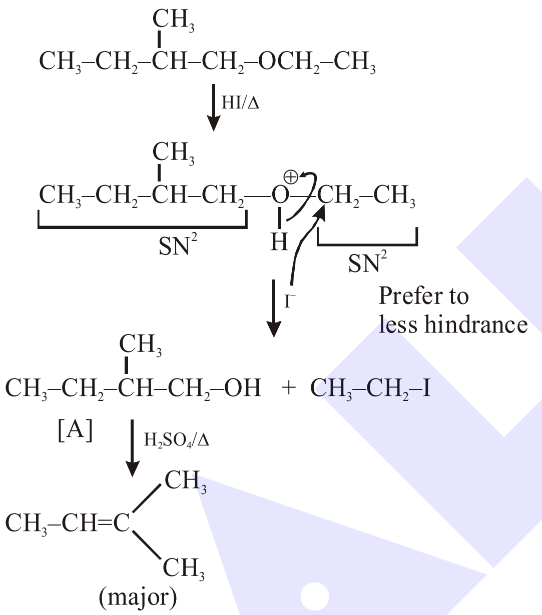
6. Official Ans. by NTA (4)

Sol.



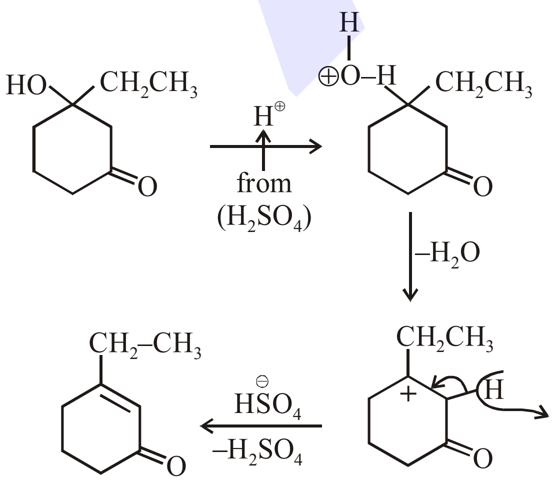
7. Official Ans. by NTA (4)

Sol.



8. Official Ans. by NTA (2)

Sol.

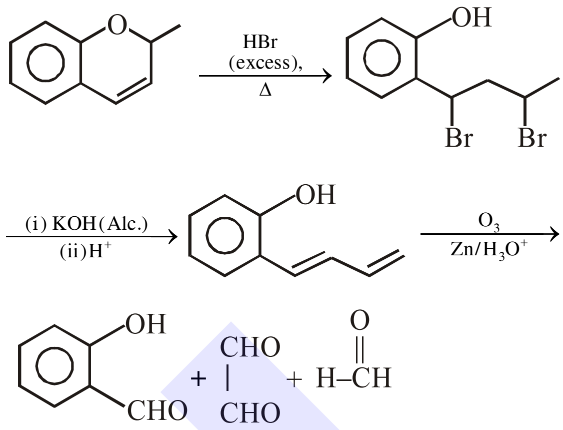


9. Official Ans. by NTA (3)

OXIDATION

1. Official Ans. by NTA (2)

Sol.

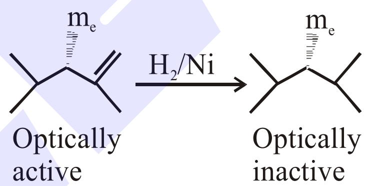


2. Official Ans. by NTA (1)

REDUCTION

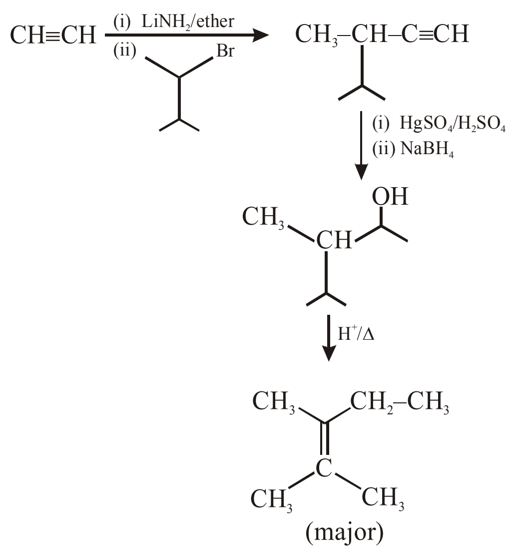
1. Official Ans. by NTA (2)

Sol.



2. Official Ans. by NTA (2)

Sol.



Now :- (i) $HgSO_4$/dil.H_2SO_4

(ii) $NaBH_4$

is convert triple bond into ketone and formed ketone is reduced by $NaBH_4$ and convert into Alcohol.

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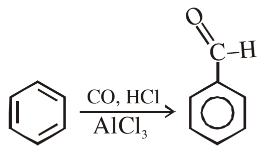
3. Official Ans. by NTA (2)

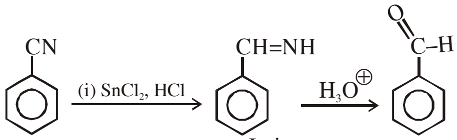
Sol. $CH_3–CH_2–C\equiv N \xrightarrow{?} CH_3–CH_2–CH_2–NH_2$

$CH_3–CH_2–C\equiv N \xrightarrow{LiAlH_4} CH_3–CH_2–CH_2–NH_2$

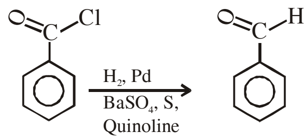
4. Official Ans. by NTA (3)

Sol.(i) 

(Gattermann koch reaction)

(ii) 

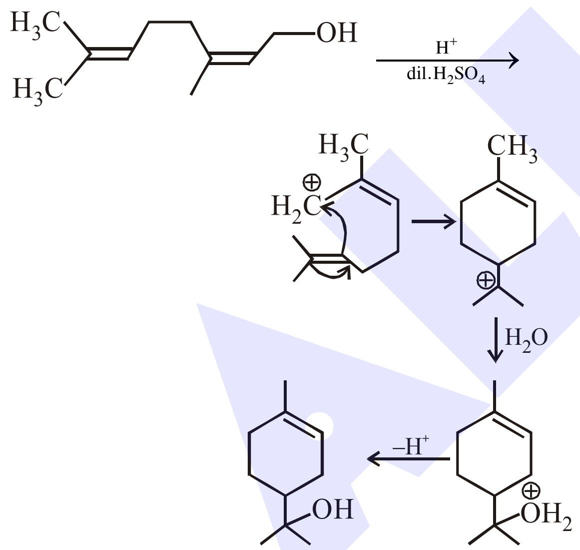
(Stephen reduction)

(iii) 

(Rosenmund reduction)

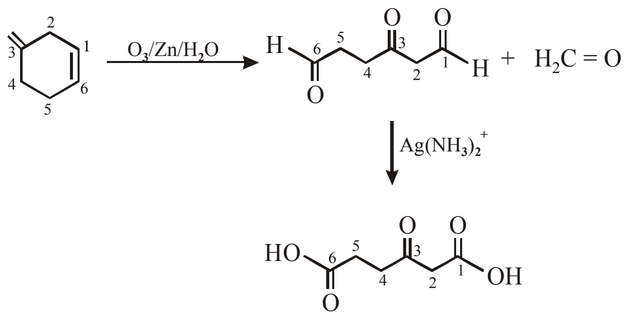
HYDROCARBON

1. NTA Ans. (2)

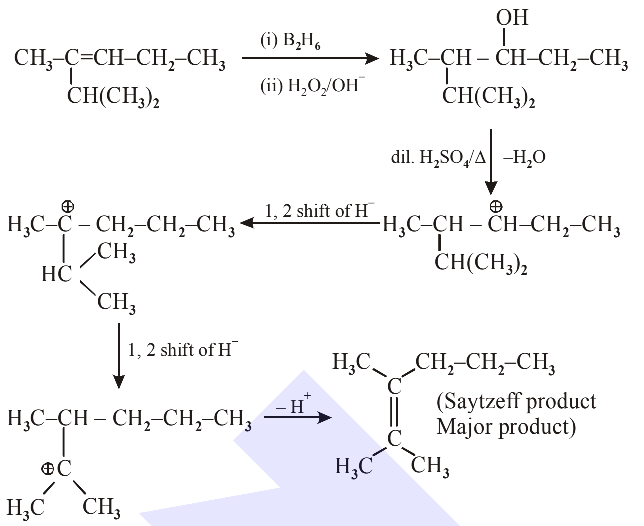
Sol. 

Terpineol

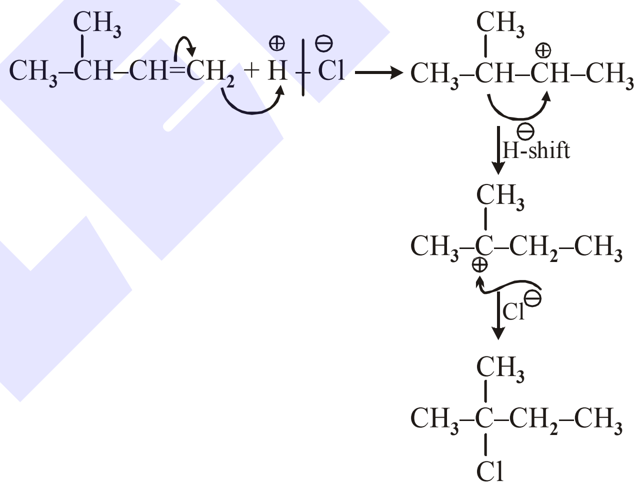
2. NTA Ans. (1)

Sol. 

3. NTA Ans. (1)

Sol. 

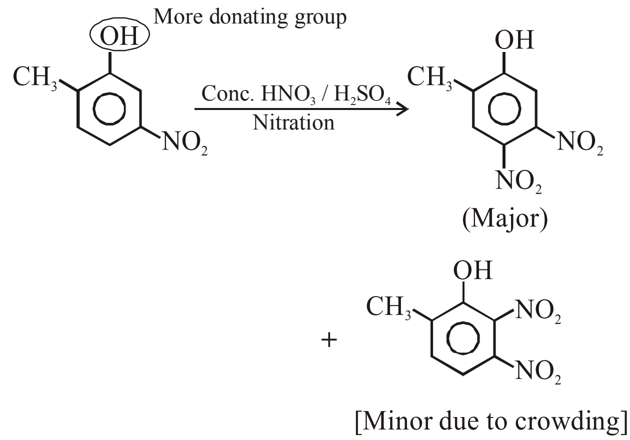
4. NTA Ans. (1)

Sol. 

(No chiral centre, so no racemisation possible)

AROMATIC COMPOUND

1. Official Ans. by NTA (3)

Sol. 

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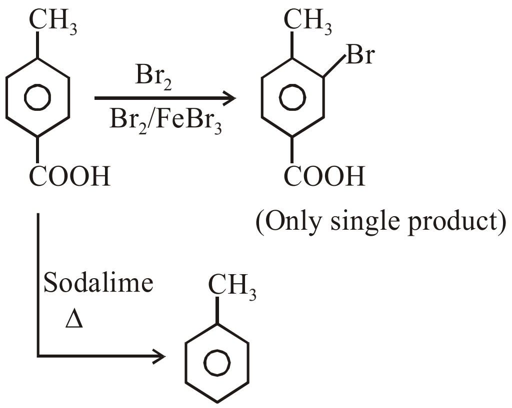
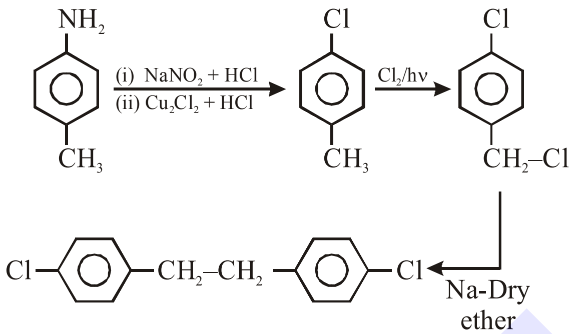
2. Official Ans. by NTA (4)

Sol.



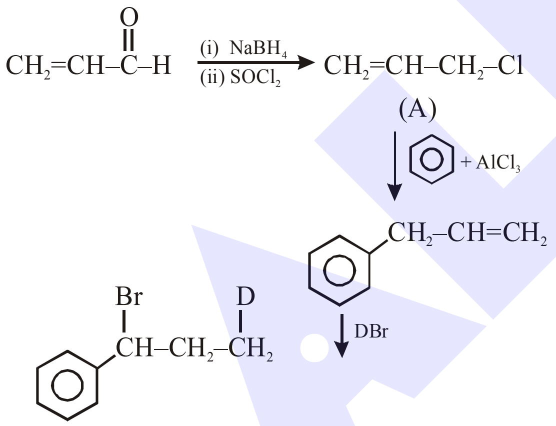
3. Official Ans. by NTA (3)

Sol.



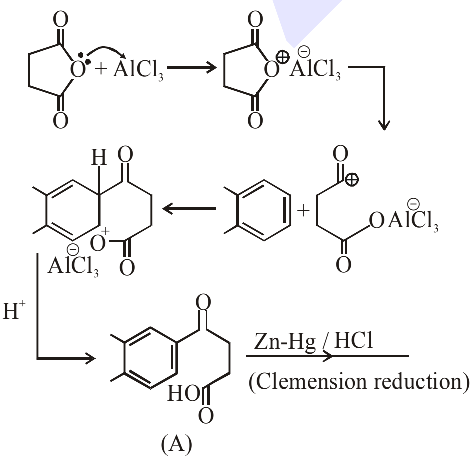
4. Official Ans. by NTA (3)

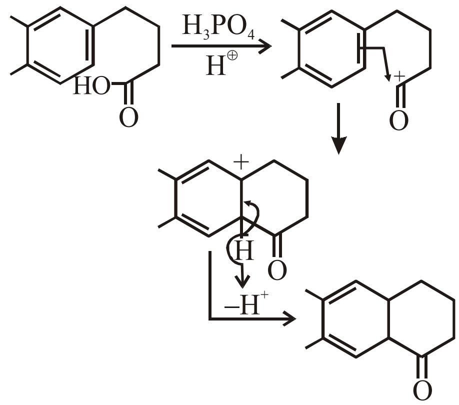
Sol.



