FINAL JEE–MAIN EXAMINATION – FEBRUARY, 2021

(Held On Thursday 25th February, 2021) TIME : 3 : 00 PM to 6 : 00 PM

CHEMISTRY — TEST PAPER WITH ANSWER & SOLUTION

SECTION-A

1. Which among the following species has unequal bond lengths ?

(1) BF_4^- (2) XeF_4

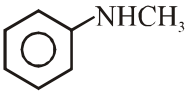
(3) SF_4 (4) SiF_4

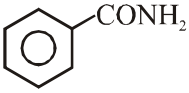
Official Ans. by NTA (3)

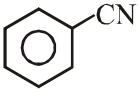
Sol.

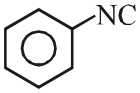
Species	Hybridisation	Bond length
$BF_4^{\ominus}$	sp^3 (Tetrahedral)	All bond lengths equal
XeF_4	sp^3d^2 (sq. planar)	All bond lengths equal
SF_4	sp^3d(see – saw)	axial bond length > equitorial bond length
SiF_4	sp^3 (Tetrahedral)	all bond lengths equal

2. Carbylamine test is used to detect the presence of primary amino group in an organic compound. Which of the following compound is formed when this test is performed with aniline?

(1) 

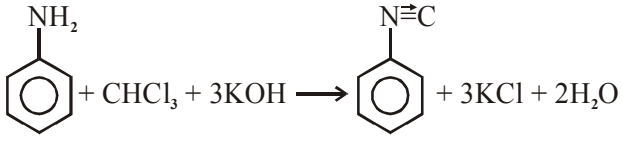
(2) 

(3) 

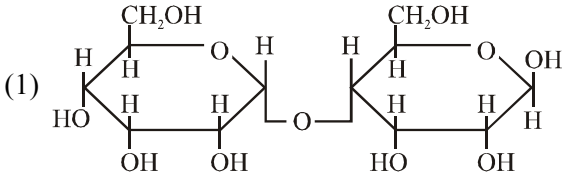
(4) 

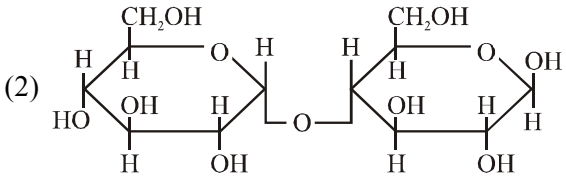
Official Ans. by NTA (4)

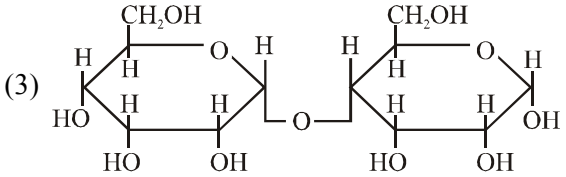
Sol. CARBYL amine given by 1° amine

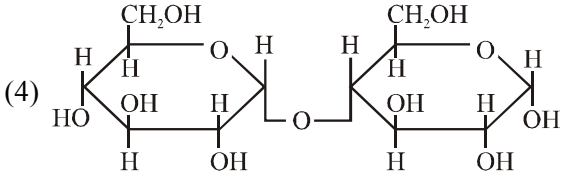


3. Which of the following is correct structure of α-anomer of maltose ?

(1) 

(2) 

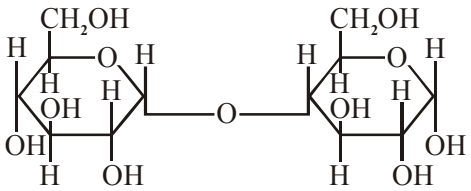
(3) 

(4) 

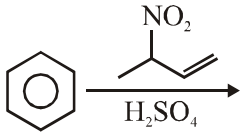
Official Ans. by NTA (4)

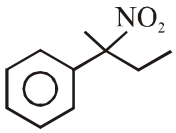
Sol. α-ANOMER OF MALTOSE

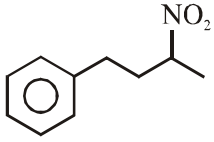
maltose is disaccharides of α-D-glucopyranose by C_1–C_4 glycosidic linkage

