FINAL JEE–MAIN EXAMINATION – AUGUST, 2021

(Held On Thursday 26th August, 2021) **TIME : 9 : 00 AM to 12 : 00 NOON**

CHEMISTRY — TEST PAPER WITH SOLUTION

SECTION-A

1. Which one of the following complexes is violet in colour?

(1) $[Fe(CN)_6]^{4-}$ (2) $[Fe(SCN)_6]^{4-}$

(3) $Fe_4[Fe(CN_6)]_3 \cdot H_2O$ (4) $[Fe(CN)_5NOS]^{4-}$

Official Ans. by NTA (4)

Sol. (1) $[Fe(CN)_6]^{4-} \rightarrow$ Pale yellow solution

(2) $[Fe(SCN)_6]^{4-} \rightarrow$ Blood red colour

(3) $Fe_4[Fe(CN_6)]_3 \cdot H_2O \rightarrow$ Prussian blue

(4) $[Fe(CN)_5NOS]^{4-} \rightarrow$ Violet colour

2. Which one of the following is correct for the adsorption of a gas at a given temperature on a solid surface?

(1) $\Delta H > 0, \Delta S > 0$ (2) $\Delta H > 0, \Delta S < 0$

(3) $\Delta H < 0, \Delta S < 0$ (4) $\Delta H < 0, \Delta S > 0$

Official Ans. by NTA (3)

Sol. (i) Adsorption of gas at metal surface is an exothermic process so $\Delta H < 0$

(ii) As the adsorption of gas on metal surface reduces the free movement of gas molecules thus restricting its randomness hences $\Delta S < 0$

3. Which one of the following when dissolved in water gives coloured solution in nitrogen atmosphere?

(1) $CuCl_2$ (2) AgCl

(3) $ZnCl_2$ (4) Cu_2Cl_2

Official Ans. by NTA (1)

Sol. (1) $CuCl_2 + nH_2O \rightarrow Cu^{+2}_{(aq.)}$

blue colour

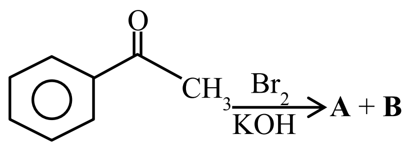
(2) $AgCl + nH_2O \rightarrow$ Insoluble

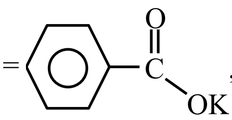
(3) $ZnCl_2 + nH_2O \rightarrow Zn^{+2}_{(aq.)}$

Colourless

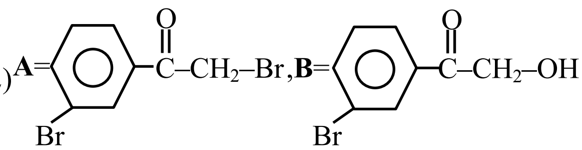
(4) $Cu_2Cl_2 + nH_2O \rightarrow$ Insoluble

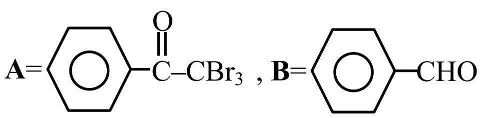
4. The major products formed in the following reaction sequence **A** and **B** are :

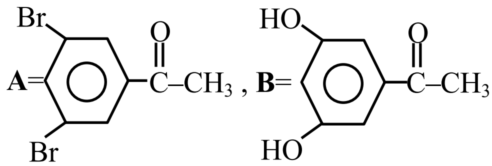


(1) **A** = 

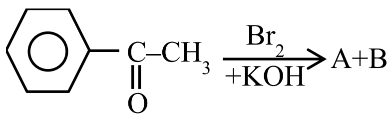
, **B**=$CHBr_3$

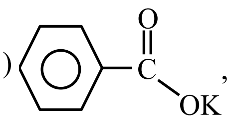
(2) 

(3) 

(4) 

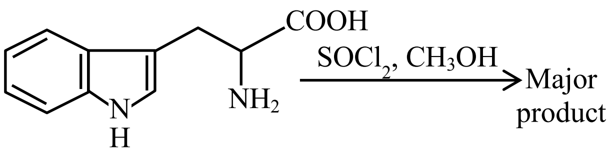
Official Ans. by NTA (1)

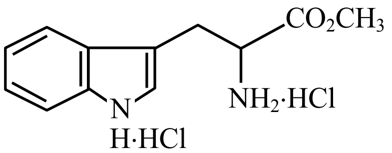
Sol. 

