CHEMISTRY
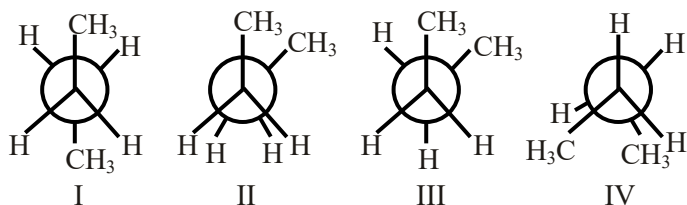
1. Arrange the following conformational isomers of n-butane in order of their increasing potential energy :

I   II   III   IV

(1) II < III < IV < I   (2) I < IV < III < II

(3) II < IV < III < I   (4) I < III < IV < II

Official Ans. by NTA (4)

Sol. More stable less potential energy.

Stability order : I > III > IV > II

So

Potential energy : II > IV > III > I

2. The Eu^{2+} ion is a strong reducing agent in spite of its ground state electronic configuration (outermost) : [Atomic number of Eu = 63]
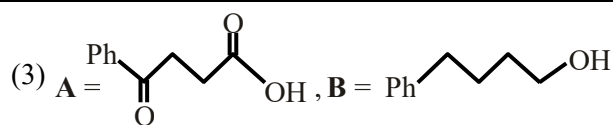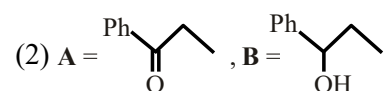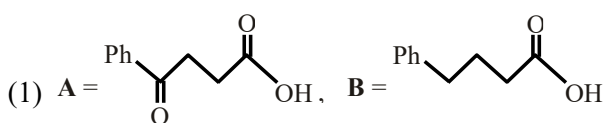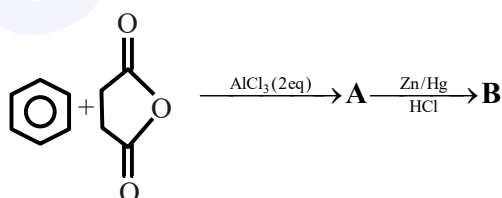
(1) $4f^{7}6s^{2}$ (2) $4f^{6}$

(3) $4f^{7}$ (4) $4f^{6}6s^{2}$
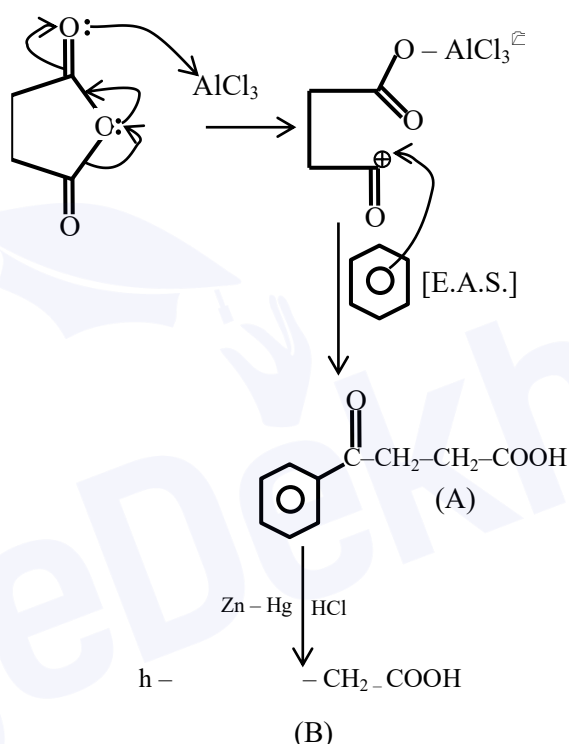
Official Ans. by NTA (3)

Sol. $Eu \rightarrow [Xe]4f^{7}6s^{2}$

$Eu^{2+} \rightarrow [Xe]4f^{7}$

3. The structures of **A** and **B** formed in the following reaction are : $[Ph = -C_6H_5]$

(1) A = , B =

(2) A = , B =

(3) A = , B = Ph OH

(4) A = , B =

Official Ans. by NTA (1)

Sol.

