FINAL JEE–MAIN EXAMINATION – SEPTEMBER, 2020

(Held On Thursday 03rd SEPTEMBER, 2020) TIME : 3 PM to 6 PM

CHEMISTRY TEST PAPER WITH ANSWER & SOLUTION

1. Among the statements (I – IV), the correct ones are:

(I) Be has smaller atomic radius compared to Mg.

(II) Be has higher ionization enthalpy than Al.

(III) Charge/radius ratio of Be is greater than that of Al.

(IV) Both Be and Al form mainly covalent compounds.

(1) (I), (II) and (IV)

(2) (II), (III) and (IV)

(3) (I), (II) and (III)

(4) (I), (III) and (IV

Official Ans. by NTA (3)

Sol. I, A_N : Be < Mg

II IE : Be > Al

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

IV Be, Al mainly form covalent compounds

2. The strengths of 5.6 volume hydrogen peroxide (of density 1 g/mL) in terms of mass percentage and molarity (M), respectively, are:

(Take molar mass of hydrogen peroxide as 34 g/mol)

(1) 1.7 and 0.25 (2) 1.7 and 0.5

(3) 0.85 and 0.5 (4) 0.85 and 0.25

Official Ans. by NTA (2)

Sol. Volume strength = 11.2 × molarity

$$\Rightarrow \text{molarity} = \frac{5.6}{11.2} = 0.5$$

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.

$$\Rightarrow \text{mass\%} = \frac{17}{1000} \times 100 = 1.7\%$$

3. Consider the hypothetical situation where the azimuthal quantum number, l, takes values 0, 1, 2, ... n + 1, where n is the principal quantum number. Then, the element with atomic number :

(1) 13 has a half-filled valence subshell

(2) 9 is the first alkali metal

(3) 8 is the first noble gas

(4) 6 has a 2p-valence subshell

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.

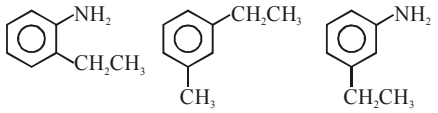
4. Three isomers A, B and C (mol. formula $C_8H_{11}N$) give the following results :

A and C $\xrightarrow{\text{Diazotization}}$ P + Q $\xrightarrow[\substack{\text{(ii) oxidation}\\(KMnO_4+H^+)}]{\text{(i) Hydrolysis}}$ R(product of A) + S(product of C)

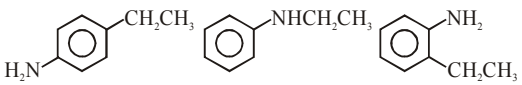
R has lower boiling point than S

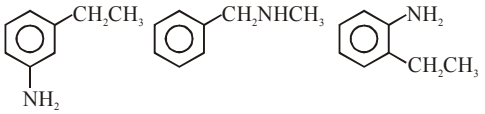
B $\xrightarrow{C_6H_5SO_2Cl}$ alkali-insoluble product

A, B and C, respectively are :

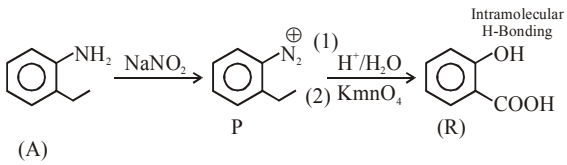
(1) 

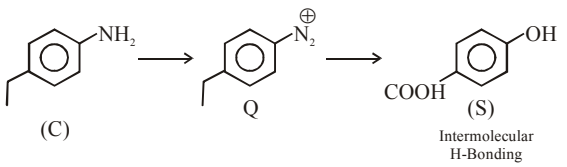
(2) 

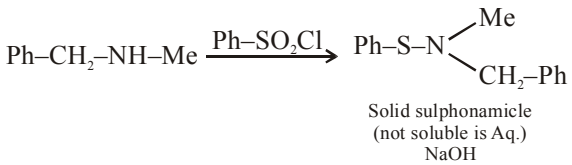
(3) 

(4) 

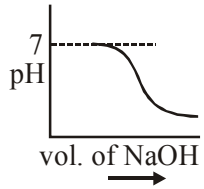
Official Ans. by NTA (2)

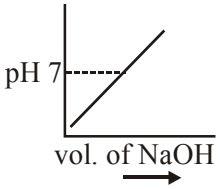
Sol. 