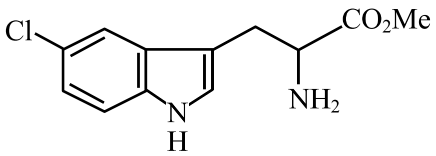
(1) 

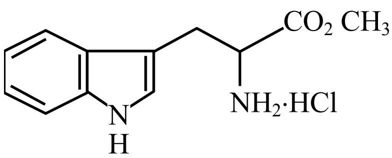
, B=$CHBr_3$

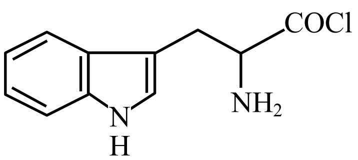
5. The major product formed in the following reaction is :



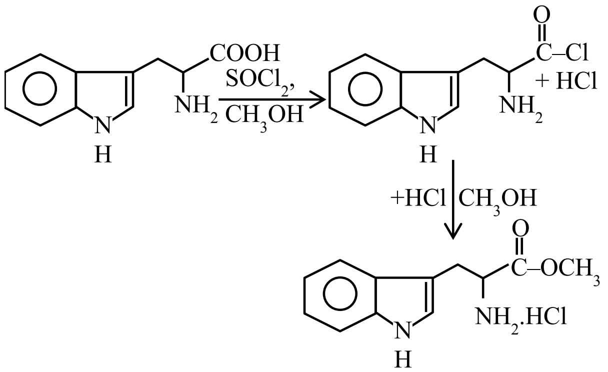
(1) 

(2) 

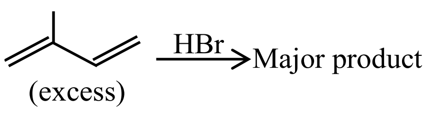
(3) 

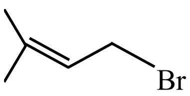
(4) 

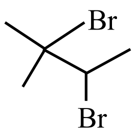
Official Ans. by NTA (3)

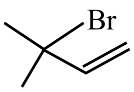
Sol. 

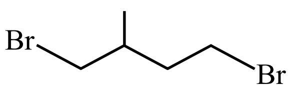
6. The major product formed in the following reaction is :



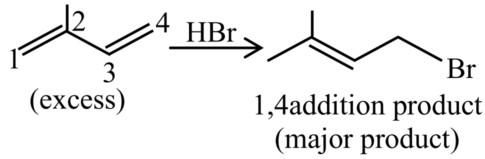
(1) 

(2) 

(3) 

(4) 

Official Ans. by NTA (1)

Sol. 

7. The polymer formed on heating Novolac with formaldehyde is :

(1) Bakelite (2) Polyester

(3) Melamine (4) Nylon 6,6

Official Ans. by NTA (1)

Sol. Novolac + formaldehyde → Bakelite

8. Given below are two statements :

Statement I : The limiting molar conductivity of KCl (strong electrolyte) is higher compared to that of CH_3COOH (weak electrolyte).

Statement II : Molar conductivity decreases with decrease in concentration of electrolyte.

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

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

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

(3) Both **Statement I** and **Statement II** are true.

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

Official Ans. by NTA (4)

Sol.