4. In which one of the following sets all species show disproportionation reaction ?

(1) ClO_2^-, F_2, MnO_4^- and $Cr_2O_7^{2-}$

(2) $Cr_2O_7^{2-}, MnO_4^-, ClO_2^-$ and Cl_2

(3) MnO_4^-, ClO_2^-, Cl_2 and Mn^{3+}

(4) $ClO_4^-, MnO_4^-, ClO_2^-$ and F_2

Official Ans. by NTA (3)

Sol. No option contains all species that show disproportionation reaction.

MnO_4^-

Mn is in +7 oxidation state (highest) hence cannot be simultaneously oxidized or reduced.

5. Match **List-I** with **List-II**

List-I		List-II	
(Parameter)		**(Unit)**	
(a)	Cell constant	(i) $S\ cm^2\ mol^{-1}$	
(b)	Molar conductivity	(ii) Dimensionless	
(c)	Conductivity	(iii) m^{-1}	
(d)	Degree of dissociation of electrolyte	(iv) $\Omega^{-1}\ m^{-1}$	

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

(1) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

(2) (a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)

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

(4) (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)

Official Ans. by NTA (1)

Sol. Cell constant $= \left(\dfrac{\ell}{A}\right) \Rightarrow$ Units $= m^{-1}$

Molar conductivity $(\Lambda_m) \Rightarrow$ Units $= Sm^2\ mole^{-1}$

Conductivity $(K) \Rightarrow$ Units $= S\ m^{-1}$

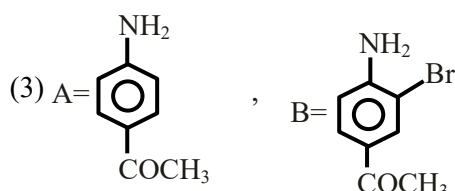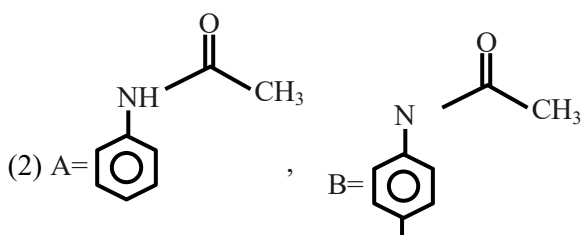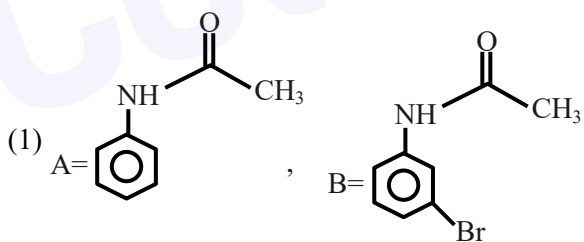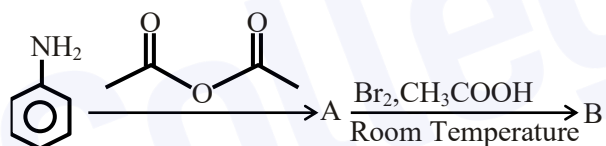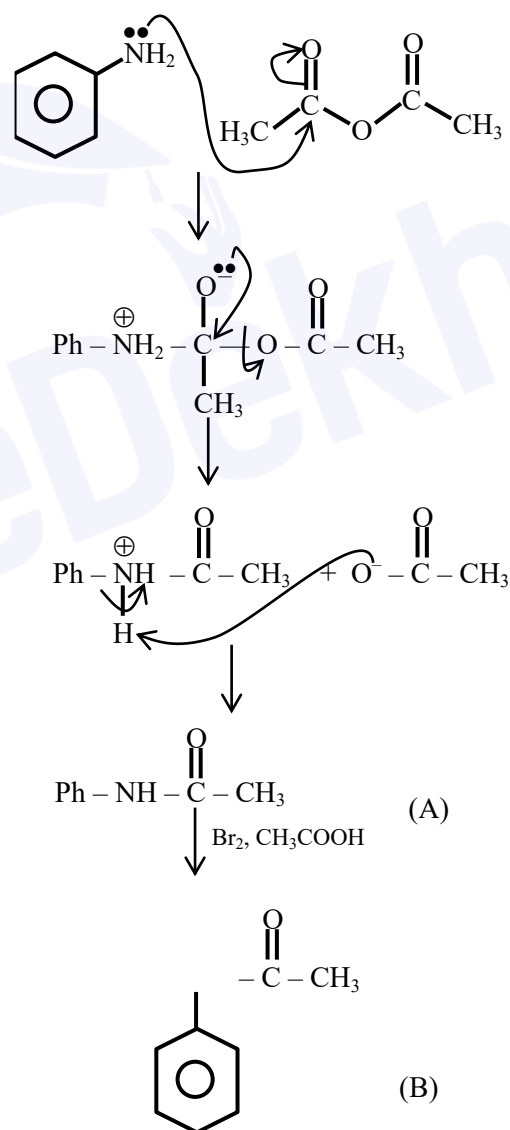Degree of dissociation $(\alpha) \rightarrow$ Dimensionless