5. Official Ans. by NTA (1)

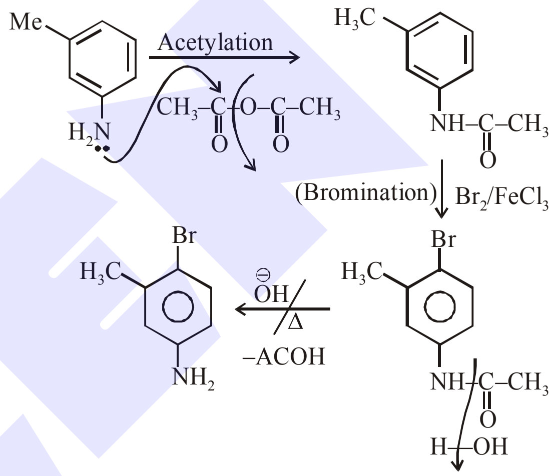
Sol.





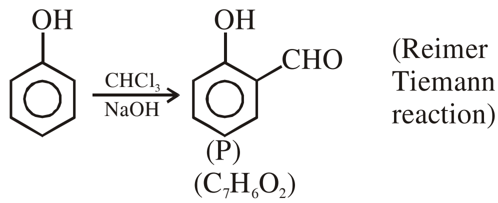
6. Official Ans. by NTA (1)

Sol.



7. Official Ans. by NTA (69.00)
Official Ans. by ALLEN (68.85)

Sol.

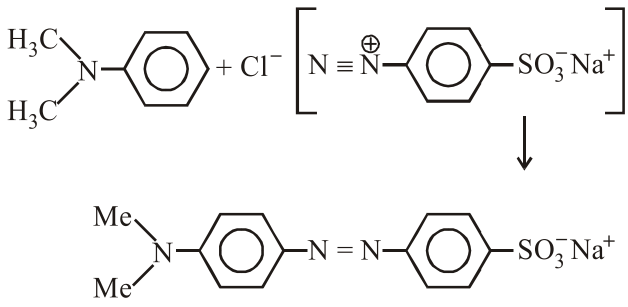


Molecular weight of $C_7H_6O_2$ = 122

$$\%C = \frac{12 \times 7 \times 100}{122} = 68.85 \approx 69$$

8. NTA Ans. (1)

Sol.



(Methyl orange)

It is an acid base indicator

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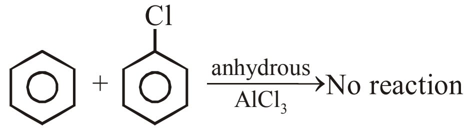
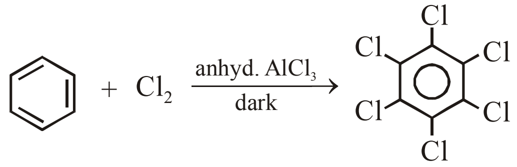
9. NTA Ans. (2)

Sol. (a)

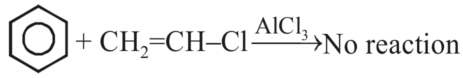


(b)

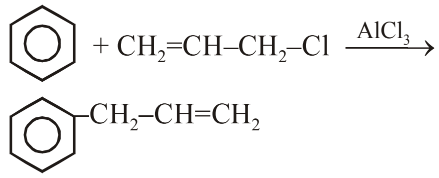


(electrophilic substitution)

(c)

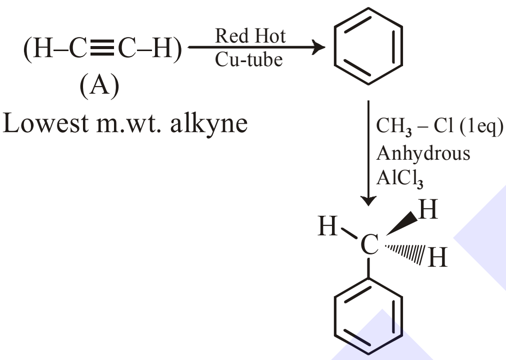


(d)



10. NTA Ans. (13)

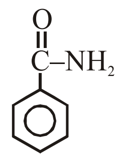
Sol.



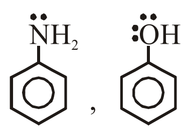
Total 13 atom are present in same plane (7 carbon & 6 hydrogen atoms.)

11. NTA Ans. (3)

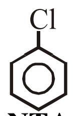
Sol. ∴



(Deactivated ring due to –R effect of amide)



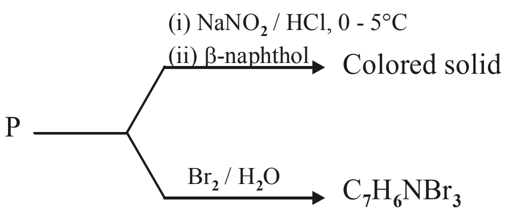
(l.p.e. of $-NH_2$ and –ÖH group do acid-base reaction with lewis acid $AlCl_3$, so ring is deactivated)

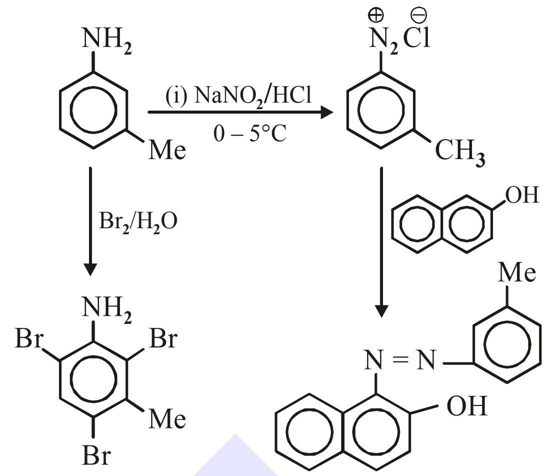


(Highest yield produced)

12. NTA Ans. (2)

Sol.



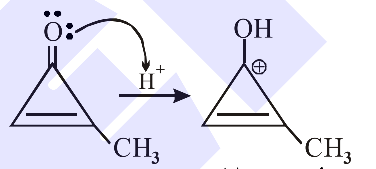


(colored dye)

CARBONYL COMPOUNDS

1. NTA Ans. (2)

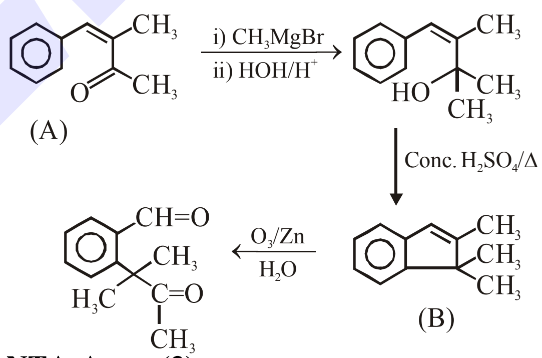
Sol.



(Aromatic stable product)

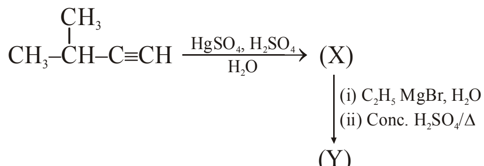
2. NTA Ans. (4)

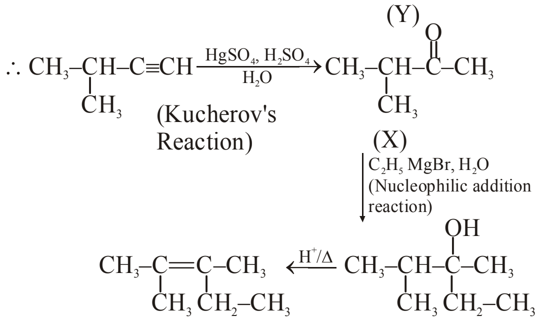
Sol.



3. NTA Ans. (3)

Sol.





Major
(Saytzeff alkene)

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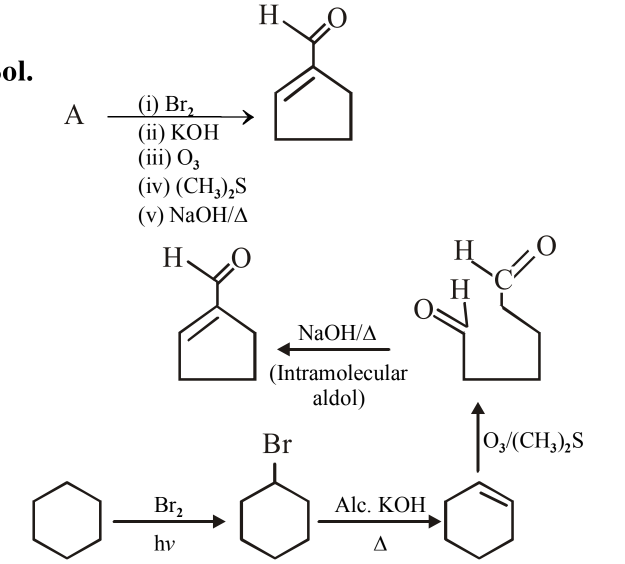
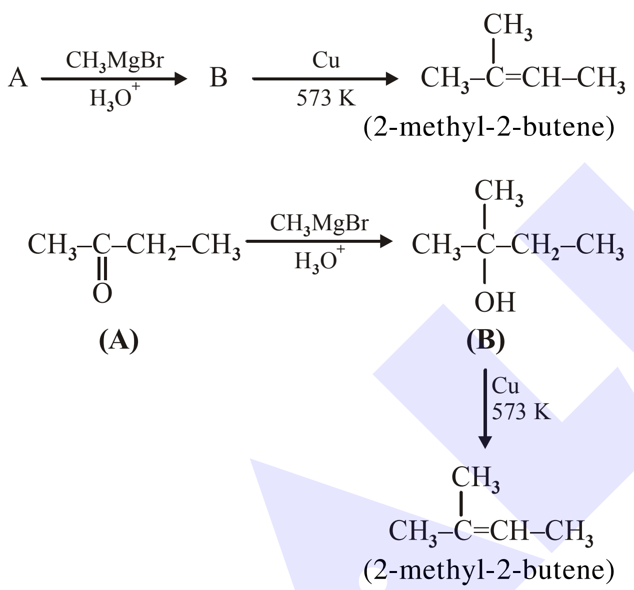
4. NTA Ans. (3)

Sol.



5. NTA Ans. (66.65 to 66.70)

Sol.



C ⇒ 12 × 4 = 48

H ⇒ 8 × 1 = 8

O ⇒ 16 × 1 = 16

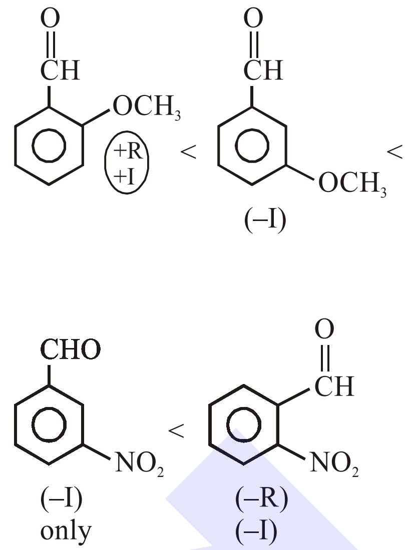
Total 72

$$\% \text{ of C} = \frac{48}{72} \times 100 = 66.66\%$$

6. Official Ans. by NTA (3)

Sol. Increasing order of reactivity towards HCN addition

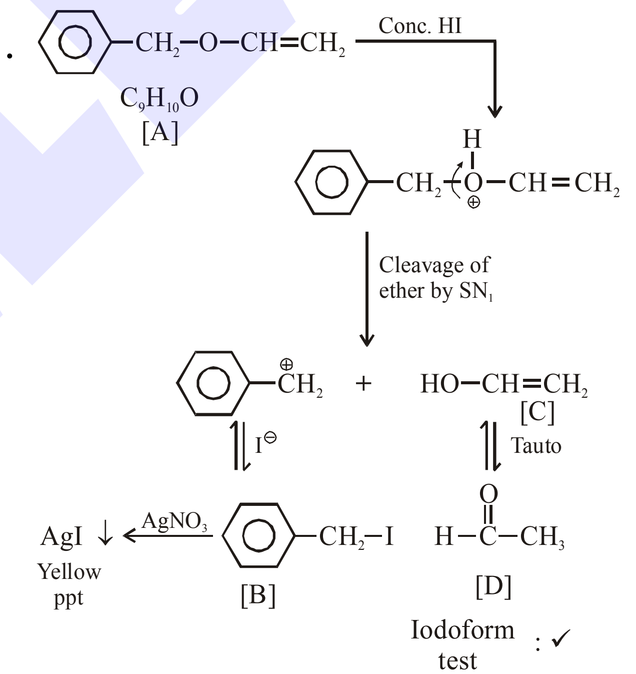
Greater the electrophilicity on $-\overset{O}{\overset{\|}{C}}-$ group greater the reactivity in nucleophilic addition.