Ion	H^+	K^+	Cl^-	CH_3COO^-
$\Lambda^{\infty}_{m\ Scm^2/mole}$	349.8	73.5	76.3	40.9

So $\Lambda^{\infty}_{m\ CH_3COOH} = \Lambda^{\infty}_{m\ (H^+)} + \Lambda^{\infty}_{m\ CH_3COO^-}$

$= 349.8 + 40.9$

$= 390.7\ Scm^2/mole$

$\Lambda^{\infty}_{m\ KCl} = \Lambda^{\infty}_{m\ (K^+)} + \Lambda^{\infty}_{m\ (Cl^-)}$

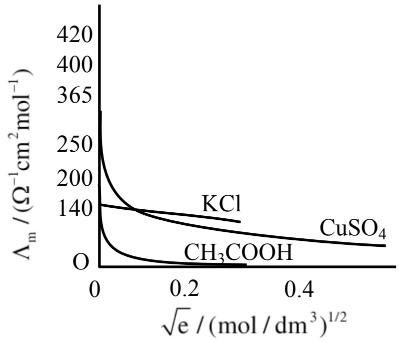
$= 73.5 + 76.3$

$= 149.3\ Scm^2/mole$

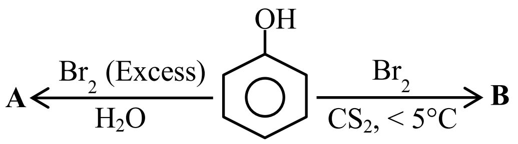
So statement-I is wrong or False.

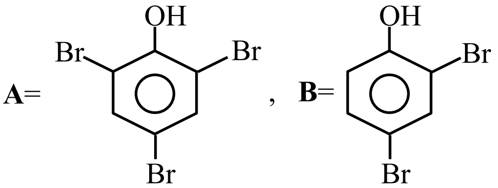
As the concentration decreases, the dilution increases which increases the degree of dissociation, thus increasing the no. of ions, which increases the molar conductance.

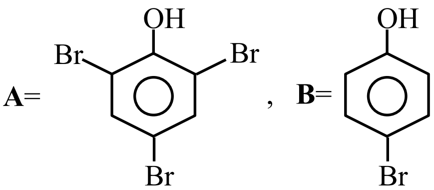
So statement-II is false.

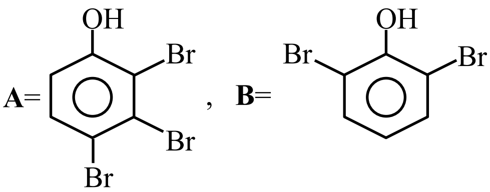


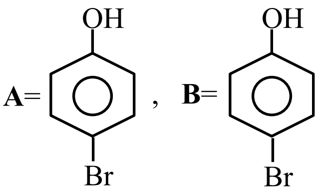
9. The correct options for the products **A** and **B** of the following reactions are :



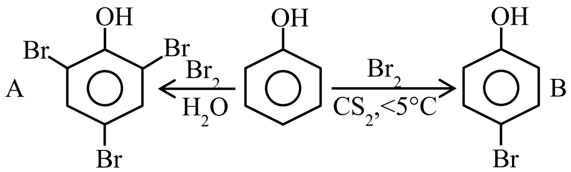
(1) 

(2) 

(3) 

(4) 

Official Ans. by NTA (2)

Sol. 

10. The conversion of hydroxyapatite occurs due to presence of F^- ions in water. The correct formula of hydroxyapatite is:

(1) $[3Ca_3(PO_4)_2 \cdot Ca(OH)_2]$

(2) $[3Ca(OH)_2 \cdot CaF_2]$

(3) $[Ca_3(PO_4)_2 \cdot CaF_2]$

(4) $[3Ca_3(PO_4)_2 \cdot CaF_2]$

Official Ans. by NTA (1)

Sol. The $F^{\ominus}$ ions make the enamel on teeth much harder by converting hydroxyapatite,$[3(Ca_3(PO_4)_2].Ca(OH)_2]$, the enamel on the surface of the teeth into much harder fluroappatite. $[3Ca_3(PO_4)_2.CaF_2]$

11. Given below are two statements.

Statement I: In the titration between strong acid and weak base methyl orange is suitable as an indicator.

Statement II: For titration of acetic acid with NaOH phenolphthalein is not a suitable indicator.