$\therefore$ (a) – (iii)

(b) – (i)

(c) – (iv)

(d) – (ii)

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

(1) A= , B=

(2) A= , B=

(3) A= , B=

(4) A= , B=
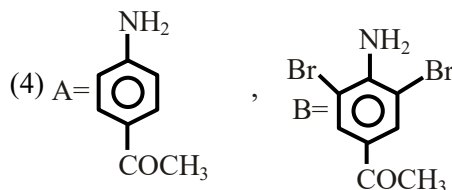
Official Ans. by NTA (2)

Sol.

7. Which of the following is NOT an example of fibrous protein ?

(1) Keratin

(2) Albumin

(3) Collagen

(4) Myosin

Official Ans. by NTA (2)

Sol. Keratin, collagen and myosin are example of fibrous protein.

8. The deposition of X and Y on ground surfaces is referred as wet and dry depositions, respectively. X and Y are :
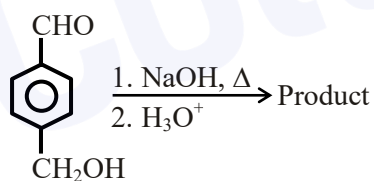
(1) X = Ammonium salts, Y = CO_2

(2) X = SO_2, Y = Ammonium salts

(3) X = Ammonium salts, Y = SO_2

(4) X = CO_2, Y = SO_2

Official Ans. by NTA (3)

Sol. Oxides of nitrogen and sulphur are acidic and settle down on ground as dry deposition.

Ammonium salts in rain drops result in wet deposition
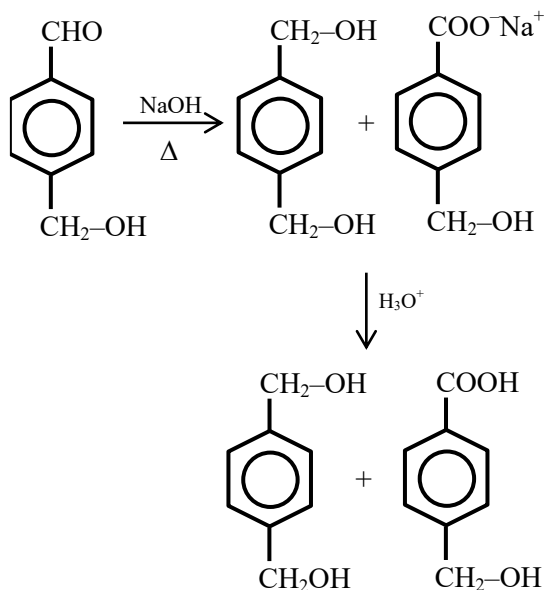
9. For the reaction given below :

The compound which is **not** formed as a product in the reaction is a :

(1) compound with both alcohol and acid functional groups

(2) monocarboxylic acid

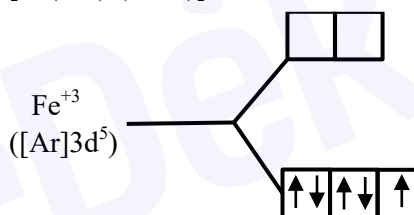(3) dicarboxylic acid

(4) diol

Official Ans. by NTA (3)

Sol.

10. Spin only magnetic moment in BM of $[Fe(CO)_4(C_2O_4)]^+$ is :

(1) 5.92   (2) 0   (3) 1   (4) 1.73

Official Ans. by NTA (4)

Sol. $[Fe(CO)_4(C_2O_4)]^+$

One unpaired electron

Spin only magnetic moment

$= \sqrt{3}$ B.M. $= 1.73$ BM

11. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A) : Lithium salts are hydrated.

Reason (R) : Lithium has higher polarising power than other alkali metal group members.

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

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

(2) **(A)** is correct but **(R)** is not correct.

(3) **(A)** is not correct but **(R)** is correct.