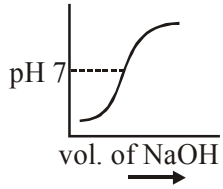


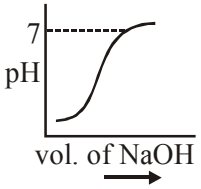


5. 100 mL of 0.1 M HCl is taken in a beaker and to it 100 mL of 0.1 M NaOH is added in steps of 2 mL and the pH is continuously measured. Which of the following graphs correctly depicts the change in pH?

(1) 

(2) 

(3) 

(4) 

Official Ans. by NTA (3)

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

6. The incorrect statement(s) among (a) – (d) regarding acid rain is (are) :

(a) It can corrode water pipes.

(b) It can damage structures made up of stone.

(c) It cannot cause respiratory ailments in animals.

(d) It is not harmful for trees

(1) (c) and (d)

(2) (a), (b) and (d)

(3) (c) only

(4) (a), (c) and (d)

Official Ans. by NTA (2)

Sol. (1) Acid rain corrodes water pipes resulting in the leaching of heavy of heavy metals such as iron, lead and copper into the drinking water.

(2) Acid rain damages buildings and other structures made of stone or metal.

(3) It causes respiratory aliments in human beings and animals.

(4) It is harmful for agriculture, trees and plants as it washes down the nutrients needed for its growth.

7. The five successive ionization enthalpies of an element are 800, 2427, 3658, 25024 and 32824 kJ mol^{-1}. The number of valence electrons in the element is :

(1) 2 (2) 3

(3) 4 (4) 5

Official Ans. by NTA (2)

Sol. Let suppose element X $\Rightarrow$

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

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

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

So valence electrons are 3

8. A mixture of one mole each of H_2, He and O_2 each are enclosed in a cylinder of volume V at temperature T. If the partial pressure of H_2 is 2 atm, the total pressure of the gases in the cylinder is :

(1) 14 atm (2) 22 atm

(3) 6 atm (4) 38 atm

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

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

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

9. The d-electron configuration of $[Ru(en)_3]Cl_2$ and $[Fe(H_2O)_6]Cl_2$, respectively are :

(1) $t_{2g}^4 e_g^2$ and $t_{2g}^6 e_g^0$

(2) $t_{2g}^6 e_g^0$ and $t_{2g}^6 e_g^0$

(3) $t_{2g}^6 e_g^0$ and $t_{2g}^4 e_g^2$

(4) $t_{2g}^4 e_g^2$ and $t_{2g}^4 e_g^2$

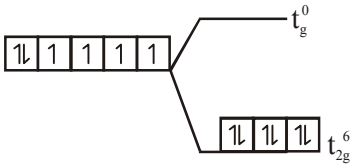
Official Ans. by NTA (3)

Sol. $[Ru(en)_3]Cl_2$ $R_u \Rightarrow$ 4d series

en $\Rightarrow$ chelating ligand

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

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

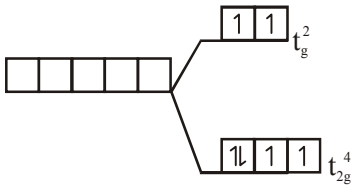


$[Fe(H_2O)_6]Cl_2 \Rightarrow H_2O \Rightarrow$ Weak filled ligand

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

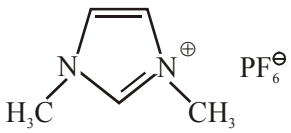
less plitting

CN = 6 octahedral splitting

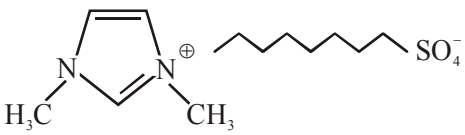


10. An ionic micelle is formed on the addition of :

(1) excess water to liquid



(2) excess water to liquid



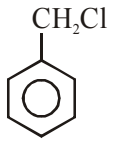
(3) liquid diethyl ether to aqueous NaCl solution

(4) sodium stearate to pure toluene

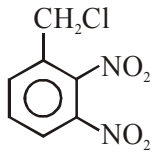
Official Ans. by NTA (2)

Sol. Correct Ans. is (2)

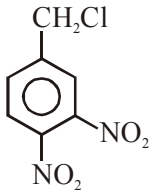
11. The decreasing order of reactivity of the following compounds towards nucleophilic substitution (S_N2) is :