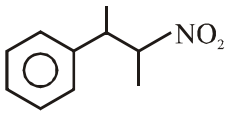


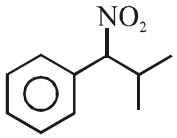
4. The major product of the following reaction is:



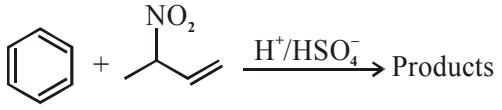
(1) 

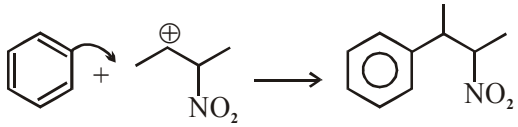
(2) 

(3) 

(4) 

Official Ans. by NTA (3)

Sol. 



5. The correct sequence of reagents used in the preparation of 4-bromo-2-nitroethyl benzene from benzene is :

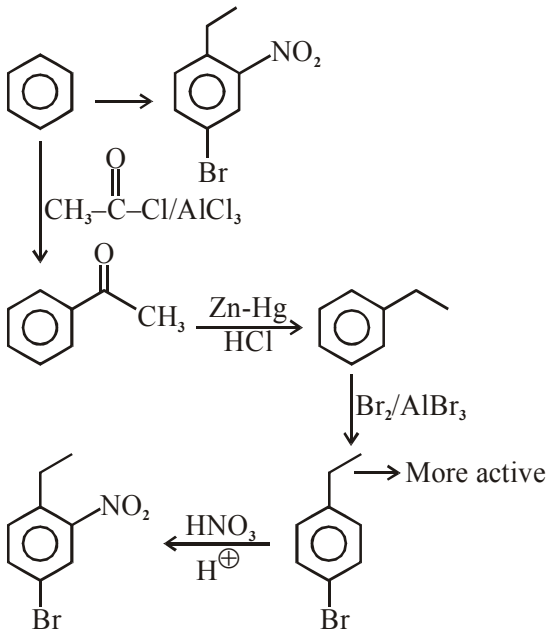
(1) HNO_3/H_2SO_4, $Br_2/AlCl_3$, $CH_3COCl/AlCl_3$, Zn-Hg/HCl

(2) $Br_2/AlBr_3$, $CH_3COCl/AlCl_3$, HNO_3/H_2SO_4, Zn/HCl

(3) $CH_3COCl/AlCl_3$, $Br_2/AlBr_3$, HNO_3/H_2SO_4, Zn/HCl

(4) $CH_3COCl/AlCl_3$, Zn-Hg/HCl, $Br_2/AlBr_3$, HNO_3/H_2SO_4

Official Ans. by NTA (4)

Sol. 

6. Water does not produce CO on reacting with:

(1) CO_2 (2) C (3) CH_4 (4) C_3H_8

Official Ans. by NTA (1)

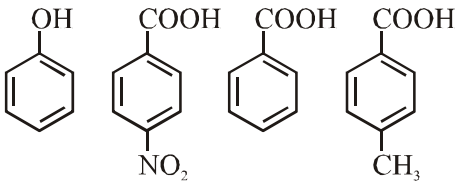
Sol. $CO_2 + H_2O \rightarrow H_2CO_3$

$C + H_2O(steam) \rightarrow CO + H_2$

$\left.\begin{matrix} CH_4 + H_2O \rightarrow CO + 3H_2 \\ C_3H_8 + H_2O \rightarrow 3CO + H_2 \end{matrix}\right]$ both reactions are carried out at 1270K temp. with Ni catalyst

Thus CO_2 does not produce CO.