(4) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A).**

Official Ans. by NTA (1)

Sol. Lithium salts are hydrated due to high hydration energy of Li^+

Li^+ due to smallest size in IA group has highest polarizing power.

12. The **incorrect** expression among the following is:

(1) $\dfrac{\Delta G_{System}}{\Delta S_{Total}} = -T(\text{at constant P})$

(2) $\ln K = \dfrac{\Delta H^\circ - T\Delta S^\circ}{RT}$

(3) $K = e^{-\Delta G^\circ / RT}$

(4) For isothermal process $w_{reversible} = -\ nRT \ln \dfrac{V_f}{V_i}$

Official Ans. by NTA (2)

Sol. Option (2) is incorrect

$\Delta G^\circ = -RT \ell n\ K$

$\Delta H^\circ - T\Delta S^\circ = -RT\ \ell n\ K$

$\ell n K = -\left[\dfrac{\Delta H^\circ - \Delta S^\circ}{RT} \right]$

13. Which one of the following statements is **incorrect ?**

(1) Atomic hydrogen is produced when H_2 molecules at a high temperature are irradiated with UV radiation.

(2) At around 2000 K, the dissociation of dihydrogen into its atoms is nearly 8.1%.

(3) Bond dissociation enthalpy of H_2 is highest among diatomic gaseous molecules which contain a single bond .

(4) Dihydrogen is produced on reacting zinc with HCl as well as $NaOH_{(aq)}$.

Official Ans. by NTA (2)

Sol. Atomic hydrogen is produced at high temperature in an electric are or under ultraviolet radiations.

The dissociation of dihydrogen at 2000 K is only 0.081%

H–H bond dissociation enthalpy is highest for a single bond for any diatomic molecule.

Dihydrogen can be produced on reacting Zn with dil. HCl as well as NaOH (aq.)

14. Which among the following is not a polyester ?

(1) Novolac   (2) PHBV

(3) Dacron   (4) Glyptal

Official Ans. by NTA (1)

Sol. Novalac is a linear polymer of [Ph–OH + HCHO]. So ester linkage not present.

So novalac is not a polyester.

15. Which one of the following correctly represents the order of stability of oxides, X_2O; (X = halogen)?

(1) Br > Cl > I   (2) Br > I > Cl

(3) Cl > I > Br   (4) I > Cl > Br

Official Ans. by NTA (4)

Sol. Stability of oxides of Halogens is
I > Cl > Br

16. Match **List-I** with **List-II** :

| List-I (Metal Ion)		List-II (Group in Qualitative analysis)
(a) Mn^{2+}	(i)	Group - III
(b) As^{3+}	(ii)	Group - IIA
(c) Cu^{2+}	(iii)	Group - IV
(d) Al^{3+}	(iv)	Group - IIB

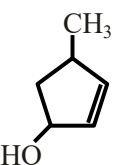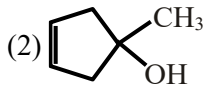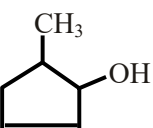Choose the **most appropriate** answer from the options given below :

(1) (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)

(2) (a)-(iii), (b)-(iv), (c)-(ii), (d)-(i)

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

(4) (a)-(iv), (b)-(ii), (c)-(iii), (d)-(i)

Official Ans. by NTA (2)

Sol. $Mn^{2+} \rightarrow$ III group

$As^{3+} \rightarrow$ II B group

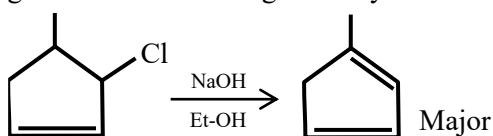$Cu^{2+} \rightarrow$ II A group

$Al^{3+} \rightarrow$ IV group
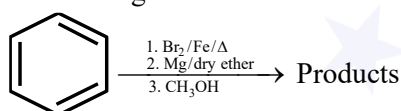
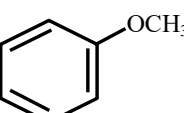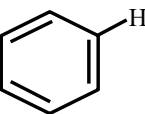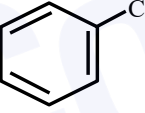**17.** The major product of the following reaction is :
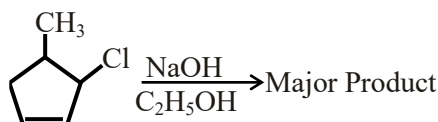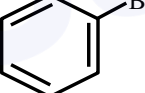

(1)

(2)

(3)

(4)

Official Ans. by NTA (4)

Sol. NaOH + EtOH is known as alcoholic NaOH, so it give E^2 reaction with given alkyl halide.