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

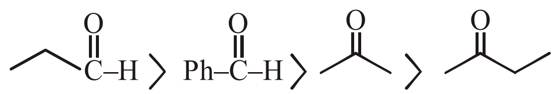
7. Official Ans. by NTA (2)

Sol



8. Official Ans. by NTA (1)

Sol. Reactivity order of various carbonyl compounds → Aldehydes > Ketones



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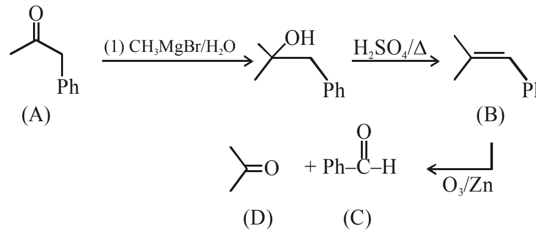
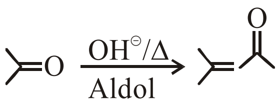
9. Official Ans. by NTA (3)

Sol.



$$Ph{-}\overset{O}{\overset{\|}{C}}{-}H \xrightarrow[\text{NaOH (cannizaro)}]{\text{Conc.}} Ph{-}COOK + Ph{-}CH_2OH$$



10. Official Ans. by NTA (2)

CARBOXYLIC ACID AND THEIR DERIVATIVES

1. NTA Ans. (3)

Sol.

$$CH_3-CH_2-C\equiv C-CH_2-\overset{O}{\overset{\|}{C}}-H \xrightarrow{NaBH_4} CH_3-CH_2-C\equiv C-CH_2-CH_2-OH$$

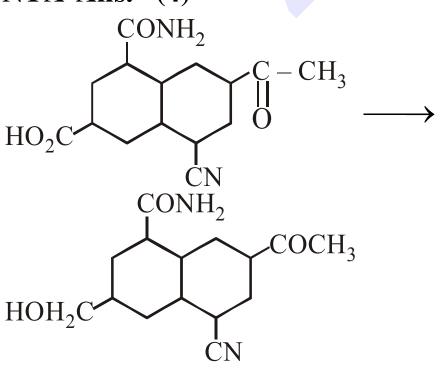
$$\xrightarrow{PBr_3} CH_3-CH_2-C\equiv C-CH_2-CH_2-Br$$

$$\xrightarrow{Mg/ether} CH_3-CH_2-C\equiv C-CH_2-CH_2-MgBr$$

$$\xrightarrow[(2)\ H_3O^+]{(1)\ CO_2} CH_3-CH_2-C\equiv C-CH_2-CH_2-\overset{O}{\overset{\|}{C}}-OH$$

2. NTA Ans. (4)

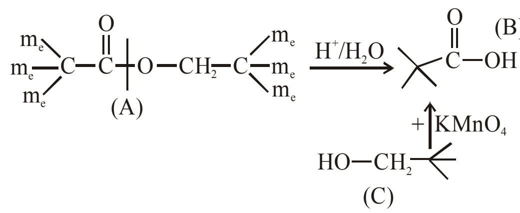
Sol.



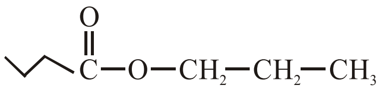
Most suitable reagent for given conversion is B_2H_6 (electrophilic reducing agent)

3. Official Ans. by NTA (3)
Official Ans. by ALLEN (2 & 3)

Sol. (1)

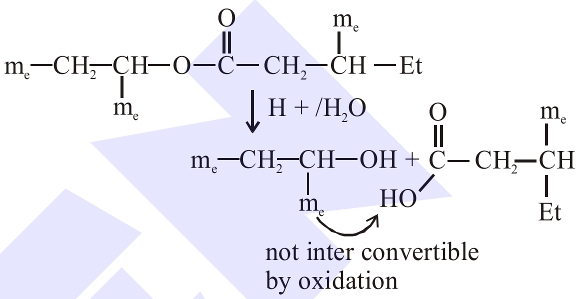


(2)

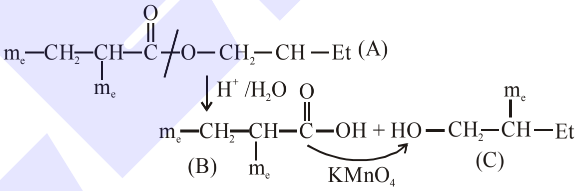


Total 8 'C' → so molecular formula not matched.

(3)

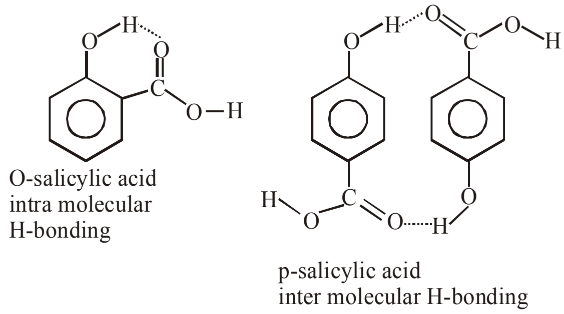


(4)



4. Official Ans. by NTA (3)
Official Ans. by ALLEN (2, 3 & 4)

Sol.



(a) B will be more crystalline due to more inter molecular interactions hence more efficient packing.

(b) B will have higher boiling point due to higher intermolecular interactions.

(c) B will be more soluble in water than A as B will have more extent of H-bonding in water

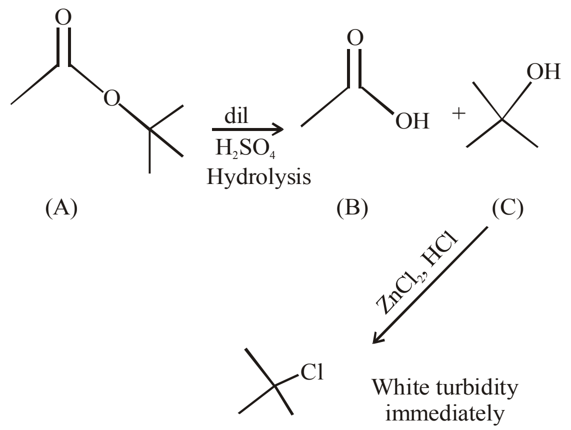
So all three statements are correct

{Solubility date ⇒ O-salicylic acid = 2g/L

P-salicylic acid = 5g/L}

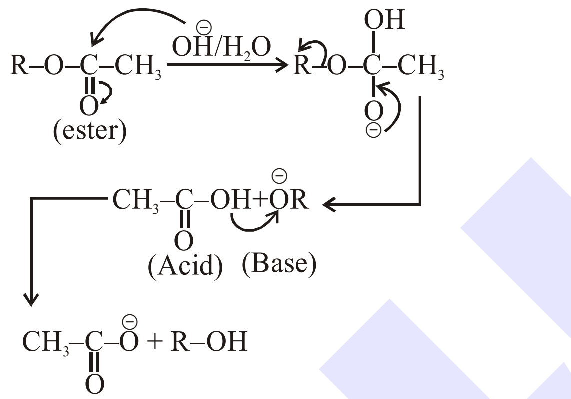
5. Official Ans. by NTA (1)

Sol.



6. Official Ans. by NTA (2)

Sol.

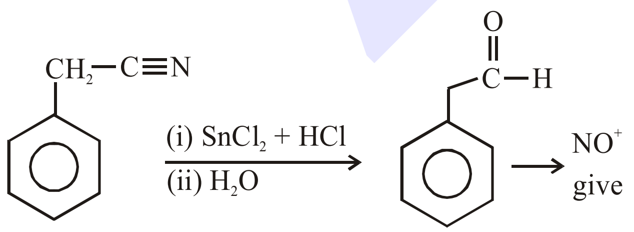


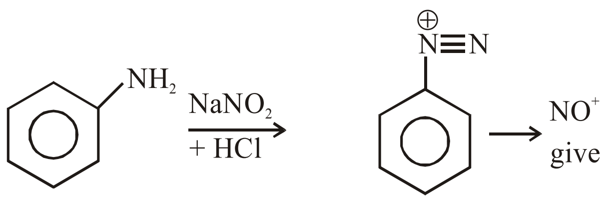
It is a hydrolysis of ester in basic medium.

AMINES

1. Official Ans. by NTA (2)

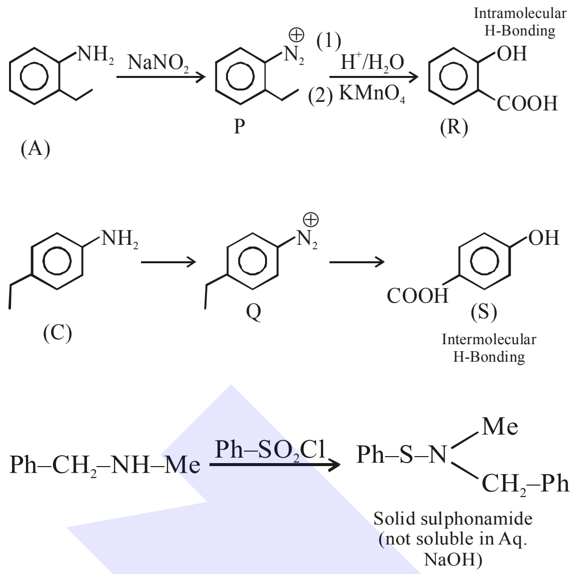
Sol. Kjeldahl method is used for N estimation But not given by 'Diazo' compounds





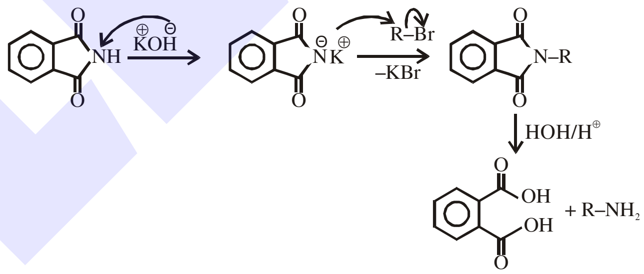
2. Official Ans. by NTA (2)

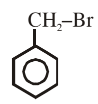
Sol.

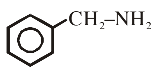


3. Official Ans. by NTA (1)

Sol. Gabriel phthalimide synthesis is used for preparation of 1° Aliphatic amine

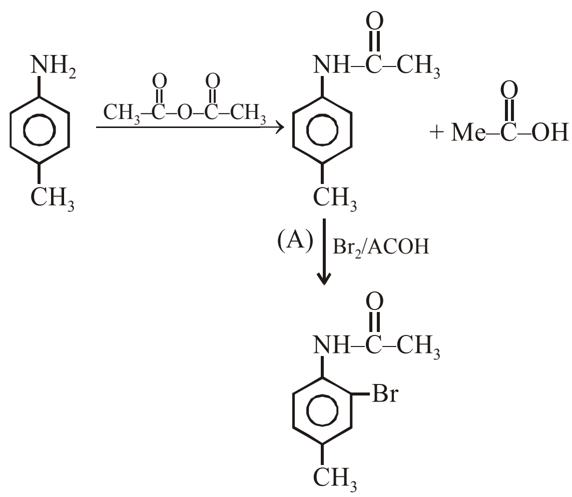


Here R–Br = 

R–NH_2 = 

4. NTA Ans. (1)

Sol.



ALLEN

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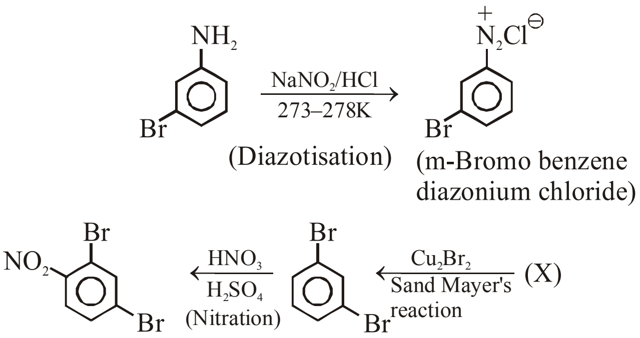
5. NTA Ans. (2)

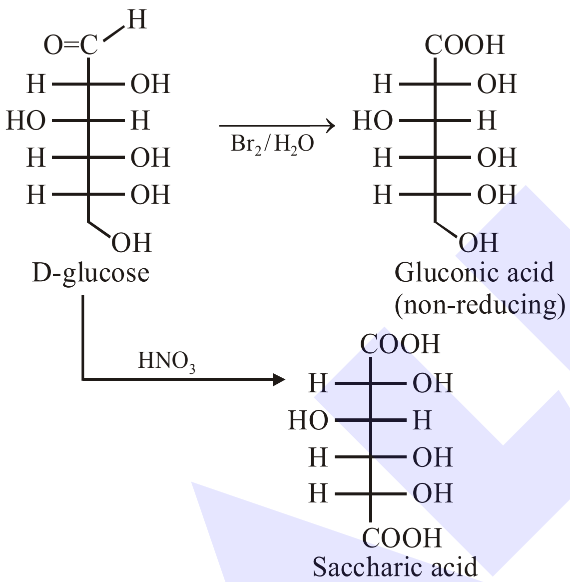
Sol.



BIOMOLECULES

1. NTA Ans. (2)

Sol.



2. NTA Ans. (2)

Sol. Glucose gives negative test with Schiff reagent

3. NTA Ans. (3)

Sol. Two monomers in maltose are α-D-glucose & α-D-glucose.

4. NTA Ans. (4)

Sol. Alanine does not show **Biuret test** because **Biuret test** is used for deduction of peptide linkage & alanine is amino acid.

Albumine is protein so have paptide linkage so it gives positive **Biuret test**.

Positive **Barfoed test** is shown by monosaccharide but not disaccharide. Positive **Molisch's test** is shown by glucose.