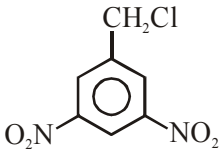
(I)



(II)



(III)



(IV)

(1) (IV) > (II) > (III) > (I)

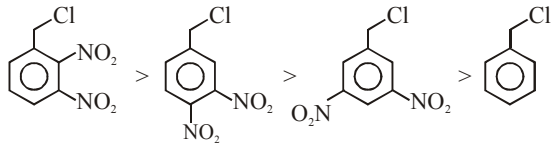
(2) (II) > (III) > (IV) > (I)

(3) (II) > (III) > (I) > (IV)

(4) (III) > (II) > (IV) > (I)

Official Ans. by NTA (2)

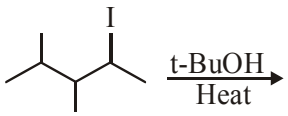
Sol.



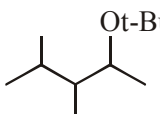
–I & –R less –I & –R Only 2 – I

rate of SN^2 reaction

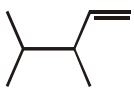
12. The major product in the following reaction is :



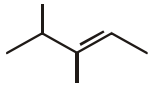
(1)



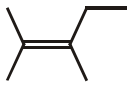
(2)



(3)

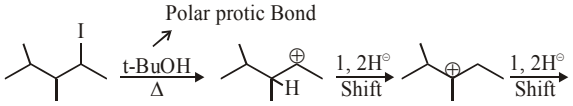


(4)



Official Ans. by NTA (4)

Sol.



more subtituted
Alkene (major)

13. The increasing order of the reactivity of the following compound in nucleophilic addition reaction is :

Propanal, Benzaldehyde, Propanone, Butanone

(1) Butanone < Propanone < Benzaldehyde < Propanal

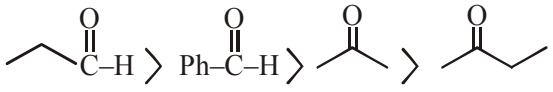
(2) Benzaldehyde < Butanone < Propanone < Propanal

(3) Propanal < Propanone < Butanone < Benzaldehyde

(4) Benzaldehyde < Propanal < Propanone < Butanone

Official Ans. by NTA (1)

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



14. The incorrect statement is :

(1) In manganate and permanganate ions, the π-bonding takes place by overlap of p-orbitals of oxygen and d-orbitals of manganese

(2) Manganate ion is green in colour and permanganate ion in purple in colour

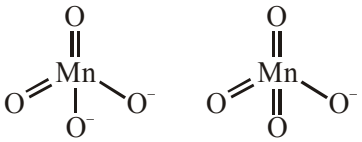
(3) Manganate and permanganate ions are paramagnetic

(4) Manganate and permanganate ions are tetrahedral

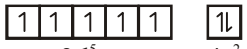
Official Ans. by NTA (3)

Sol. Option 1) Manganate $\Rightarrow MnO_4^{2-}$,

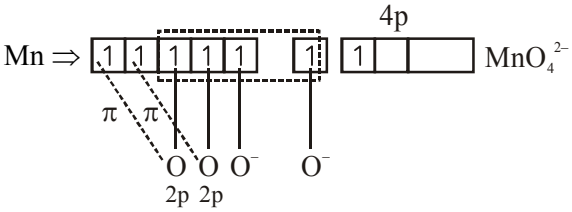
Permanganate $\Rightarrow MnO_4^-$



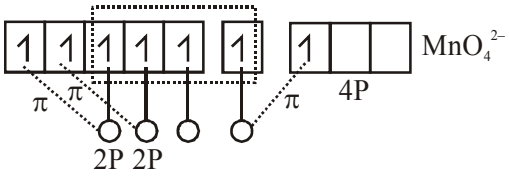
hybridisation of Mn $\Rightarrow d^3s$ | hybridisation of Mn $\Rightarrow d^3s$

Mn $\Rightarrow$ 

After excitation



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



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

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

(2) $MnO_4^{2-} \Rightarrow$ green

$MnO_4^- \Rightarrow$ 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.