18. For the following :
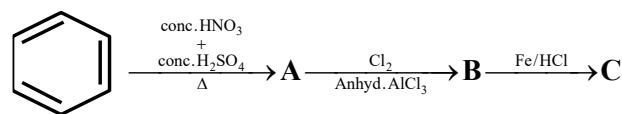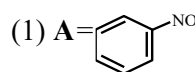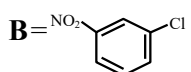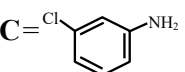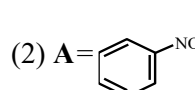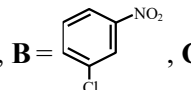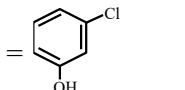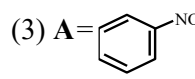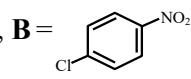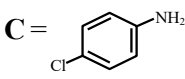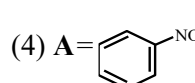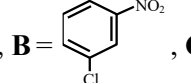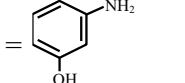

(1) + HMgBr

(2)

(3)

(4)

Official Ans. by NTA (2)
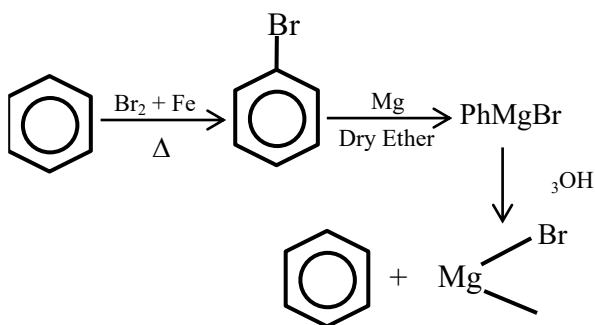
19. Identify correct **A, B** and **C** in the reaction sequence given below :

(1) **A**= , **B**= , **C**=

(2) **A**= , **B**= , **C** =

(3) **A**= , **B**= , **C** =

(4) **A**= , **B**= , **C** =

Official Ans. by NTA (1)

Sol.
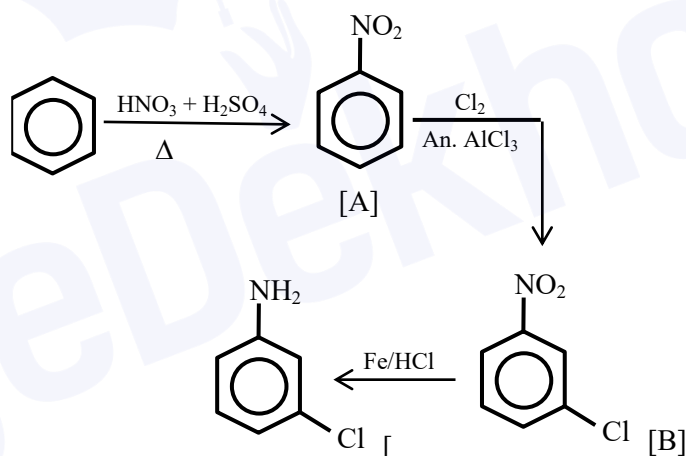
20. The number of S=O bonds present in sulphurous acid, peroxodisulphuric acid and pyrosulphuric acid, respectively are :

(1) 2, 3 and 4

(2) 1, 4 and 3

(3) 2, 4 and 3

(4) 1, 4 and 4

Official Ans. by NTA (4)

Sol.

Sulphurous acid

Peroxodisulphuric acid

$$\underset{1\ S\ Bond.}{O}$$

$$\underset{4\ S\ Bond.}{O}$$

Pyrosulphuric acid

$$\underset{4\ S\ Bond.}{O}$$
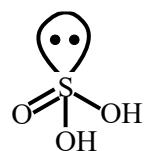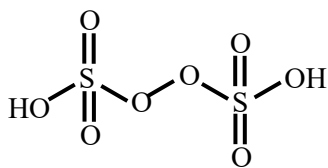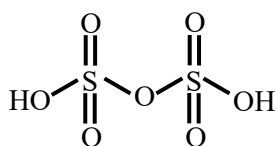
SECTION-B

1. CH_4 is adsorbed on 1 g charcoal at 0°C following the Freundlich adsorption isotherm. 10.0 mL of CH_4 is adsorbed at 100 mm of Hg, whereas 15.0 mL is adsorbed at 200 mm of Hg. The volume of CH_4 adsorbed at 300 mm of Hg is 10^x mL. The value of x is _____ × 10^{-2}.