7. The correct order of acid character of the following compounds is :



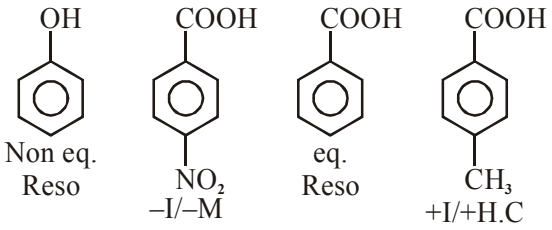
I **II** **III** **IV**

Options:

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

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

Official Ans. by NTA (4)

Sol. 

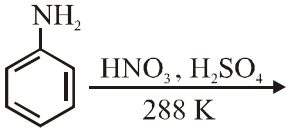
Non eq. Reso

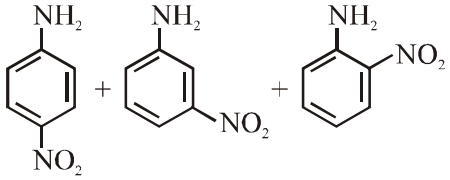
NO_2 –I/–M

eq. Reso

CH_3 +I/+H.C

2 > 3 > 4 > 1

8. 



(A) (B) (C)

Correct statement about the given chemical reaction is :

(1) $-\ddot{N}H_2$ group is *ortho* and *para* directive, so product (B) is not possible.

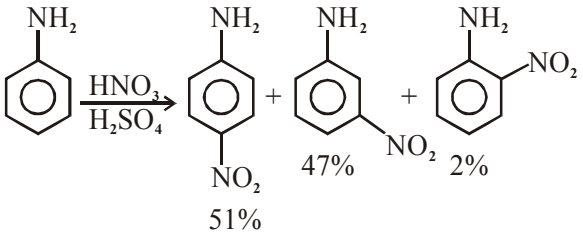
(2) Reaction is possible and compound (B) will be the major product.

(3) The reaction will form sulphonated product instead of nitration.

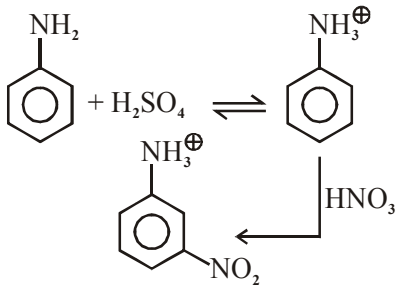
(4) Reaction is possible and compound (A) will be major product.

Official Ans. by NTA (4)

Sol.



Due to formation of anilinium ion by acid base reaction m-product is form as considerable amount.



9. The correct order of bond dissociation enthalpy of halogens is :

(1) $Cl_2 > F_2 > Br_2 > I_2$

(2) $I_2 > Br_2 > Cl_2 > F_2$

(3) $Cl_2 > Br_2 > F_2 > I_2$

(4) $F_2 > Cl_2 > Br_2 > I_2$

Official Ans. by NTA (3)

Sol. Correct order of bond dissociation enthalpy of halogens is $Cl_2 > Br_2 > F_2 > I_2$.

Due to inter electronic repulsions F–F bond becomes weak and easily broken.

10. Given below are two statements :

Statement I :

The pH of rain water is normally ~5.6.

Statement II :

If the pH of rain water drops below 5.6, it is called acid rain.

In the light of the above statements, choose the correct answer from the options given below:

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

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

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

(4) Both Statement I and Statement II are true.

Official Ans. by NTA (4)

Sol. Both statements are correct.

Normally rain water has pH of 5.6 due to the presence of H^+ ions formed by the reaction of rain water with carbon dioxide present in the atmosphere.

11. The major components of German Silver are :

(1) Ge, Cu and Ag (2) Zn, Ni and Ag

(3) Cu, Zn and Ni (4) Cu, Zn and Ag

Official Ans. by NTA (3)

Sol. Major components of German silver are:

Cu, Zn, Ni

(50%) (30%) (20%)

12. In which of the following order the given complex ions are arranged correctly with respect to their decreasing spin only magnetic moment ?