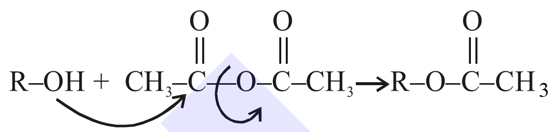
5. Official Ans. by NTA (4)

Sol. (i) Glucose + dry HCl $\xrightarrow{ROH}$ Acetal $\xrightarrow[(CH_3CO)_2O]{x\ Eq}$ acetyl derivative

(ii) Glucose $\xrightarrow{Ni/H_2}$ A $\xrightarrow[(CH_3CO)_2O]{y\ Eq}$ Acetyl derivative

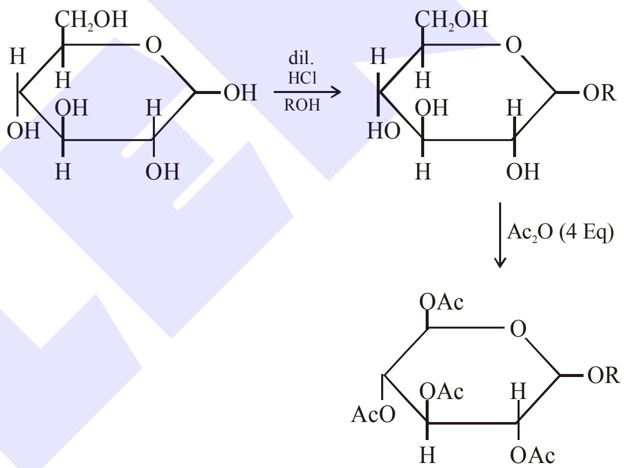
(iii) Glucose $\xrightarrow[(CH_3CO)_2O]{z\ Eq}$ Acetyl derivative

due to presence of –OH group in Glucose the reaction is



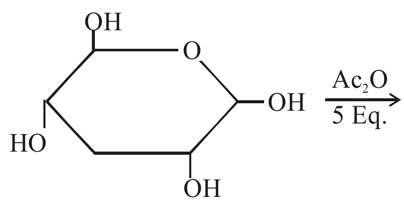
Acetyl derivative

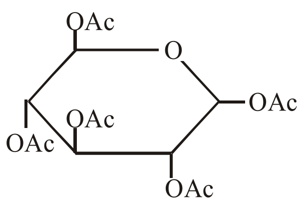
so for (i)



(ii) $\begin{array}{l} CH{=}O \\ | \\ (CH\text{–}OH)_4 \\ | \\ CH_2\text{–}OH \end{array} \xrightarrow[H_2]{Ni} \begin{array}{l} CH_2\text{–}OH \\ | \\ (CH\text{–}OH)_4 \\ | \\ CH_2\text{–}OH \end{array} \xrightarrow[Ac_2O]{6\ Eq.}$

$\begin{array}{l} CH_2\text{–}OAc \\ | \\ (CH_2\text{–}OAc)_4 \\ | \\ CH_2\text{–}OAc \end{array}$

(iii) 

Glucose pentacetase 

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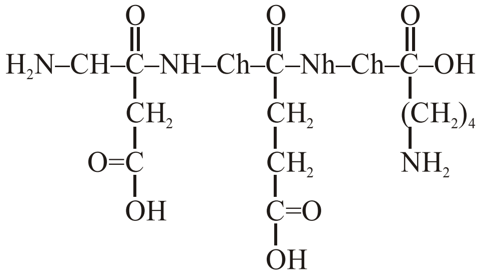
6. Official Ans. by NTA (3)

Sol. Seliwanoff's test is used to distinguish between aldose and ketose sugars; when added to a solution containing ketose, red colour is formed rapidly.

Sucrose $\xrightarrow{\text{Hydrolysis}}$ Glucose + Fructose $\xrightarrow[\text{reagent}]{\text{Seliwanoff's}}$ Red colour

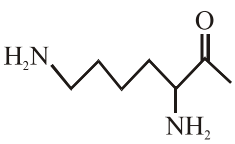
7. Official Ans. by NTA (5)

Sol. Structure of Tri peptide Asp – Glu – Lys

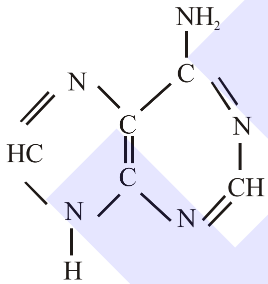


8. Official Ans. by NTA (1)

Sol. Adenine and lysine Both have primary amine react with $CHCl_3$ + alc. KOH



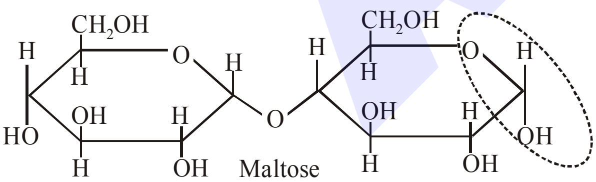
Lysine



Adenine

9. Official Ans. by NTA (2)

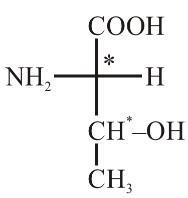
Sol.



Hemiacetal

10. Official Ans. by NTA (2)

Sol. Structure of Threonine is :



S. 2-chiral center is present

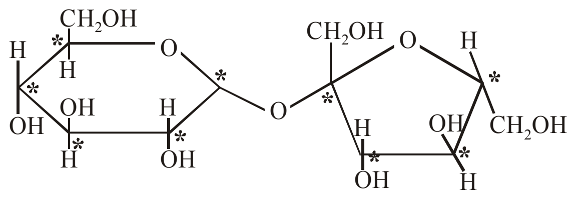
11. Official Ans. by NTA (4)

Sol. Tyrosine is not an essential amino acid.

12. Official Ans. by NTA (4)

13. Official Ans. by NTA (9)

Sol.

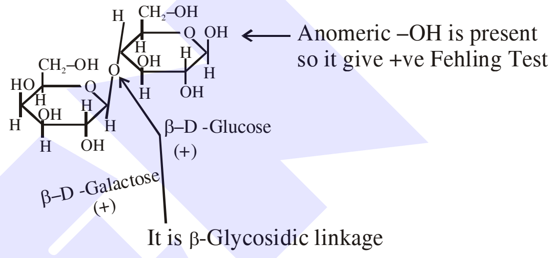


[α-D-Glucose] [β-D-Fructose]

Total no. of chiral carbon in sucrose = 9

14. Official Ans. by NTA (1)

Sol.



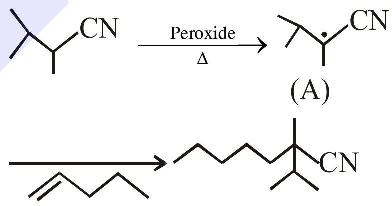
Structure of Lactose

structure of lactose

POLYMER

1. NTA Ans. (1)

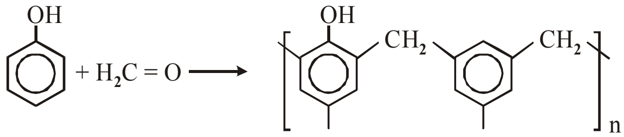
Sol.



(B)

2. NTA Ans. (3)

Sol. Bakelite formation is example of electrophilic substitution and dehydration.



3. NTA Ans. (4)

Sol. PHBV :

Poly β-hydroxy butyrate-co-β-hydroxy valerate

$CH_3–\underset{\displaystyle OH}{CH}–CH_2–COOH$

(3-hydroxy butanoic acid)

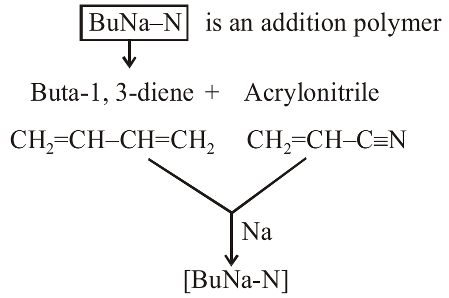
+

$CH_3–CH_2–\underset{\displaystyle OH}{CH}–CH_2–\overset{\displaystyle O}{\overset{\|}{C}}–OH$

(3-hydroxy pentanoic acid)

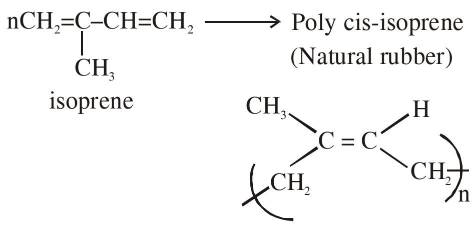
4. Official Ans. by NTA (1)

Sol.

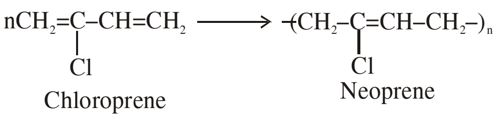


5. Official Ans. by NTA (2)

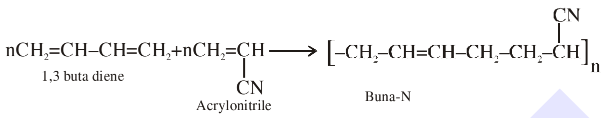
Sol.(a)



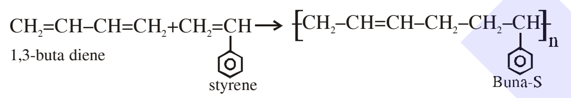
(b)



(c)



(d)

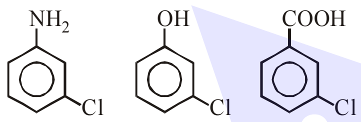


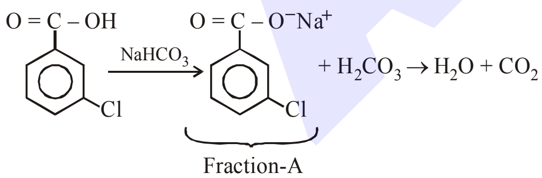
6. Official Ans. by NTA (3)

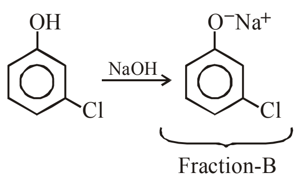
PRACTICAL ORGANIC CHEMISTRY (POC)

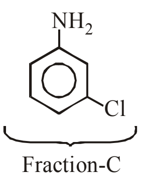
1. NTA Ans. (3)

Sol.









2. NTA Ans. (2)

Sol. (A) Benzanilide → Ph–NH–C(=O)–Ph (μ = 2.71 D)

(B) Aniline → Ph–NH_2 (μ = 1.59 D)

(C) Acetophenone → Ph–C(=O)–CH_3 (μ = 3.05 D)

Dipole moment : C > A > B

Hence the sequence of obtained compounds is (C), (A) and (B)

3. NTA Ans. (3)

Sol. Liquid which have less difference in boiling point can be isolated by fractional distillation and liquid with less boiling point will be isolated first.

4. NTA Ans. (1)

Sol. Kjeldahl's method for estimation of nitrogen is not applicable for nitrobenzene $C_6H_5NO_2$. because reaction with H_2SO_4, nitrobenzene can not give ammonia.

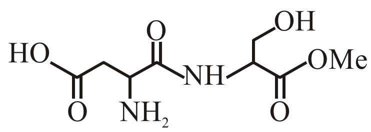
5. NTA Ans. (1)

Sol. (i) Blue voilet color with Ninhydrine → amino acid derivative. So it cannot be saccharide or sucralose.

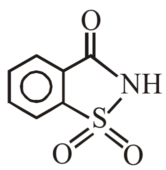
(ii) Lassaigne extract give +ve test with $AgNO_3$. So Cl is present, –ve test with $Fe_4[Fe(CN)_6]_3$ means N is absent. So it can't be Aspartame or Saccharine or Alitame, so C is sucralose.

(iii) Lassaigne solution of B and D given +ve sodium nitroprusside test, so it is having S, so it is Saccharine and Alitame.

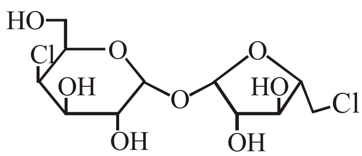
(A) Aspartame



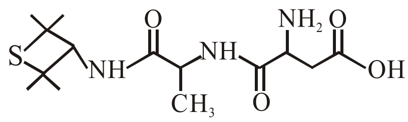
(B) Saccharine



(C) Sucralose



(D) Alitame



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6. Official Ans. by NTA (3)

Sol.

$$\underset{(A)}{CH_3-CH_2-\overset{O}{\overset{\|}{C}}-H} \xrightarrow{CH_3MgBr} \underset{(C)}{CH_3-CH_2-\overset{OH}{\overset{|}{CH}}-CH_3}$$

2° Alcohol

CAN test for alcohol : ✓

Iodoform test : ✓

$$\underset{(B)}{CH_3-\overset{O}{\overset{\|}{C}}-CH_3} \xrightarrow{CH_3MgBr} CH_3-\underset{CH_3}{\underset{|}{\overset{OH}{\overset{|}{C}}}}-CH_3$$

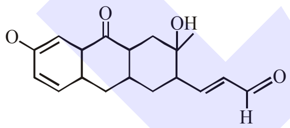
3° Alcohol

CAN test for alcohol : ✓

Lucas test : Immediately

Iodoform test : ×

7. Official Ans. by NTA (2)

Sol. Compound $\xrightarrow[\text{anhydride}]{\text{Chromic}}$ 

due to pressure of b

8. Official Ans. by NTA (1)

Sol. Test		**Correct reagent**
(i) Lucas test	⟶	conc. HCl + $ZnCl_2$
(ii) Dumas method	⟶	CuO / CO_2
(iii) Kjeldahl's method	⟶	H_2SO_4
(iv) Hinsberg Test	⟶	$C_6H_5SO_2Cl$ + aq. KOH

PURIFICATION AND SEPRATION TECHNIQUE

1. Official Ans. by NTA (1)

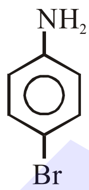
Sol. In Carius method

mass of organic compound = 0.172 gm

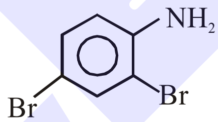
mass of Bromine = 0.08 gm

Hence % of Bromine = $\frac{0.08}{0.172} \times 100$

= 46.51%

(1)  C_6H_6NBr $\left[\%Br = \frac{80}{172} \times 100\right] = 46.51\%$

(2) CH_3CH_2Br C_2H_5Br $\%Br = \frac{80}{109} \times 100 = 73.33\%$

(3)  $C_6H_5NBr_2$

(4) CH_3Br

CHEMISTRY IN EVERYDAY LIFE

1. NTA Ans. (1)

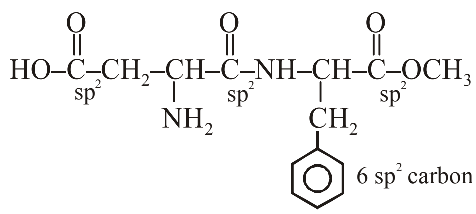
Sol. (i) Riboflavin ⟶ (c) Cheilosis

(ii) Thiamine ⟶ (a) Beriberi

(iii) Pyridoxin ⟶ (d) Convulsions

(iv) Ascorbic acid ⟶ (b) Scurvy

2. NTA Ans. (9.00)

Sol. 

no. of sp^2–carbon → 9

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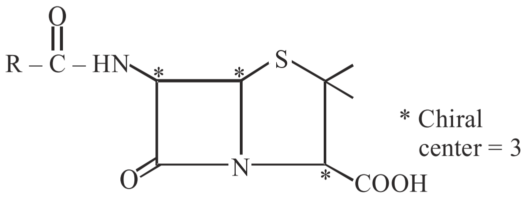
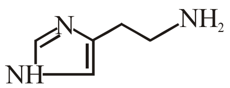
3. **NTA Ans. (3.00)**

Sol. The structure of penicillin is



4. **NTA Ans. (37.80 to 38.20)**

Sol.