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

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

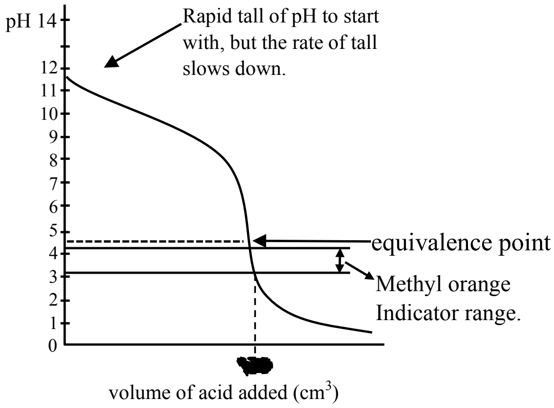
(2) **Statement I** is true but **Statement II** is false

(3) Both **Statement I** and **Statement II** are true

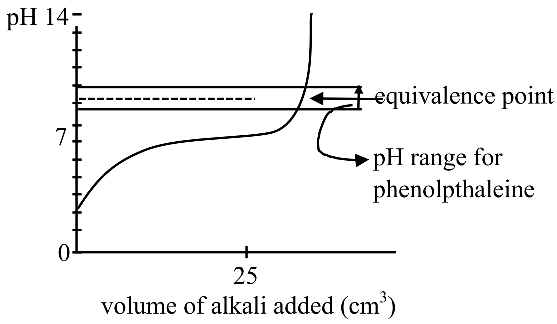
(4) Both **Statement I** and **Statement II** are false

Official Ans. by NTA (2)

Sol. Titration curve for strong acid and weak base initially a buffer of weak base and conjugate acid is :



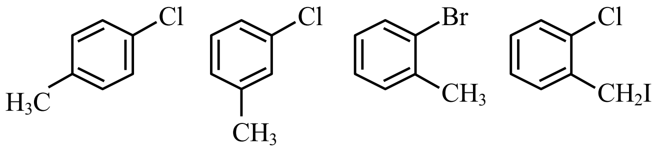
Formed, thus pH falls slowly and after equivalence point, so the pH falls sharply so methyl arrange, having pH range of 3.2 to 4.4 will weak as indicator. So statement-I is correct.



Titration curve for weak acid and strong base (NaOH)

Initially weak acid will form a buffer so pH increases slowly but after equivalence point. it rises sharply covering range of phenolphthalein so it will be suitable indicator so statement-II is false.

12. Among the following compounds I-IV, which one forms a yellow precipitate on reacting sequentially with (i) NaOH (ii) dil. HNO_3 (iii) $AgNO_3$?



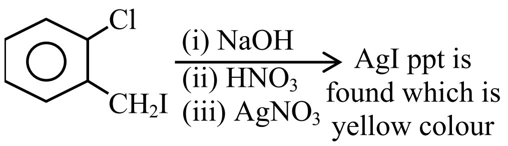
I　　II　　III　　IV

(1) II　　(2) IV

(3) I　　(4) III

Official Ans. by NTA (2)

Sol.



Other compounds halide can't be removed because corresponding C^+ is highly unstable.

13. Which one of the following methods is most suitable for preparing deionized water?

(1) Synthetic resin method

(2) Clark's method

(3) Calgon's method

(4) Permutit method

Official Ans. by NTA (1)

Sol. Pure demineralised (de-ionized) water free from all soluble mineral salts is obtained by passing water successively through a cation exchange (in the H^+ form) and an anion exchange (in the OH^- form) resins.

14. Given below are two statements.

Statement I: The choice of reducing agents for metals extraction can be made by using Ellingham diagram, a plot of ΔG vs temperature.

Statement II: The value of ΔS increases from left to right in Ellingham diagram.

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

(1) Both **Statement I** and **Statement II** are true

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

(3) Both **Statement I** and **Statement II** are false

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

Official Ans. by NTA (4)

Sol. Given statement-I is true as in a number of processes, one element is used to reduce the oxide of another metal. Any element will reduce the oxide of other metal which lie above it in the Ellingham diagram because the free energy change will become more negative.

Given statement-II is false as the value of ΔS is decreases from left to right in Ellingham diagram.