15. The compound A in the following reaction is :

$$A \xrightarrow[\text{(ii) Conc. } H_2SO_4/\Delta]{\text{(i) } CH_3MgBr/H_2O}$$

$$B \xrightarrow[\text{(ii) } Zn/H_2O]{\text{(i) } O_3} C + D$$

$$C \xrightarrow[\text{(ii) } \Delta]{\text{(i) Conc.KOH}} C_6H_5-COO^{\ominus}K^{+} + C_6H_5-CH_2OH$$

$$D \xrightarrow[\Delta]{Ba(OH)_2} H_3C-\overset{CH_3}{\overset{|}{C}}=CH-\overset{O}{\overset{||}{C}}-CH_3$$

(1) $C_6H_5-\overset{O}{\overset{||}{C}}-CH(CH_3)_2$

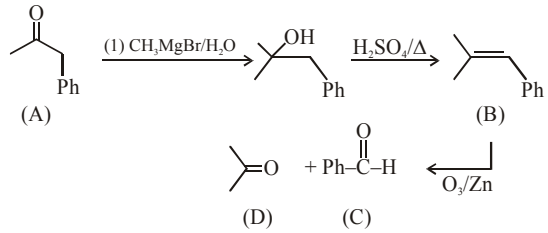
(2) $C_6H_5-\overset{O}{\overset{||}{C}}-CH_2CH_3$

(3) $C_6H_5-CH_2-\overset{O}{\overset{||}{C}}-CH_3$

(4) $C_6H_5-\overset{O}{\overset{||}{C}}-CH_3$

Official Ans. by NTA (3)

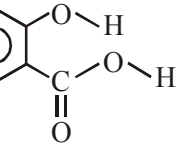
Sol.

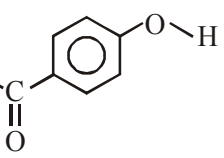


$$Ph-\overset{O}{\overset{||}{C}}-H \xrightarrow[\text{NaOH}]{\text{Conc.}} Ph-COOK + Ph-CH_2OH$$
(cannizaro)

$$\text{>C=O} \xrightarrow[\text{Aldol}]{OH^{\ominus}/\Delta} \text{>C(OH)-C=O}$$

16. Consider the following molecules and statements related to them :

(A) 

(B) 

(a) (B) is more likely to be crystalline than (A)

(b) (B) has higher boiling point than (A)

(c) (B) dissolves more readily than (A) in water

Identify the correct option from below :

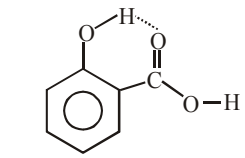
(1) only (a) is true (2) (a) and (c) are true

(3) (b) and (c) are true (4) (a) and (b) are true

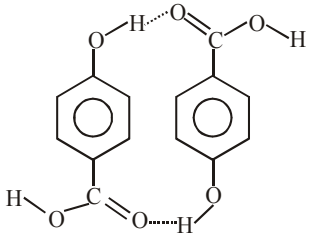
Official Ans. by NTA (3)

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

Sol.



O-salicylic acid
intra molecular
H-bonding



p-salicylic acid
inter molecular H-bonding

(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.

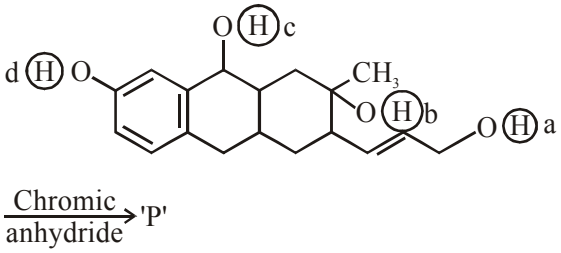
(c) B will be more soluble in water than A as B will have more extent of H-bonding in water

So all three statements are correct

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

P-salicylic acid = 5g/L}

17. Consider the following reaction :



The product 'P' gives positive ceric ammonium nitrate test. This is because of the presence of which of these –OH group(s) ?

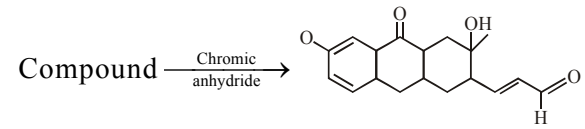
(1) (c) and (d)

(2) (b) only

(3) (d) only

(4) (b) and (d)

Official Ans. by NTA (2)

Sol. Compound 

due to pressure of b

18. Match the following drugs with their therapeutic actions :

(i) Ranitidine	(a) Antidepressant
(ii) Nardil (Phenelzine)	(b) Antibiotic
(iii)Chloramphenicol	(c) Antihistamine
(iv)Dimetane (Brompheniramine)	(d) Antacid
	(e) Analgesic