M.F. of Histamine is $C_5H_9N_3$

Molecular mass of Histamine is 111

Now, mass % of nitrogen = $\left(\frac{42}{111}\right)\times 100$

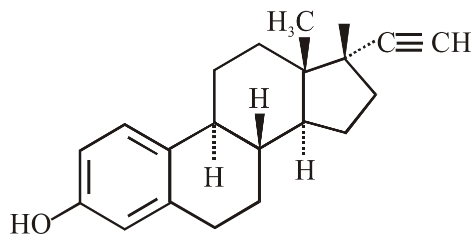
= 37.84%

5. **Official Ans. by NTA (3)**

Sol. Glycerol is separated by reduced pressure distillation in soap industries.

6. **Official Ans. by NTA (1)**

Sol.



Ethynylestradiol (novestrol)

gives (1) Br_2 + H_2O test

(2) Lucas test with $ZnCl_2$ + HCl

(3) $FeCl_3$ test of phenolic group.

7. **Official Ans. by NTA (3)**

Sol. Ranitidine → Antacid

Nardil → Antidepressant

Chloramphenicol → Antibiotic

Dimetane → Antihistamine

8. **Official Ans. by NTA (4)**

Sol. Anti depressant → drug which enhance the mood. Non adrenaline is neurotransmitter and its level is low in body due to some reason then person suffers from depression and in that situation anti depressant drug is required.

9. **Official Ans. by NTA (3)**

JANUARY & SEPTEMBER 2020 ATTEMPT (IOC)

QUANTUM NUMBER

1. Official Ans. by NTA (2)

Sol. Electronic configuration of Gd^{3+} is

$_{64}Gd^{3+}$ = [Xe]$4f^7$

[Xe] | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Gd^{3+} having 7 unpaired electrons.

Magnetic moment (μ) = $\sqrt{n(n+2)}$B.M.

$\mu = \sqrt{7(7+2)}$B.M.

= 7.9 B.M.

n ⇒ Number of unpaired electrons.

2. Official Ans. by NTA (4)

Sol. As per $(n + \ell)$ rule in 6^{th} period, order of orbitals filling is 6s, 4f, 5d, 6p.

3. Official Ans. by NTA (1)

Official Ans. by ALLEN (2,3)

Sol. l = 0 to (n + 1)

n = 1   n = 2

l = 0, 1, 2 l = 0, 1, 2, 3

$(n + l) \Rightarrow \frac{1s}{1}\ \frac{1p}{2}\ \frac{1d}{3}$ $\frac{2s}{2}\ \frac{2p}{3}\ \frac{2d}{4}\ \frac{2f}{5}$

n = 3

l = 0, 1, 2, 3, 4

$\frac{3s}{3}\ \frac{3p}{4}\ \frac{3d}{5}\ \frac{3f}{6}\ \frac{3g}{7}$

Now, in order to write electronic configuration, we need to apply $(n + l)$ rule

Energy order : 1s < 1p < 2s < 1d < 2p < 3s < 2d...

Option 1) 13 : $1s^2 1p^6 2s^2 1d^3$ is not half filled

Option 2) 9 : $1s^2 1p^6 2s^1$ is the first alkali metal because after losing one electron, it will achieve first noble gas configuration

Option 3) 8 : $1s^2 1p^6$ is the first noble gas because after $1p^6$ e^- will enter 2s hence new period

Option 4) 6 : $1s^2$ $1p^4$ has 1p valence subshell.

4. Official Ans. by NTA (4)

Sol. For n = 4

ℓ = 0, 1, 2, 3

	4s	4p	4d	4f
m	0	–1 0 +1	–2 –1 0 +1 +2	–3 –2 –1 0 +1 +2 +3

∴ 4d & 4f subshell associated with n = 4, m = –2

PERIODIC TABLE

1. NTA Ans. (1)

Sol. Order of electron gain enthalpy (magnitude) is Cl > F > Br > I

2. NTA Ans. (3)

Sol. (i) Electron affinity of second period p-block element is less than third period p-block element due to small size of second period p-block element.

E.A. order : F < Cl

(ii) Down the group electron affinity decreases due to size increases.

EA. order : S > Se

Li > Na

3. NTA Ans. (1)

Sol. Elecronic configuration of Na = [Ne] $3s^1$

Mg = [Ne] $3s^2$

Al = [Ne] $3s^2 3p^1$

Si = [Ne] $3s^2 3p^2$

So order of first ionisation energy is

$\underset{496}{Na} < \underset{737}{Mg} > \underset{577}{Al} < \underset{786}{Si}$ kj/mol

Na < Al < Mg < Si (IE_1 order)

4. NTA Ans. (4)

Sol. If the given elements are arranged according to their position in periodic table

Atomic radius

C > O > F

        ∧

        Cl

        ∧

        Br

Br > Cl > C > O > F

c < b < a < d < e

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5. NTA Ans. (1)

Sol. Be $\Rightarrow$ $1s^2\ 2s^2$

B $\Rightarrow$ $1s^2\ 2s^2\ 2p^1$

B has a smaller size than Be

it is easier to remove 2p electron than 2s electron due to less pentration effect of 2p than 2s.

2p electron of Boron is more shielded from the nucleus by the inner core of electron than the 2s electron of Be

B has a smaller size than Be

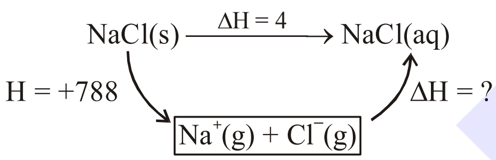
6. Official Ans. by NTA (3)

Sol. Correct order of size for isoelectronic species.

$Al^{3+} < Mg^{2+} < Na^{+} < F^{-} < O^{2-} < N^{3-}$

7. Official Ans. by NTA (2)

Sol.



$4 = 788 + \Delta H$

$\Delta H = -784$ kJ

8. Official Ans. by NTA (2)

Sol. $H_{(g)} + e^- \rightarrow H^-$ is exothermic

rest of all endothermic process.

9. Official Ans. by NTA (4)

Sol.

	O^{-2}	F^-	Na^+	Mg^{2+}
z	8	9	11	12
e^-	10	10	10	10
$\frac{z}{e}$	0.8	0.9	1.1	1.2

as $\frac{z}{e}$ ratio increases size decreases.

Thus correct ionic radii order is

$O^{-2} > F^- > Na^+ > Mg^{2+}$

Therefore correct option is (4)

10. Official Ans. by NTA (2)

Sol. Element with atomic no. 101 is an Actinoid element.

11. Official Ans. by NTA (2)

Sol. Let suppose element X $\Rightarrow$

$$X_{(g)} \xrightarrow[800]{IE_1} \overset{+}{X}(g) \xrightarrow[2427]{IE_2} \overset{+2}{X}(g) \xrightarrow[3658]{IE_3}$$

$$\overset{+3}{X}(g) \xrightarrow[25024]{IE_4} \overset{+4}{X}(g) \xrightarrow[32824]{IE_5} \overset{+5}{X}(g)$$

X^{+3} has stable inert gas configuration as there is high jump after IE_3

So valence electrons are 3

12. Official Ans. by NTA (3)

Sol. I, A_N : Be < Mg

II IE : Be > Al

III Charge/radius ratio of Be is less than that of Al

IV Be, Al mainly form covalent compounds

13. Official Ans. by NTA (4)

Sol. 1 0 9

un nil enn

Hence correct name $\rightarrow$ unnilennium

14. Official Ans. by NTA (3)

Sol. When we are moving from left to right in a periodic table acidic character of oxides increases (as well as atomic number of atom increases)

$\therefore$ X < Y < Z (acidic character)

X < Y < Z (atomic number)

15. Official Ans. by NTA (4)

Sol. In general across a period atomic radius decreases while ionisation enthalpy, electron gain enthalpy and electronegativity increases because effective nuclear charge (Z_{eff}) increases.

16. Official Ans. by NTA (101.00)

Sol. Unnilunium $\Rightarrow$ 101

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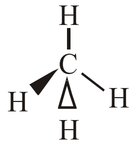
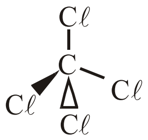
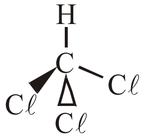
CHEMICAL BONDING

1. NTA Ans. (1)

Sol.  $\mu_{net} = 0$  $\mu_{net} = 0$

 $\mu_{net} \neq 0$

2. NTA Ans. (4)

Sol. Order is

ion – ion > ion – dipole > dipole – dipole

3. NTA Ans. (1)

Sol. According to MOT (If z is internuclear axis)

The configuration of

$CN^- : \sigma_{1s}^2, \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}, \pi_{2p_x}^2 = \pi_{2p_y}^2, \sigma_{2p_z}^2$

Bond order $= \frac{1}{2}(10-4)$

$= 3$

CN^- is diamagnetic due to absence of unpaired electron

4. NTA Ans. (3)

Sol. Ethyl acetate $\left(H_3C{-}\underset{\underset{O}{\|}}{C}{-}O{-}CH_2{-}CH_3\right)$ is polar molecule. Hence there will be dipole-dipole attraction and london dispersion forces are present.

5. NTA Ans. (3)

Sol. Bond length order in carbon halogen bonds are in the order of C – F < C – Cl < C – Br < C – I

Hence, Bond energy order

C – F > C – Cl > C – Br > C – I

6. NTA Ans. (1)

Sol. CCl_4 is molecular solid so does not conduct electricity in liquid & solid state.

7. NTA Ans. (1)

Sol.

	number of unpaired electron	magnetic moment
$O_2^{\ominus}$	1	1.73 B.M
$O_2^{\oplus}$	1	1.73 B.M
O_2	2	2.83 BM

8. NTA Ans. (4)

Sol. 1. MgO Basic

Cl_2O Acidic

Al_2O_3 amphoteric

2. Cl_2O Acidic

CaO Basic

P_4O_{10} Acidic

3. Na_2O Basic

SO_3 Acidic

Al_2O_3 amphoteric

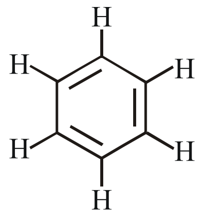
4. N_2O_3 Acidic

Li_2O Basic

Al_2O_3 amphoteric

9. NTA Ans. (4)

Sol.



Each carbon atom is sp^2 hybridized

Therefore each carbon has 3 sp^2 hybrid orbitals.

Hence total sp^2 hybrid orbitals are 18.

10. Official Ans. by NTA (1)

11. Official Ans. by NTA (3.00)

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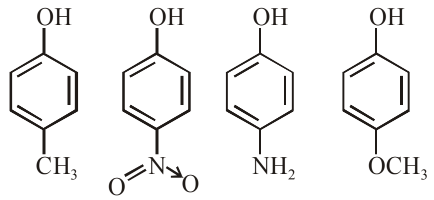
12. Official Ans. by NTA (1)

Sol.



	(I)	(II)	(III)	(IV)
BP value from net	≃202°C	≃279°	≃284°C	≃243°C

BP ∝ dipolemoment (μ)

Alter

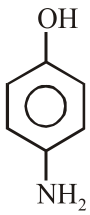
Increasing order of boiling point is :

I. 

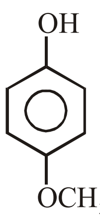
⇒ Shows hydrogen bonding from –O–H group only

II. 

⇒ Shows strongest hydrogen bonding from both sides of –OH group as well as $-NO_2$ group.

III. 

⇒ Shows stronger hydrogen from both side of –OH group as well as $-NH_2$ group.

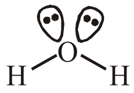
IV. 

⇒ Shows stronger hydrogen bonding from one side –OH–group and another side of $-OCH_3$ group shows only dipole-dipole interaction.

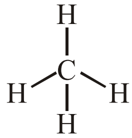
⇒ Hence correct order of boiling point is:

(I) < (IV) < (III) < (II)

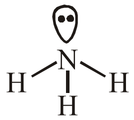
13. Official Ans. by NTA (2)

Sol. (1) 

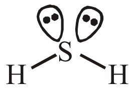
sp^3, 104°5'

(2) 

sp^3, 109°28'

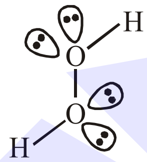
(3) 

sp^3, 107°

(4) 

92°

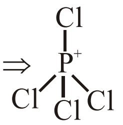
14. Official Ans. by NTA (1)

Sol. 

hydrogen peroxide, in the pure state, is non-planar and almost colourless (very pale blue) liquid.

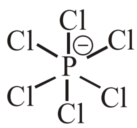
15. Official Ans. by NTA (2)

Sol. $PCl_{5(s)}$ exist as $[PCl_4]^+$ and $[PCl_6]^-$

$[PCl_4]^+$ ⇒ 

(sp^3 hybridisation)

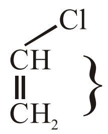
Tetrahedral

$[PCl_6]^-$ ⇒ 

octahedral

sp^3d^2 hybridization

16. Official Ans. by NTA (3)

Sol. 

In option (3) C—Cl bond is shortest due to resonance of lone pair of –Cl.