(Nearest integer)

[Use $\log_{10}2 = 0.3010$, $\log_{10}3 = 0.4771$]

Official Ans. by NTA (128)

Sol. We know

$$\frac{x}{m} = KP^{1/n}\ ;\ using\ (x \propto V)$$

$$\Rightarrow \quad \frac{10}{1} = K \times (100)^{1/n} \quad …(1)$$

$$\frac{15}{1} = K \times (200)^{1/n} \quad …(2)$$

$$\frac{V}{1} = K \times (300)^{1/n} \quad …(3)$$

Divide

(2) / (1)

$$\frac{15}{10} = 2^{1/n}$$

$$\log\left(\frac{3}{2}\right) = \frac{1}{n}\log 2$$

$$\frac{1}{n} = \frac{\log 3 - \log 2}{\log 2} = \frac{0.4771 - 0.3010}{0.3010}$$

$$\frac{1}{n} = 0.585$$

Divide

(3) / (1)

$$\frac{V}{10} = 3^{1/n}$$

$$\log\left(\frac{V}{10}\right) = \frac{1}{n}\log 3$$

$$\log\left(\frac{V}{10}\right) = 0.585 \times 0.4771 = 0.2791$$

$$\frac{V}{10} = 10^{0.279} \Rightarrow V = 10 \times 10^{0.279}$$

$$\Rightarrow V = 10^{1.279} = 10^x$$

$$\Rightarrow x = 1.279$$

$$\Rightarrow x = 128 \times 10^{-2} \text{ (Nearest integer)}$$

2. 1.22 g of an organic acid is separately dissolved in 100 g of benzene ($K_b = 2.6$ K kg mol^{-1}) and 100 g of acetone ($K_b = 1.7$ K kg mol^{-1}). The acid is known to dimerize in benzene but remain as a monomer in acetone. The boiling point of the solution in acetone increases by 0.17°C.

The increase in boiling point of solution in benzene in °C is x × 10^{-2}. The value of x is _____.(Nearest integer)

[Atomic mass : C = 12.0, H = 1.0, O= 16.0]

Official Ans. by NTA (13)

Sol. With benzene as solvent

$$\Delta T_b = i\, K_b\, m$$

$$\Delta T_b = \frac{1}{2} \times 2.6 \times \frac{1.22/M_w}{100/1000} \quad …(1)$$

With Acetone as solvent

$$\Delta T_b = i\, K_b\, m$$

$$0.17 = 1 \times 1.7 \times \frac{1.22/M_w}{100/1000} \quad …(2)$$

(1) / (2)

$$\frac{\Delta T_b}{0.17} = \frac{\dfrac{1}{2} \times 2.6 + \dfrac{1.22/M_w}{100/1000}}{1 \times 1.7 \times \dfrac{1.22/M_w}{100/1000}}$$
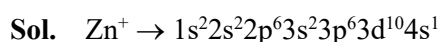
$$\Delta T_b = \frac{0.26}{2}$$

$$\Delta T_b = 13 \times 10^{-2}$$

$$\Rightarrow x = 13$$

3. The value of magnetic quantum number of the outermost electron of Zn^+ ion is _____.

Official Ans. by NTA (0)

Sol. $Zn^+ \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$

Outermost electron is in 4s subshell

$m = 0$

4. The empirical formula for a compound with a cubic close packed arrangement of anions and with cations occupying all the octahedral sites in A_xB. The value of x is _____

(Integer answer)

Official Ans. by NTA (1)

Sol. Anions froms CCP or FCC (A^-) = 4 A^- per unit cell

Cations occupy all octahedral voids (B^+) = 4 B^+ per unit cell

cell formula $\rightarrow A_4B_4$

Empirical formula $\rightarrow$ AB

$\rightarrow$ (x = 1)

5. In the electrolytic refining of blister copper, the total number of main impurities, from the following, removed as anode mud is _____
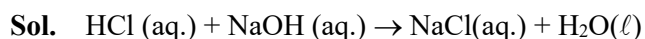
Pb, Sb, Se, Te, Ru, Ag, Au and Pt