(i) $[FeF_6]^{3-}$ (ii) $[Co(NH_3)_6]^{3+}$

(iii) $[NiCl_4]^{2-}$ (iv) $[Cu(NH_3)_4]^{2+}$

(1) (i) > (iii) > (iv) > (ii)

(2) (ii) > (iii) > (i) > (iv)

(3) (iii) > (iv) > (ii) > (i)

(4) (ii) > (i) > (iii) > (iv)

Official Ans. by NTA (1)

Sol. Complex

(i) $[FeF_6]^{3-}$ $Fe^{3+} \Rightarrow [Ar]3d^5, F^-$ is WFL

Fe^{3+} | 1 | 1 | 1 | 1 | 1 | (3d)

$n = 5, \quad \mu = \sqrt{35}$ B.M.

(ii) $[Co(NH_3)_6]^{3+} \Rightarrow Co^{3+}[Ar]3d^6$, NH_3 is SFL

Co^{3+} | 1↓ | 1↓ | 1↓ | | | (3d)

$n = 0, \quad \mu = 0$

(iii) $[NiCl_4]^{2-}$ $Ni^{2+} \Rightarrow [Ar]3d^8$, $Cl^- \rightarrow$ WFL

Ni^{2+} | 1↓ | 1↓ | 1↓ | 1 | 1 | (3d)

$n = 2, \quad \mu = \sqrt{8}$ B.M.

(iv) $[Cu(NH_3)_4]^{2+}$ $Cu^{2+} \Rightarrow [Ar]\ 3d^9$, $NH_3 \rightarrow$SFL

Cu^{2+} | 1↓ | 1↓ | 1↓ | 1↓ | | (3d) | | (4s) | | | 1 | (4p)

$n = 1, \quad \mu = \sqrt{3}$ B.M.

Thus correct order of spin only magnetic moment is (i) > (iii) > (iv) > (ii)

13. Which of the following compound is added to the sodium extract before addition of silver nitrate for testing of halogens?

(1) Nitric acid (2) Ammonia

(3) Hydrochloric acid (4) Sodium hydroxide

Official Ans. by NTA (1)

Sol. For testing of halogens, Nitric acid is added to the sodium extract because if CN^- or S^{2-} are present then they will be oxidised and removed before the test of halides.

14. Which one of the following statements is FALSE for hydrophilic sols ?

(1) Their viscosity is of the order of that of H_2O.
(2) The sols cannot be easily coagulated.
(3) They do not require electrolytes for stability.
(4) These sols are reversible in nature.

Official Ans. by NTA (1)

Sol. → Viscosity of hydrophilic sol > viscosity of H_2O
→ Hydrophilic sol is more stable so can't be easily coagulated.
→ Hydrophilic sols are reversible sols.
→ No electrolytes are required to stabilise hydrophilic sol.

15. The solubility of $Ca(OH)_2$ in water is :

[Given : The solubility product of $Ca(OH)_2$ in water = 5.5×10^{-6}]

(1) 1.77×10^{-6} (2) 1.11×10^{-6}
(3) 1.11×10^{-2} (4) 1.77×10^{-2}

Official Ans. by NTA (3)

Sol. $Ca(OH)_2 \rightleftharpoons Ca^{2+}(aq) + 2OH^-(aq)$

s 2s

$k_{sp} = s(2s)^2 \Rightarrow 5.5 \times 10^{-6} = 4S^3$

$\Rightarrow s = \left(\frac{5.5}{4}\right)^{\frac{1}{3}} \times 10^{-2} = 1.11 \times 10^{-2}$

16. Given below are two statements :

Statement I :

The identification of Ni^{2+} is carried out by dimethyl glyoxime in the presence of NH_4OH.

Statement II :

The dimethyl glyoxime is a bidentate neutral ligand.

In the light of the above statements, choose the correct answer from the options given below:

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

Official Ans. by NTA (3)

Sol. Neutral dimethyl glyoxime does not act as ligand.