Due to resonance C—Cl bond acquire partial double bond character.

Hence C—Cl bond length is least.

17. Official Ans. by NTA (2)

Sol. $XeF_4 + SbF_5 \rightarrow [XeF_3]^+[SbF_6]^-$

sp^3d^2 sp^3d sp^3d sp^3d^2

18. Official Ans. by NTA (4)

Sol. Bond order of NO^{2+} = 2.5

Bond order of NO^{+} = 3

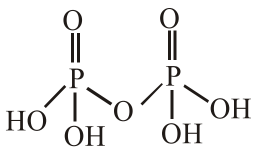
Bond order of NO = 2.5

Bond order of NO^{-} = 2

Bond order α bond strength.

19. Official Ans. by NTA (4)

Sol. Pyrophosphoric acid.



P – OH linkages = 4

P = O linkages = 2

P–O–P linkages = 1

20. Official Ans. by NTA (3)

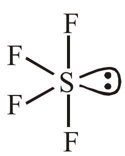
Official Ans. by ALLEN (2)

Sol.

Type of interaction	Interaction Energy(E)
ion - ion	$E \propto \frac{1}{r}$
dipole - dipole	$E \propto \frac{1}{r^3}$
London dispersion	$E \propto \frac{1}{r^6}$

21. Official Ans. by NTA (1)

Sol.

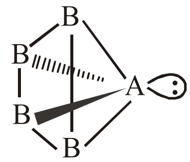


4σ bonds +1 lone pair

$\therefore$ Shape (including lone pair of electrons) is Trigonal bipyramidal

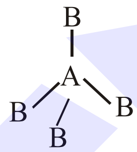
22. Official Ans. by NTA (1)

Sol. (1) If AB_4 molecule is a square pyramidal then it has one lone pair and their structure should be



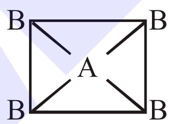
and it should be polar because dipole moment of lone pair of 'A' never be cancelled by others.

(2) If AB_4 molecule is a tetrahedral then it has no lone pair and their structure should be



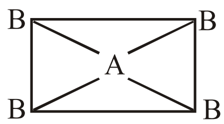
and it should be non polar due to perfect symmetry.

(3) If AB_4 molecule is a square planar then



it should be non polar because vector sum of dipole moment is zero.

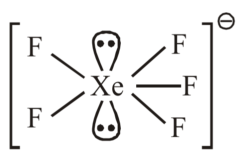
(4) If AB_4 molecule is a rectangular planar then

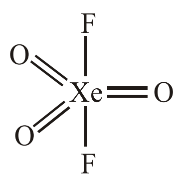


it should be non polar because vector sum of dipole moment is zero.

23. Official Ans. by NTA (1)

Sol.





XeF_5^-	XeO_3F_2
sp^3d^3	sp^3d
Pentagonal planar	Trigonal bipyramidal

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COORDINATION CHEMISTRY

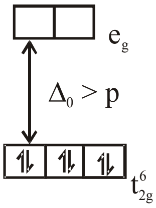
1. NTA Ans. (4)

Sol. In complex $[Ni(CO)_4]$ decrease in Ni–C bond length and increase in C–O bond length as well as it's magnetic property is explained by MOT.

2. NTA Ans. (4)

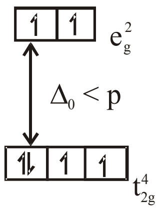
3. NTA Ans. (4)

Sol. (a) Co^{+3} (with strong field ligands)



diamagnetic

(b) If $\Delta_0 < p$;



(c) Splitting power of ethylenediamine (en) is greater than fluoride (F^-) ligand therefore more energy absorbed by $[Co(en)_3]^{3+}$ as compared to $[CoF_6]^{3-}$.

So wave length of light absorbed by $[Co(en)_3]^{3+}$ is lower than that of $[CoF_6]^{3-}$

(d) $\Delta_t = \frac{4}{9}\Delta_0$

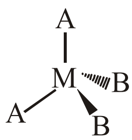
so if Δ_0 = 18,000 cm^{-1}

$\Delta_t = \frac{4}{9} \times 18000 = 8000\ cm^{-1}$

Statement (a) and (d) are incorrect.

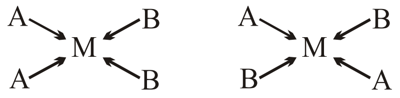
4. NTA Ans. (1)

Sol. (a) If the complex MA_2B_2 is sp^3 hybridised then the shape of this complex is tetrahedral this structure is opticaly inactive due to the presence of plane of symmetry.



Optical isomes = 0

(b) If the complex MA_2B_2 is dsp^2 hybridised then the shape of this complex is square planar.



(Cis-isomer) (Trans-isomer)

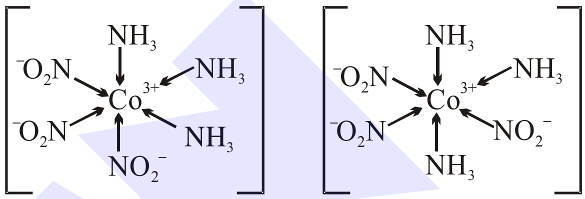
Both isomers are optically inactive due to the presence of plane of symmetry.

Optical isomers = 0

5. NTA Ans. (3)

Sol. $[Ma_3b_3]$ type complex shows fac and mer isomerism.

$[Co(NH_3)_3(NO_2)_3]$



fac-isomer mer-isomer

6. NTA Ans. (26.60 to 27.00)

Sol. Number of moles of Cl^- precipitated in $[Co(NH_3)_6]Cl_3$ is equal to number of moles of $AgNO_3$ used.

$$\frac{0.3}{267.46} \times 3 = \frac{0.125 \times V}{1000}$$

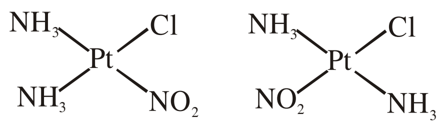
where V is volume of $AgNO_3$ (in mL)

V = 26.92 mL

7. NTA Ans. (4)

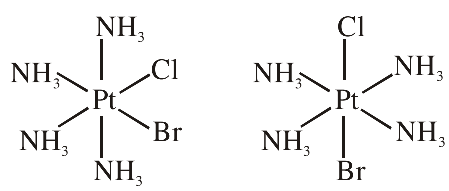
Sol. $[Pt(NH_3)_3Cl]^+$ & $[Pt(NH_3)Cl_5]^-$ does not show geometrical isomerism

(c)



cis trans

(d)



cis trans

8. NTA Ans. (1)

Sol.

$[Ni(CO)_4]$ μ_m = 0 B.M.

$[Ni(H_2O)_6]Cl_2$ μ_m = 2.8 B.M.

$Na_2[Ni(CN)_4]$ μ_m = 0 B.M.

$[PdCl_2(PPh_3)_2]$ μ_m = 0 B.M.

A ≈ C ≈ D < B

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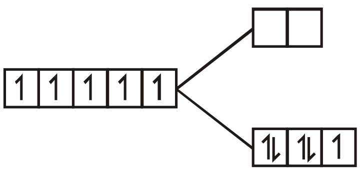
9. NTA Ans. (20)

10. NTA Ans. (2)

Sol. $[Pb(F)(Cl)(Br)(I)]^{2-}$ have three geometrical isomer so formula for $[Fe(CN)_6]^{n-6}$ is $[Fe(CN)_6]^{3-}$ and CFSE for this complex is $Fe^{3\oplus} \Rightarrow 3d^5 4s^\circ$



Magnetic Moment = $\sqrt{3}$

= 1.73 B.M

CFSE = $[(-0.4\times5) + (0.6 \times 0)]\ \Delta_0$

= $-2.0\ \Delta_0$

11. NTA Ans. (1)

Sol. $Cr(H_2O)_6\ Cl_n$

if magnetic mement is 3.83 BM then it contain three unpaired electrons. It means chromium in +3 oxidation state so molecular formula is $Cr(H_2O)_6\ Cl_3$

∴ This formula have following isomers

(a) $[Cr(H_2O)_6]Cl_3$: react with $AgNO_3$ but does not show geometrical isomerism.

(b) $[Cr(H_2O)_5Cl]Cl_2.H_2O$ react with $AgNO_3$ but does not show geometrical isomerism.

(c) $[Cr(H_2O)_4Cl_2]Cl.2H_2O$ react with $AgNO_3$ & show geometrical isomerism.

(d) $[Cr(H_2O)_3Cl_3].3H_2O$ does not react with $AgNO_3$ & show geometrical isomerism.

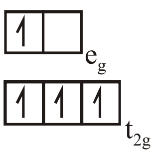
$[Cr(H_2O)_4Cl_2]Cl.2H_2O$ react with $AgNO_3$ & show geometrical isomerism and it's IUPAC nomenclature is Tetraaquadichlorido chromium (III) Chloride dihydrate.

12. NTA Ans. (2)

Sol. I $[Cr(H_2O)_6]^{2+}$

$Cr^{+2} \Rightarrow [Ar]\,3d^4$

$H_2O \rightarrow$ Weak field ligand



Unpaired e^- = 4

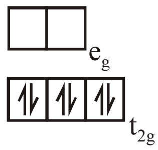
Magnetic moment = $\sqrt{24}$ BM

= 4.89 BM

II $[Fe(CN)_6]^{4-}$

$Fe^{+2} \Rightarrow [Ar]\,3d^6$

$CN^- \rightarrow$Strong field ligand



Unpaired e^- = 0

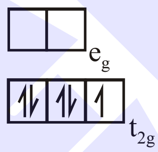
Magnetic moment = 0 BM

= 0 BM

III $[Fe(C_2O_4)_3]^{3-}$

$Fe^{+3} \Rightarrow [Ar]\,3d^5$

As $\Delta_0 > P$



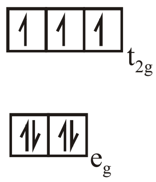
Unpaired e^- = 1

Magnetic moment = $\sqrt{3}$ BM = 1.73 BM

IV $(Et_4N)^+[CoCl_4]^{2-}$

$Co^{+2} \Rightarrow [Ar]\,3d^7$

$[CoCl_4]^{-2}$ =



Unpaired electrons = 3

Magnetic moment = $\sqrt{15}$ BM

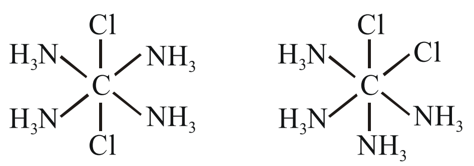
= 3.87 BM

Hence order of magnetic moment is

I > IV > III > II

13. NTA Ans. (4)

Sol. $[Co(NH_3)_4Cl_2]$ has 2 geometrical isomers



trans cis

cis isomer has Cl–Co–Cl angle of 90°

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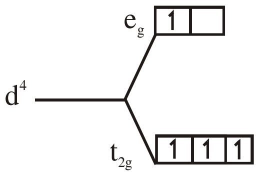
14. Official Ans. by NTA (2)

15. Official Ans. by NTA (3)

Sol.



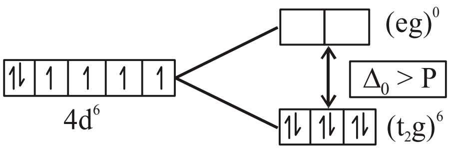
back pairing is not possible because pairing energy > Δ_O.

16. Official Ans. by NTA (00)

Sol. Magnetic moment (in B.M.) of $[Ru(H_2O)_6]^{2+}$ would be; while considering that $\Delta_0 > P$,

$Ru_{(44)}$; $[Kr]4d^75s^1$ (in ground state)

$\Rightarrow$ In $Ru^{2+} \Rightarrow 4d^6 \Rightarrow (t_2g)^6(eg)^0$

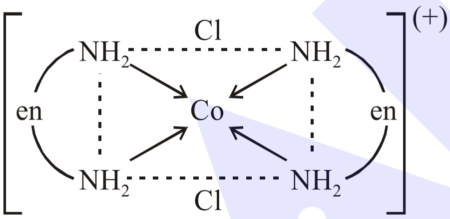


$\Rightarrow$ Here number of unpaired electrons in $Ru^{2+} = (t_2g)^6\ (eg)^0 = 0$ and Hence

$\mu_m = \sqrt{n(n+2)}B.M. = \boxed{0\ B.M.}$

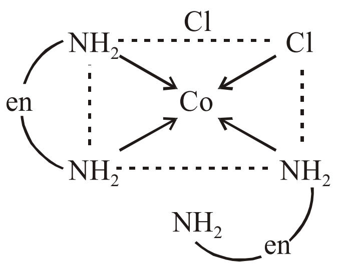
17. Official Ans. by NTA (4)

Sol. (A) *trans*-$[Co(en)_2Cl_2]^+$



$\Rightarrow$ (A) is trans form and shows plane of symmetry which is optically inactive (not optically active)

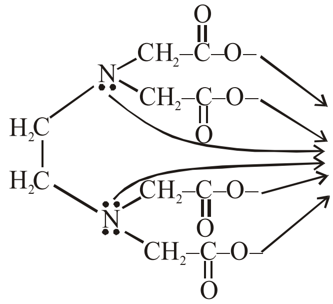
(B) *cis*-$[Co(en)_2Cl_2]^+$



$\Rightarrow$ (B) is cis form and does not shows plane of symmetry, hence it is optically active.

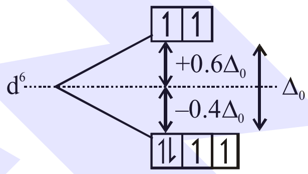
18. Official Ans. by NTA (6)

Sol. $EDTA^{4-}$ is hexadentate ligand, so its donation sites are six.