15. What are the products formed in sequence when excess of CO_2 is passed in slaked lime?

(1) $Ca(HCO_3)_2$, $CaCO_3$

(2) $CaCO_3$, $Ca(HCO_3)_2$

(3) CaO, $Ca(HCO_3)_2$

(4) CaO, $CaCO_3$

Official Ans. by NTA (2)

Sol. $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3\downarrow + H_2O$

$CaCO_3\downarrow + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$

16. Given below are two statements.

Statement I: According to Bohr's model of an atom, qualitatively the magnitude of velocity of electron increases with decrease in positive charges on the nucleus as there is no strong hold on the electron by the nucleus.

Statement II: According to Bohr's model of an atom, qualitatively the magnitude of velocity of electron increases with decrease in principal quantum number.

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

(1) Both **Statement I** and **Statement II** are false

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

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

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

Official Ans. by NTA (3)

Sol. Velocity of electron in Bohr's atom is given by

$$V \propto \frac{Z}{n}$$

Z = atomic number of atom, corresponds to +ve charge so as Z increase velocity increases so statement-I is wrong.

and as 'n' decreases velocity increases so statement-II is correct.

17. The correct sequential addition of reagents in the preparation of 3-nitrobenzoic acid from benzene is:

(1) $Br_2/AlBr_3$, HNO_3/H_2SO_4, Mg/ether, CO_2, H_3O^+

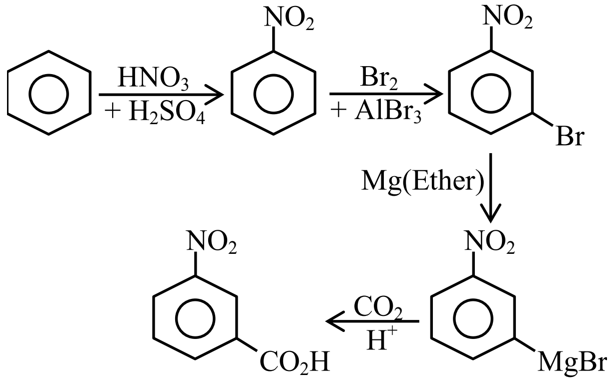
(2) $Br_2/AlBr_3$, NaCN, H_3O^+, HNO_3/H_2SO_4

(3) $Br_2/AlBr_3$, HNO_3/H_2SO_4, NaCN, H_3O^+

(4) HNO_3/H_2SO_4, $Br_2/AlBr_3$, Mg/ether, CO_2, H_3O^+

Official Ans. by NTA (4)

Sol.



3–nitrobenzoic acid

18. Given below are two statements.

Statement I: Frenkel defects are vacancy as well as interstitial defects.

Statement II: Frenkel defect leads to colour in ionic solids due to presence of F-centres.

Choose the **most appropriate** answer for the statements from the options given below:

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

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

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

(4) Both **Statement I** and **Statement II** are false

Official Ans. by NTA (3)

Sol. Theory based.

19. The **incorrect** statement is:

(1) Cl_2 is more reactive than ClF.

(2) F_2 is more reactive than ClF.

(3) On hydrolysis ClF froms HOCl and HF.

(4) F_2 is a stronger oxidizing agent than Cl_2 in aqueous solution

Official Ans. by NTA (1)

Sol. (i) Reactivity order :

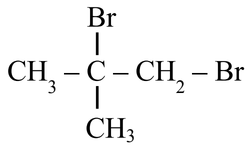
$F_2 > ClF$ (inter halogen) $> Cl_2$

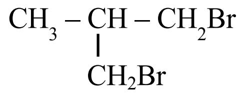
(ii) $ClF + H_2O \rightarrow HOCl + HF$

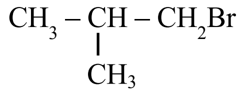
(iii) Oxidizing power in aqueous solution

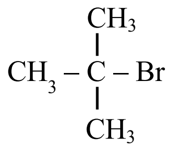
$F_2 > Cl_2 > Br_2 > I_2$

20. Excess of isobutane on reaction with Br_2 in presence of light at 125°C gives which one of the following, as the major product?

(1) 

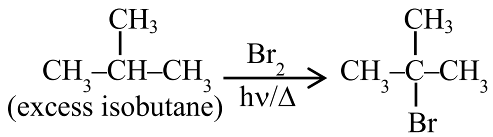
(2) 

(3) 

(4) 

Official Ans. by NTA (4)

Sol.