(1) (i)-(a); (ii)-(c); (iii)-(b); (iv)-(e)

(2) (i)-(e); (ii)-(a); (iii)-(c); (iv)-(d)

(3) (i)-(d); (ii)-(a); (iii)-(b); (iv)-(c)

(4) (i)-(d); (ii)-(c); (iii)-(a); (iv)-(e)

Official Ans. by NTA (3)

Sol. Raniticline → Antacid

Nard1 → Antidepressant

Chloramphenicol → Antibiotic

Dimetane → Antihistamine

19. For the reaction $2A + 3B + \frac{3}{2}C \rightarrow 3P$, which statement is correct ?

(1) $\frac{dn_A}{dt} = \frac{dn_B}{dt} = \frac{dn_C}{dt}$

(2) $\frac{dn_A}{dt} = \frac{2}{3}\frac{dn_B}{dt} = \frac{3}{4}\frac{dn_C}{dt}$

(3) $\frac{dn_A}{dt} = \frac{3}{2}\frac{dn_B}{dt} = \frac{3}{4}\frac{dn_C}{dt}$

(4) $\frac{dn_A}{dt} = \frac{2}{3}\frac{dn_B}{dt} = \frac{4}{3}\frac{dn_C}{dt}$

Official Ans. by NTA (4)

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

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

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

20. Complex A has a composition of $H_{12}O_6Cl_3Cr$. If the complex on treatment with conc. H_2SO_4 loses 13.5% of its original mass, the correct molecular formula of A is :

[Given : atomic mass of Cr = 52 amu and Cl = 35 amu]

(1) $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$

(2) $[Cr(H_2O)_3Cl_3] \cdot 3H_2O$

(3) $[Cr(H_2O)_4Cl_2]Cl \cdot 2H_2O$

(4) $[Cr(H_2O)_6]Cl_3$

Official Ans. by NTA (3)

Sol. % mass of water

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

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

21. An acidic solution of dichromate is electrolyzed for 8 minutes using 2A current. As per the following equation

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

The amount of Cr^{3+} obtained was 0.104 g. The efficiency of the process(in%) is

(Take : F = 96000 C, At. mass of chromium = 52)

_____.

Official Ans. by NTA (60)

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

Using stoichiometry; theoritically

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

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

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

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

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

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

$$= 60\%$$

22. 6.023×10^{22} molecules are present in 10 g of a substance 'x'. The molarity of a solution containing 5 g of substance 'x' in 2 L solution is _____ $\times 10^{-3}$.

Official Ans. by NTA (25)

$$\text{moles} = \frac{\text{number of molecules}}{6 \times 10^{23}} = \frac{\text{given mass}}{\text{molar mass}}$$

$$\Rightarrow \quad \text{molar mas} = \frac{10 \times 6.023 \times 10^{23}}{6.023 \times 10^{22}} = 100 g/mol$$

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

$$= 0.025$$

23. The volume (in mL) of 0.1 N NaOH required to neutralise 10 mL of 0.1 N phosphinic acid is _____ .

Official Ans. by NTA (10)

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

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

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

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

24. If 250 cm^3 of an aqueous solution containing 0.73 g of a protein A is isotonic with one litre of another aqueous solution containing 1.65 g of a protein B, at 298 K, the ratio of the molecular mases of A and B is _____ $\times 10^{-2}$ (to the nearest integer).

Official Ans. by NTA (177)

Sol. Let molar mass of protein A = x g/mol
Let molar mass of protein B = y g/mol

$$\pi_A = \text{osmotic pressure of protein A} = \frac{\left(\frac{0.73}{x}\right)}{0.25}RT$$

$$\pi_B = \text{osmotic pressure of protein B} = \frac{\left(\frac{1.65}{y}\right)}{1}RT$$

$$\pi_A = \pi_B$$

$$\Rightarrow \left(\frac{0.73}{x\times 0.25}\right)RT = \left(\frac{1.65}{y}\right)RT$$

$$\Rightarrow \left(\frac{x}{y}\right) = \frac{0.73}{0.25\times 1.65} = 1.769 \cong 1.77$$

25. The number of $\diagup\!\!C=O$ groups present in a tripeptide Asp – Glu – Lys is _____ .

Official Ans. by NTA (5)

Sol. Structure of Tri peptide Asp – Glu – Lys