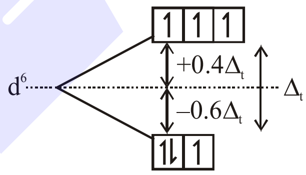
19. Official Ans. by NTA (3)

Sol. For high spin octahedral field



CFSE = (4) $(-0.4\Delta_0) + 2(0.6\ \Delta_0) = -\ 0.4\ \Delta_0$

For high spin tetrahedral field



CFSE = $3(-0.6\Delta_t) + 3(0.4\ \Delta_t) = -\ 0.6\ \Delta_t$

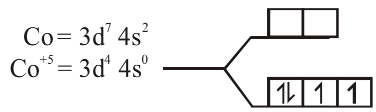
20. Official Ans. by NTA (1)

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

dsp^2 hybridisation.

21. Official Ans. by NTA (3)

Sol. $[Co(OX)_2(OH)_2]^-$ $\quad \Delta_0 > P$ [S.F.L]



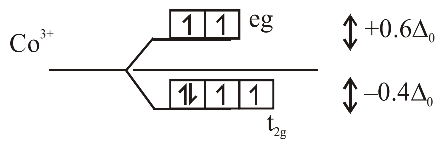
It has highest number of unpaired e⁻s. so it is most paramagnetic.

22. Official Ans. by NTA (4)

Official Ans. by ALLEN (2, 4)

Sol. $[CoF_3(H_2O)_3]$ $\quad \Delta_0 < P$

Means all ligands behaves as weak field ligands



$= [-0.4\times4+0.6\times2]\Delta_0$

$= [-1.6+1.2]\Delta_0$

$= [-0.4\Delta_0]$

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23. Official Ans. by NTA (3)

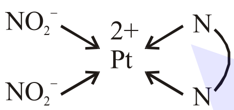
Sol.

Complex	e^- configuration	no. of unpaired e^-
$[Mn(H_2O)_6]^{2+}$ WFL	↿ ↿ eg; ↿ ↿ ↿ t2g	5
$[Cr(H_2O)_6]^{2+}$ WFL	↿ ☐ eg; ↿ ↿ ↿	4
$[COCl_4]^{2-}$ Tetrahedral	↿ ↿ ↿ t_2; ⥮ ⥮ e	3
$[Fe(H_2O)_6]^{2+}$ WFL	↿ ↿ eg; ⥮ ↿ ↿ t_2g	4
$[Co(OH)_4]^{2-}$ WFL	↿ ↿ ↿ t_2; ⥮ ⥮ e	3
Tetrahedral $[Fe(NH_3)_6]^{2+}$	↿ ↿; ⥮ ↿ ↿	4

Thus complex $[Cr(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{2+}$ have same no. of unpaired e^- and hence same magnetic moment (spin only).

24. Official Ans. by NTA (1)

Sol. $[Pt\ (en)\ (NO_2)_2]$ ⇒ does not show G.I. as well as optical isomerism.



This complex will have three linkage isomers as follows :-

$[Pt\ (en)\ (NO_2)_2]$ I

$[Pt\ (en)\ (NO_2)(ONO)]$ II

$[Pt\ (en)\ (ONO)_2]$ III

25. Official Ans. by NTA (3)

Sol. % mass of water

$$= \frac{x \times 18}{(12 + 6 \times 16 + 35 \times 3 + 52)} \times 100 = 13.5$$

$$\Rightarrow \quad x = \frac{265 \times 13.5}{18 \times 100} \simeq 2$$

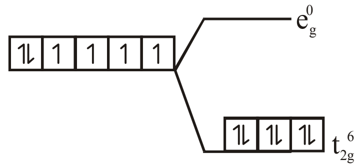
26. Official Ans. by NTA (3)

Sol. $[Ru(en)_3]Cl_2$ Ru ⇒ 4d series

en ⇒ chelating ligand

CN = 6, octahedral splitting hence large splitting of d-subshell

$Ru^{+2} \Rightarrow [Kr]4d^6 5s^0$

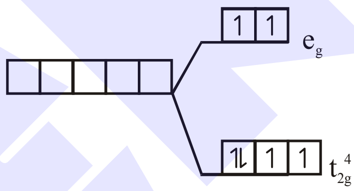


$[Fe(H_2O)_6]Cl_2$ ⇒ H_2O ⇒ Weak filled ligand

$Fe^{+2} \Rightarrow [Ar]\ 3d^6 4s^0$

less splitting

CN = 6 octahedral splitting



27. Official Ans. by NTA (4)

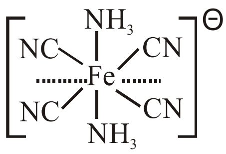
Sol. CFSE = $0.4\ \Delta_0$

$$= 0.4 \times \frac{20300}{83.7}$$

= 97 kJ/mol

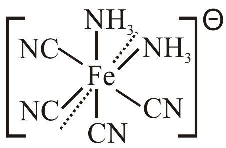
28. Official Ans. by NTA (3)

Sol. (1)



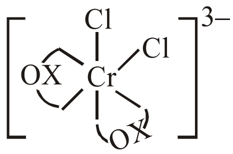
optically inactive

(2)



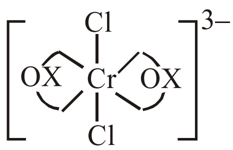
optically inactive

(3)



optically active

(4)



optically inactive

29. Official Ans. by NTA (2)

Sol. $[Ni(NH_3)_2Cl_2]$ is tetrahedral complex, therefore does not show geometrical and optical isomerism.

$[Ni(NH_3)_2Cl_2]$ does not show structural isomerism

$[Ni(NH_3)_4(H_2O)_2]^{2+}$ & $[Pt(NH_3)_2Cl_2]$ show geometrical isomerism

$[Ni(en)_3]^{2+}$ show optical isomerism

30. Official Ans. by NTA (3)

Sol. (I) Under weak field ligand, octahedral Mn(II) and tetrahedral Ni(II) both the complexes are high spin complex.

(II) Tetrahedral Ni(II) complex can very rarely be low spin because square planar (under strong ligand) complexes of Ni(II) are low spin complexes.

(III) With strong field ligands Mn (II) complexes can be low spin because they have less number of unpaired electron (unpaired electron = 1)

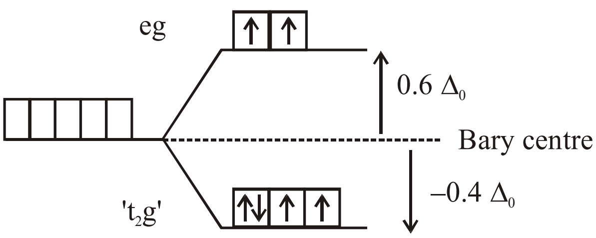
While with weak field ligands Mn(II) complexes can be high spin because they have more number of unpaired electron (unpaired electron = 5)

(IV) Aqueous solution of Mn(II) ions is pink in colour.

31. Official Ans. by NTA (2)

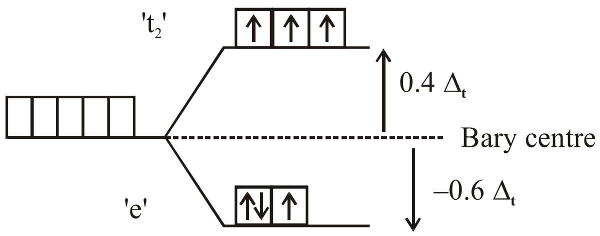
Sol. If spin only magnetic moment of the complex is 4.90 BM, it means number of unpaired electrons should be 4.

(A) In octahedral complex : $[M(H_2O)_6]^{2+}$
d^6



C.F.S.E. $= (-0.4\ \Delta_0) \times 4 + (+0.6\ \Delta_0) \times 2 + 0 \times P$
$= -0.4\ \Delta_0$

(B) In tetrahedral complex : $[M(H_2O)_4]^{2+}$
d^6



C.F.S.E. $= (-0.6\ \Delta_t) \times 3 + (+0.4\ \Delta_t) \times 3 + 0 \times P$
$= -0.6\ \Delta_t$

32. Official Ans. by NTA (6)

Sol. (A) $Na_4[\overset{x}{Fe}(CN)_5(NOS)]$

$(+1)4 + x + (-1)5 + (-1)\ 1 = 0$

$\boxed{x = +2}$

(B) $Na_4[\overset{y}{Fe}O_4]$

$(+1)4 + y + (-2)4 = 0$

$\boxed{y = +4}$

(C) $[\overset{z}{Fe_2}(CO)_9]$

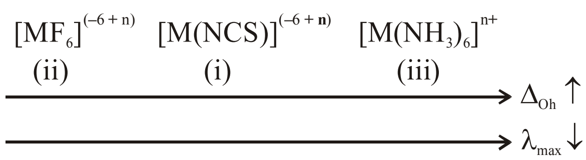
$2z + 0 \times 9 = 0$

$\boxed{z = 0}$

so $(x + y + z) = +2 + 4 + 0$
$= 6$

33. Official Ans. by NTA (2)

Sol. Strength of ligand $F^- < NCS^- < NH_3$



As given in graph : A < B < C (λ_{max})

$\therefore$ Correct matching is A–(iii), B-(i), C-(ii)

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METALLURGY

1. NTA Ans. (2)

Sol. Wrought iron is purest from of commercial iron.

2. NTA Ans. (2)

Sol. Liquation method is used when the melting point of metal is less compare to the melting point of the associated impurity.

3. NTA Ans. (1)

Sol. In blast furnace (metallugy of iron) involved reactions are

(a) $CaO + SiO_2 \longrightarrow CaSiO_3$

(b) $3Fe_2O_3 + CO \longrightarrow 2Fe_3O_4 + CO_2$

4. NTA Ans. (2)

Sol. A reduces BO_2 when temperature is above 1400°C because above 1400°C A has more –ve $\Delta G°$ for AO_2 formation than B to BO_2 formation.

5. Official Ans. by NTA (2)

Sol. Impure zinc is refined by distillation method.

6. Official Ans. by NTA (4)

Sol. "Boron" and "Silicon" of very high purity can be obtained through :-
zone refining method only.
While other methods are used for other metals/ elements i.e.
(i) Vapour phase refining
(ii) electrolytic refining
(iii) liquation etc.

7. Official Ans. by NTA (3)

Sol. Ellingham diagram provides information about temperature dependence of the standard gibbs energies of formation of some metal oxides.

8. Official Ans. by NTA (1)

Sol. Due to industrial process SO_2 gas is released which is responsible for acid rain & global warming.

9. Official Ans. by NTA (4)

Sol. (a) $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$ {In Blast furnace}
lime stone
(b) Ag form cyanide complex $[Ag(CN)_2]^-$ during cyaride process

$$Ag / Ag_2S + CN^{\ominus} \rightarrow [Ag(CN)_2]^-$$

(c) Ni is purified by mond's process
(d) Zr and Ti are purified by van arkel method
All (a), (b), (c), (d) are correct statements
Thus correct option is (4)

10. Official Ans. by NTA (2)

Sol. Cast iron is used for manufacturing of wrought iron and steel.

HYDROGEN & IT'S COMPOUND

1. Official Ans. by NTA (1)

Sol. High purity (>99.95%) dihydrogen is obtained by electrolysing warm aqueous barium hydroxide solution between nickel electrodes.

2. Official Ans. by NTA (3)

Sol. Temporary hardness of water is removed by clark method and boiling. While permanent hardness of water is removed by treatment with sodium carbonate (Na_2CO_3), calgons method and ion-exchange method

SALT ANALYSIS

1. Official Ans. by NTA (2)

Sol.

$$\underset{(X)}{Na_2SO_3} \xrightarrow{\text{dil. } H_2SO_4} \underset{(Y)}{SO_2} \xrightarrow{NaOH} \underset{(X)}{Na_2SO_3}$$

$$\underset{(X)}{Na_2SO_3} \xrightarrow{SO_2 + H_2O} \underset{(Z)}{NaHSO_3}$$

COMPLETE S-BLOCK

1. NTA Ans. (1)

Sol. $6NaOH + 3Cl_2 \longrightarrow NaClO_3 + 5NaCl + 3H_2O$
(hot and conc.) (A) side product

$2Ca(OH)_2 + 2Cl_2 \longrightarrow Ca(OCl)_2 + CaCl_2 + 2H_2O$
dry (B) side product

2. NTA Ans. (4)

Sol. $\underset{\text{Gypsum}}{CaSO_4.2H_2O} \xrightarrow{393K} \underset{\text{Plaster of paris}}{CaSO_4.\frac{1}{2}H_2O} + \frac{3}{2}H_2O$

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3. **NTA Ans. (1)**

Sol. $3Mg + N_2 \xrightarrow{\Delta} Mg_3N_2$
(A) (B)

$\downarrow 6H_2O$

$3Mg(OH)_2 + 2NH_3$
colourless gas

$CuSO_4 + 4NH_3 \longrightarrow [Cu(NH_3)_4]SO_4$
deep blue solution

4. **NTA Ans. (3)**

Sol. Lithium has highest hydration enthalpy among alkali metals due to its small size.
LiCl is soluble in pyridine because LiCl have more covalent character.
Li does not form ethynide with ethyne.
Both Li and Mg reacts slowly with H_2O

5. **Official Ans. by NTA (4)**

Sol. (I) $Ca(OH)_2$ is used in white wash

(II) NaCl is used in preparation of washing soda

$2NH_3 + H_2O + CO_2 \longrightarrow (NH_4)_2CO_3$

$(NH_4)_2CO_3 + H_2O + CO_2 \longrightarrow 2NH_4HCO_3$

$NH_4HCO_3 + NaCl \longrightarrow NH_4Cl + NaHCO_3(s)$

$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$

(III) $CaSO_4.\frac{1}{2}H_2O$ (Plaster of Paris) is used for making casts of statues

(IV) $CaCO_3$ is used as an antacid

6. **Official Ans. by NTA (2)**

Sol. [Be]

$BeSO_4$ is water soluble

$Be(OH)_2$ is water insoluble

BeO is stable to heat

7. **Official Ans. by NTA (3)**

Sol. $Li + O_2 \rightarrow Li_2O$ (Major Oxides)
excess

$Na + '' \rightarrow Na_2O_2$ ('')

$K + '' \rightarrow KO_2$ ('')

8. **Official Ans. by NTA (3)**

Sol. Toilet cleaning liquid has about 10.5% w/v HCl; to neutralise its affect aqueous $NaHCO_3$ is used while NaOH is avoid for this purpose because its highly corosive in nature and can burn body.