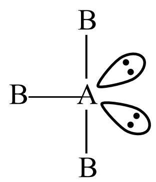


SECTION-B

1. AB_3 is an interhalogen T-shaped molecule. The number of lone pairs of electrons on A is _______. (Integer answer)

Official Ans. by NTA (2)

Sol. T-shaped molecule means 3 sigma bond and 2 lone pairs of electron on central atom.



2. These are physical properties of an element

(A) Sublimation enthalpy

(B) Ionisation enthalpy

(C) Hydration enthalpy

(D) Electron gain enthalpy

The total number of above properties that affect the reduction potential is _________ (Integer answer)

Official Ans. by NTA (3)

Sol. Sublimation enthalpy, Ionisation enthalpy and hydration enthalpy affect the reduction potential.

3. Of the following four aqueous solutions, total number of those solutions whose freezing point is lower than that of 0.10 M C_2H_5OH is ________ (Integer answer)

(i) 0.10 M $Ba_3(PO_4)_2$

(ii) 0.10 M Na_2SO_4

(iii) 0.10 M KCl

(iv) 0.10 M Li_3PO_4

Official Ans. by NTA (4)

Sol. As 0.1 M C_2H_5OH is non-dissociative and rest all salt given are electrolyte so in each case effective molarity > 0.1 so each will have lower freezing point.

4. The OH^- concentration in a mixture of 5.0 mL of 0.0504 M NH_4Cl and 2 mL of 0.0210 M NH_3 solution is x × 10^{-6} M. The value of x is _______. (Nearest integer)

[Given $K_w = 1 \times 10^{-14}$ and $K_b = 1.8 \times 10^{-5}$]

Official Ans. by NTA (3)

Sol. $\left[NH_4^+\right] = 0.0504$ & $\left[NH_3\right] = 0.0210$

So $K_b = \dfrac{[NH_4^+][HO^-]}{[NH_3]}$

$[HO^-] = \dfrac{K_b \times [NH_3]}{[NH_4^+]} = 1.8 \times 10^{-5} \times \dfrac{2}{5} \times \dfrac{210}{504}$

$= 3 \times 10^{-6}$

5. The number of 4*f* electrons in the ground state electronic configuration of Gd^{2+} is ________.

[Atomic number of Gd = 64]

Official Ans. by NTA (7)

Sol. The electronic configuration of

${}_{64}Gd$: [Xe] $4f^7\ 5d^1\ 6s^2$

So the electronic configuration of

${}_{64}Gd^{2+}$: [Xe] $4f^7\ 5d^1\ 6s^0$

i.e. the number of 4f electrons in the ground state electronic configuration of Gd^{2+} is 7.

6. The ratio of number of water molecules in Mohr's salt and potash alum is ________ × 10^{-1}.

(Integer answer)

Official Ans. by NTA (5)

Sol. **(5)**

Mohr's salt : $(NH_4)_2\ Fe(SO_4)_2.6H_2O$

The number of water molecules in Mohr's salt = 6

Potash alum : $KAl(SO_4)_2.12H_2O$

The number of water molecules in potash alum = 12

So ratio of number of water molecules in Mohr's salt and potash alum = $\dfrac{6}{12}$

$= \dfrac{1}{2}$

= 0.5

= 5 × 10^{-1}

7. The following data was obtained for chemical reaction given below at 975 K.

$$2NO_{(g)} + 2H_{2(g)} \rightarrow N_{2(g)} + 2H_2O_{(g)}$$

	[NO] mol L^{-1}	[H_2] mol L^{-1}	Rate mol $L^{-1}s^{-1}$
(A)	8 × 10^{-5}	8 × 10^{-5}	7 × 10^{-9}
(B)	24 × 10^{-5}	8 × 10^{-5}	2.1 × 10^{-8}
(C)	24 × 10^{-5}	32 × 10^{-5}	8.4 × 10^{-8}

The order of the reaction with respect to NO is _______. [Integer answer]

Official Ans. by NTA (1)

Sol. $7 \times 10^{-9} = K \times (8 \times 10^{-5})^x\ (8 \times 10^{-5})^y$ ....(1)