Official Ans. by NTA (6)

Sol. Anode mud contains Sb, Se, Te, Ag, Au and Pt

6. The pH of a solution obtained by mixing 50 mL of 1 M HCl and 30 mL of 1 M NaOH is $x \times 10^{-4}$. The value of x is _____. (Nearest integer)

[log 2.5 = 0.3979]

Official Ans. by NTA (6021)

Sol. HCl (aq.) + NaOH (aq.) $\rightarrow$ NaCl(aq.) + $H_2O(\ell)$

50 ml,1M   30ml, 1M   –   –

t = 0   50 mm   30 mm

t = ∞   20 mm   –

$[HCl] = \dfrac{20}{80} = \dfrac{1}{4}M = 2.5 \times 10^{-1}M$

pH = $-\log 2.15 \times 10^{-1}$ = 1 – 0.3979 = 0.6021

pH = 6021×10^{-4}

7. For the reaction A $\rightarrow$ B, the rate constant k(in s^{-1}) is given by

$$\log_{10} k = 20.35 - \frac{(2.47 \times 10^3)}{T}$$

The energy of activation in kJ mol^{-1} is _____. (Nearest integer)

[Given : R = 8.314 J K^{-1} mol^{-1}]

Official Ans. by NTA (47)

Sol. Given $\qquad \log K = 20.35 - \dfrac{2.47 \times 10^3}{T}$

We know $\quad \log K = \log A - \dfrac{E_a}{2.303\,RT}$

$\Rightarrow \quad \dfrac{E_a}{2.303\,RT} = 2.47 \times 10^3$

$E_a = 2.47 \times 10^3 \times 2.303 \times \dfrac{8.314}{1000}$ KJ / mole

$= 47.29 = 47$ (Nearest integer)

8. Sodium oxide reacts with water to produce sodium hydroxide. 20.0 g of sodium oxide is dissolved in 500 mL of water. Neglecting the change in volume, the concentration of the resulting NaOH solution is _____ $\times 10^{-1}$ M. (Nearest integer)

[Atomic mass : Na = 23.0, O = 16.0, H = 1.0]

Official Ans. by NTA (13)

Sol. $Na_2O + H_2O \rightarrow 2NaOH$

$\dfrac{20}{62}$ moles

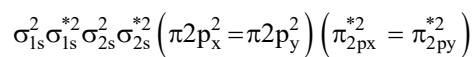Moles of NaOH formed = $\dfrac{20}{62} \times 2$

$[NaOH] = \dfrac{\dfrac{40}{62}}{\dfrac{500}{1000}} = 1.29\,M = 13 \times 10^{-1}$ M

(Nearest integer)

9. According to molecular orbital theory, the number of unpaired electron(s) in O_2^{2-} is :
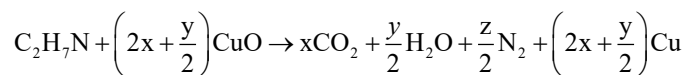
Official Ans. by NTA (0)

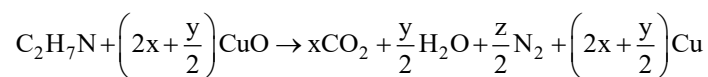**Sol.** Molecular orbital configuration of O_2^{2-} is

$$\sigma_{1s}^2 \sigma_{1s}^{*2} \sigma_{2s}^2 \sigma_{2s}^{*2} \left(\pi 2p_x^2 = \pi 2p_y^2 \right) \left(\pi_{2px}^{*2} = \pi_{2py}^{*2} \right)$$

Zero unpaired electron

10. The transformation occurring in Duma's method is given below :

$$C_2H_7N + \left(2x + \frac{y}{2} \right) CuO \rightarrow xCO_2 + \frac{y}{2}H_2O + \frac{z}{2}N_2 + \left(2x + \frac{y}{2} \right) Cu$$

The value of y is _____. (Integer answer)

Official Ans. by NTA (7)

Sol.

$$C_2H_7N + \left(2x + \frac{y}{2} \right) CuO \rightarrow xCO_2 + \frac{y}{2}H_2O + \frac{z}{2}N_2 + \left(2x + \frac{y}{2} \right) Cu$$

On balancing

$$C_2H_7N + \frac{15}{2}CuO \rightarrow 2CO_2 + \frac{7}{2}H_2O + \frac{1}{2}N_2 + \frac{15}{2}Cu$$

On comparing

$y = 7$