9. **Official Ans. by NTA (4)**

Sol. Cs used in photoelectric cell as it has least ionisation energy.

10. **Official Ans. by NTA (2)**

Sol. Both Li and Mg form nitride when reacts directly with nitrogen.

The hydrogen carbonate of both Li and Mg does not exist in solid state.

All alkali metal hydrogen carbonate exist in solid state except $LiHCO_3$.

COMPLETE D-BLOCK

1. **NTA Ans. (3)**

Sol. Atomic radius of Ag and Au is nearly same due to lanthanide contraction.

2. **NTA Ans. (18.00)**

Sol. $4NaCl + K_2Cr_2O_7 + 6H_2SO_4$
$\downarrow$
$2CrO_2Cl_2 + 4NaHSO_4 + 2KHSO_4 + 3H_2O$
(A)

$CrO_2Cl_2 + 4NaOH \longrightarrow Na_2CrO_4 + 2NaCl + 2H_2O$
(B)

$Na_2CrO_4 + 2H_2SO_4 + 2H_2O_2$
$\downarrow$
$CrO_5 + 2NaHSO_4 + 3H_2O$
(C)

$A = CrO_2Cl_2$
$B = Na_2CrO_4$
$C = CrO_5$

Total number of atom in A + B + C = 18

3. **NTA Ans. (1)**

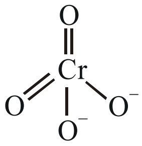
Sol. Electronic configuration of

	$_{25}Mn$	$_{26}Fe$	$_{27}Co$	$_{28}Ni$
M =	$[Ar]3d^54s^2$	$[Ar]3d^64s^2$	$[Ar]3d^74s^2$	$[Ar]3d^84s^2$
M^{2+} =	$[Ar]3d^54s^0$	$[Ar]3d^64s^0$	$[Ar]3d^74s^0$	$[Ar]3d^84s^0$

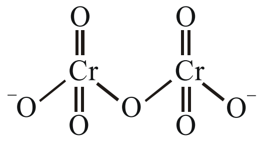
So third ionisation energy is minimum for Fe.

4. **NTA Ans. (12.00)**
ALLEN Ans. (18.00)

Sol. Chromate CrO_4^{2-}



Dichromate $Cr_2O_7^{2-}$



Total Cr-O bonds = 6 ($4\sigma + 2\pi$)   Total Cr-O bonds = 12 ($8\sigma + 4\pi$)

Total number of bonds between chromium and oxygen in both structures are 18.

Note :- But answer of NTA is 12. They consider only linkages between Chromium and Oxygen but in question total no. of bonds are asked so σ and π bonds must be considered separately.

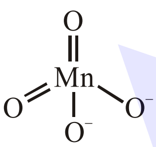
5. **Official Ans. by NTA (2)**
6. **Official Ans. by NTA (4)**

Sol. $KMnO_4$ will not give satisfactory result when it is titrated by HCl.

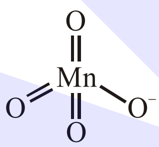
7. **Official Ans. by NTA (2)**
8. **Official Ans. by NTA (3)**

Sol. Option 1) Manganate ⇒ MnO_4^{2-},

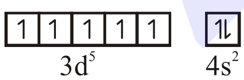
Permanganate ⇒ MnO_4^-



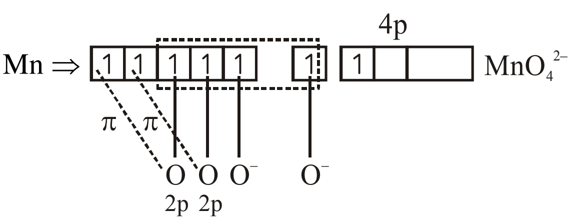
hybridisation of Mn ⇒ d^3s



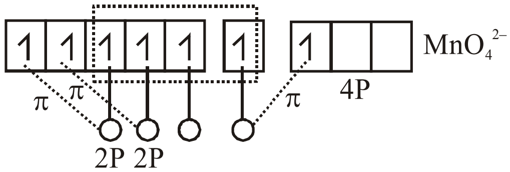
hybridisation of Mn ⇒ d^3s

Mn ⇒ 

After excitation



$2 \times 2p_\pi - 3d_{\pi\sigma}$



$2 \times 2P_\pi - 3d_\pi$

$1 \times 2P_\pi - 4P_\pi$

(2) MnO_4^{2-} ⇒ green

MnO_4^- ⇒ purple/violet

(3) Manganate contains 1 unpaired electron hence it is paramagnetic

where as permanganetic contains no unpaired electrons hence it is diamagnetic.

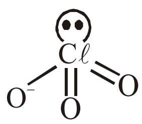
(4) Both have d^3s hybridisation hence both have tetrahedral geometry.

COMPLETE P-BLOCK

1. **NTA Ans. (1.66 to 1.67)**

Sol. $3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$
(X) (X)

$NaCl + AgNO_3 \rightarrow AgCl \downarrow + NaNO_3$
(X)

ClO_3^- 

Bond order of Cl–O Bond $= 1 + \frac{2}{3} = \frac{5}{3}$
$= 1.66$ or 1.67

2. **NTA Ans. (1)**

Sol. (i) $N_2 + O_2 \xrightarrow{2000\,K} 2NO$ (Redox reaction)

during the reaction, oxidation of nitrogen take place from 0 to 2 and reduction of oxygen take place from 0 to –2. It means this reaction is redox reaction.

(ii) $3O_2 \xrightarrow{h\nu} 2O_3$ (Non – redox reaction)

(iii) $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$
(neutralization reaction)

(iv) $[Co(H_2O)_6]Cl_3 + 3AgNO_3$
$\rightarrow 3AgCl\downarrow + [Co(H_2O)_6](NO_3)_3$
(White ppt.)

3. NTA Ans. (3)

Sol. (a) $H_2O_2 \rightarrow 2H_2O + O_2$

(b) $KClO_3 \xrightarrow[MnO_2]{\Delta} KCl + \frac{3}{2}O_2$

$Pb(NO_3)_2 \xrightarrow{\Delta} PbO + 2NO_2 + \frac{1}{2}O_2$

$NaNO_3 \xrightarrow{\Delta} NaNO_2 + \frac{1}{2}O_2$

(c) 2-ethylanthraquinol $\underset{H_2/Pd}{\overset{O_2(air)}{\rightleftharpoons}}$ 2-ethylanthraquinone + H_2O_2

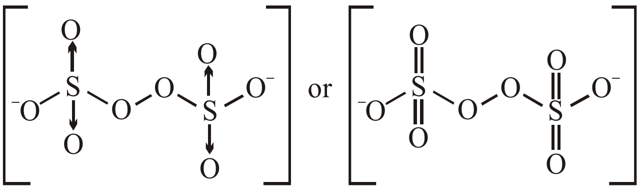
(d) $2H_3BO_3 + 2NaOH + 2H_2O_2$

$\longrightarrow Na_2[B_2(O_2)(OH)_4] + 4H_2O$

All statements are correct

4. NTA Ans. (3)

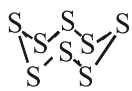
Sol. $S_2O_8^{2-}$:



8 bonds are present between sulphur and oxygen. (It is best answer in given options)

Rhombic sulphur :

(S_8)

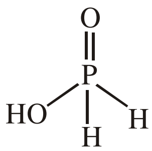


8 bonds are present between sulphur and sulphur atoms.

5. NTA Ans. (2)

Sol. $P_4 + 3NaOH + 3H_2O \longrightarrow \underset{(X)}{3NaH_2PO_2} + PH_3$

$NaH_2PO_2 + HCl \longrightarrow NaCl + \underset{(Y)}{H_3PO_2}$



(mono basic acid)

6. NTA Ans. (2)

Sol.

$\underset{(A)}{H_3N_3B_3Cl_3} + 3LiBH_4 \xrightarrow[(T.H.F.)]{\text{In tetrahydrofurane}} \underset{\substack{(B)\\ \text{Inorganic Benzene}\\ \text{(Borazene)}}}{H_3N_3B_3H_3}$

$+ 3LiCl$

$+ 3BH_3.THF$

$\underset{(A)}{H_3N_3B_3Cl_3} + \underset{(C)}{3CH_3MgBr} \xrightarrow{\rightarrow} H_3N_3B_3(CH_3)_3 + 3MgBrCl$

7. Official Ans. by NTA (4)

Sol. $2NO + N_2O_4 \xrightarrow{250K} \underset{\text{blue solid}}{2N_2O_3}$

8. Official Ans. by NTA (4)

Sol. $NH_3 + \underset{\text{excess}}{3Cl_2} \longrightarrow NCl_3 + 3HCl$

9. Official Ans. by NTA (2)

10. Official Ans. by NTA (1)

Sol. (1) Water gas shift reaction

$CO_{(g)} + H_2O_{(g)} \xrightarrow[\text{catalyst}]{673K} CO_{2(g)} + H_{2(g)}$

(2) Water gas is produced by this reaction.

$CH_{4(g)} + H_2O_{(g)} \xrightarrow[Ni]{1270K} CO_{(g)} + 3H_{2(g)}$

(3) Water gas is produced by this reaction

$C_{(s)} + H_2O_{(g)} \xrightarrow{1270K} CO_{(g)} + H_{2(g)}$

(4) producer gas is produced by this reaction.

$2C_{(s)} + O_{2(g)} + 4N_{2(g)} \xrightarrow{1270K} 2CO_{(g)} + 4N_{2(g)}$

11. Official Ans. by NTA (4)

Sol. $Pb(NO_3)_2 \xrightarrow{\Delta} PbO + \underset{\substack{\text{Brown}\\ \text{gas}\\ (A)}}{2NO_2} + \frac{1}{2}O_2(g)$

$NO_2(g) \xrightarrow{\text{Cooling}} \underset{(B)}{N_2O_4}$

$N_2O_4 + NO \xrightarrow{\Delta} \underset{\substack{\text{Blue Solid}\\ (C)}}{N_2O_3}$

O.S. of nitrogen in N_2O_3 is + 3

N_2O_3 $2x + 3(-2) = 0$

$x = +3$

12. Official Ans. by NTA (4)

Sol. In the stratosphere, CFCs release chlorine free radical $(\dot{Cl})$

$CF_2Cl_2(g) \xrightarrow{UV} \dot{Cl}(g) + \dot{C}F_2Cl(g)$

which react with O_3 to give chlorine oxide $(Cl\dot{O})$ radical not chlorine dioxide $(\dot{Cl}O_2)$ radical.

$\dot{Cl}(g) + O_3(g) \rightarrow Cl\dot{O}(g) + O_2(g)$

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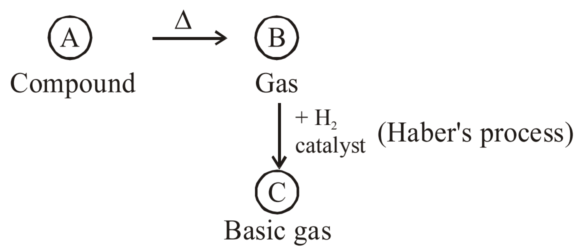
13. Official Ans. by NTA (2)

Sol.



Basic gas (C) must be ammonia (NH_3).
It means (B) gas should be N_2 which is formed by heating of compound (A).

(1) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2\uparrow + Cr_2O_3 + 4H_2O\uparrow$

(2) $Pb(NO_3)_2 \xrightarrow{\Delta} PbO + 2NO_2\uparrow + \frac{1}{2}O_2\uparrow$

(3) $2NaN_3 \xrightarrow{\Delta} 2Na + 3N_2\uparrow$

(4) $NH_4NO_2 \xrightarrow{\Delta} N_2\uparrow + 2H_2O\uparrow$

So, (A) should not be $Pb(NO_3)_2$

HYDROGEN AND ITS COMPOUND

1. NTA Ans. (4)

Sol. (a) Zeolite method removes only cations (Ca^{2+} and Mg^{2+} ion) present in hard water

$2NaZ + M^{2+}(aq) \rightarrow MZ_2(s) + 2Na^+(aq)$

($M \rightarrow Mg, Ca$)

(b) Synthetic resin method removes cations (Ca^{2+} and Mg^{2+} ion) and anions (like Cl^-, HCO_3^-, SO_4^{2-} etc.)

(i) $2RNa(s) + M^{2+}(aq) \rightarrow R_2M(s) + 2Na^+(aq)$

(Cation exchange resin) ($M \rightarrow Mg, Ca$)

(ii) $RNH_3^+ OH^-(s) + X^-(aq) \rightarrow RNH_3^+ X^-(s) + OH^-(aq)$

(Anion exchange resin) ($X^- = Cl^-, HCO_3^-, SO_4^{2-}$ etc)

2. NTA Ans. (2)

Sol. Hydrogen has three isotopes

Isotopes	Number of neutrons
Protium (^1_1H)	0
Deutrium (^2_1H)	1
Tritium (^3_1H)	2

Hence the sum of neutrons are 3

ENVIRONMENTAL CHEMISTRY

1. NTA Ans. (4)

Sol. CO_2, H_2O, CFCs and O_3 are green house gases.

2. NTA Ans. (3)

Sol. Biochemical oxygen demand (BOD) is amount of oxygen required by bacteria to break down organic waste in a certain volume of water sample.

F-BLOCK

1. NTA Ans. (2)

Sol. $Eu_{63} \Rightarrow [Xe]\ 4f^7\ 5d^\circ\ 6s^2$

$Eu^{2\oplus} \Rightarrow [Xe]\ 4f^7$

$Ce_{58} \Rightarrow [Xe]\ 4f^1\ 5d^1\ 6s^2$

$Ce^{3\oplus} \Rightarrow [Xe]\ 4f^1$

2. Official Ans. by NTA (2)

3. Official Ans. by NTA (1)

Sol. Alloys of lanthanides with Fe are called Misch metal, which consists of a lanthanoid metal (~95%) and iron (~5%) and traces of S, C, Ca and Al.

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