$2.1 \times 10^{-8} = K \times (24 \times 10^{-5})^x\ (8 \times 10^{-5})^y$ ....(2)

$\dfrac{1}{3} = \left(\dfrac{1}{3}\right)^x \Rightarrow x = 1$

8. The Born-Haber cycle for KCl is evaluated with the following data :

$\Delta_f H^\ominus$ for KCl = –436.7 kJ mol^{-1};

$\Delta_{sub}H^\ominus$ for K = 89.2 kJ mol^{-1};

$\Delta_{ionization}\ H^\ominus$ for K = 419.0 kJ mol^{-1}; $\Delta_{electron\ gain}\ H^\ominus$ for $Cl_{(g)}$ = –348.6 kJ mol^{-1}; $\Delta_{bond}\ H^\ominus$ for Cl_2 = 243.0 kJ mol^{-1}

The magnitude of lattice enthalpy of KCl in kJ mol^{-1} is _______ (Nearest integer)

Official Ans. by NTA (718)

Sol. $\Delta_f H^\ominus_{KCl} = \Delta_{sub}H^\ominus_{(K)} + \Delta_{ionization}H^\ominus_{(K)} + \dfrac{1}{2}\Delta_{bond}H^\ominus_{(Cl_2)}$

$$+\ \Delta_{\text{electron gain}}H^{\ominus}_{(Cl)} + \Delta_{\text{lattice}}H^{\ominus}_{(KCl)}$$

$$\Rightarrow -436.7 = 89.2 + 419.0 + \frac{1}{2}(243.0) + \{-348.6\}$$

$$+\ \Delta_{\text{lattice}}H^{\ominus}_{(KCl)}$$

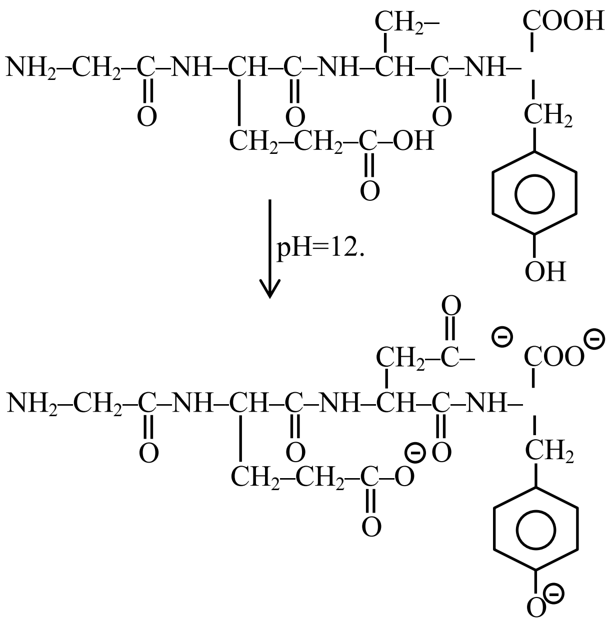
$$\Rightarrow \Delta_{\text{lattice}}H^{\ominus}_{(KCl)} = -717.8 \text{ kJ mol}^{-1}$$

The magnitude of lattice enthalpy of KCl in kJ mol^{-1} is 718 (Nearest integer).

9. The total number of negative charge in the tetrapeptide, Gly-Glu-Asp-Tyr, at pH 12.5 will be ________. (Integer answer)

Official Ans. by NTA (4)

Sol.



Total negative charge produced = 4.

10. An aqueous KCl solution of density 1.20 g mL^{-1} has a molality of 3.30 mol kg^{-1}. The molarity of the solution in mol L^{-1} is ________ (Nearest integer)

[Molar mass of KCl = 74.5]

Official Ans. by NTA (3)

Sol. 1000 kg solvent has 3.3 moles of KCl

1000 kg solvent $\longrightarrow$ 3.3 × 74.5 gm KCl

$\longrightarrow$ 245.85

Weight of solution = 1245.85 gm

Volume of solution = $\frac{1245.85}{1.2}$ ml

So molarity = $\frac{3.3 \times 1.2}{1245.85} \times 1000 = 3.17$