When Ni^{2+} reacts with dimethyl glyoxime in presence of NH_4OH, it produce dimethyl glyoximate then it form rozy red ppt.

$$Ni^{2+}_{(aq)} + 2dmg^- \rightarrow \underset{\text{Rosy red ppt.}}{[Ni(dmg)_2]}$$

17. The major product of the following reaction is:

$$CH_3CH_2CH=CH_2 \xrightarrow[\text{Rh catalyst}]{H_2/CO}$$

(1) $CH_3CH_2CH=CH-CHO$

(2) $CH_3CH_2\underset{\underset{CHO}{|}}{C}=CH_2$

(3) $CH_3CH_2CH_2CH_2CHO$

(4) $CH_3CH_2CH_2CHO$

Official Ans. by NTA (3)

Sol. OXO PROCESS (Hydroformylation) :

$$CH_3-CH_2-CH=CH_2 + CO + H_2 \xrightarrow[\text{catalyst}]{Rh}$$

CHO
+
CHO
(Major)

18. The method used for the purification of Indium is :

(1) van Arkel method
(2) liquation
(3) zone refining
(4) vapour phase refining

Official Ans. by NTA (3)

Sol. Zone refining is used for the purification of indium.

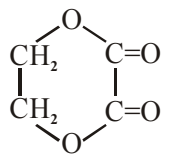
19. What is 'X' in the given reaction?

$$\underset{\underset{CH_2OH}{|}}{\overset{CH_2OH}{|}} + \text{oxalic acid} \xrightarrow{210°C} \underset{\text{(major product)}}{X}$$

(1) $\underset{\underset{CH_2}{\|}}{\overset{CH_2}{\|}}$ (2) $\underset{\underset{CH_2}{\|}}{\overset{CH-OH}{\|}}$

(3) $\underset{\underset{CHO}{|}}{\overset{CHO}{|}}$ (4) $\underset{\underset{CHO}{|}}{\overset{CH_2OH}{|}}$

Official Ans. by NTA (1)

Sol. $\underset{\underset{CH_2OH}{|}}{\overset{CH_2OH}{|}} + \underset{\underset{COOH}{|}}{\overset{COOH}{|}} \xrightarrow{110°C}$  $\xrightarrow{\Delta} CH_2=CH_2+2CO_2$

20. Given below are two statements :

Statement-I : α and β forms of sulphur can change reversibly between themselves with slow heating or slow cooling.

Statement-II : At room temperature the stable crystalline form of sulphur is monoclinic sulphur.

In the light of the above statements, choose the correct answer 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) Both Statement I is true but Statement II is false.

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

Official Ans. by NTA (3)

Sol. $\alpha - \text{sulphur} \underset{<369K}{\overset{>369K}{\rightleftharpoons}} \beta - \text{sulphur}$

at room temperature α–sulphur (Rhombic) is most stable form.

SECTION-B

1. If a compound AB dissociates to the extent of 75% in an aqueous solution, the molality of the solution which shows a 2.5 K rise in the boiling point of the solution is _____ molal. (Rounded-off to the nearest integer)

[K_b = 0.52K kg mol^{-1}]

Official Ans. by NTA (3)

Sol. $\alpha = 0.75$, $n = 2$

$i = 1 - \alpha + n\alpha = 1 - 0.75 + 2 \times 0.75 = 1.75$

$\Delta T_b = ik_b m$

or, $2.5 = 1.75 \times 0.52 \times m$

or, $m = \dfrac{2.5}{1.75 \times 0.52} = 2.74$

$\therefore$ nearest integer answer will be 3

2. The number of compound/s given below which contain/s –COOH group is _____.

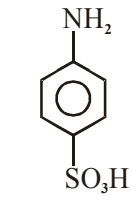
(A) Sulphanilic acid (B) Picric acid

(C) Aspirin (D) Ascorbic acid

Official Ans. by NTA (1)

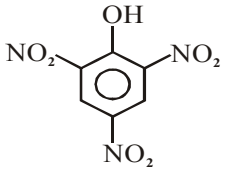
Sol. ⟶ COOH group present in

(A)



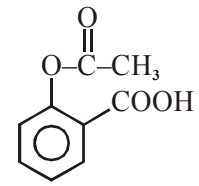
Sulphanilic acid

(B)



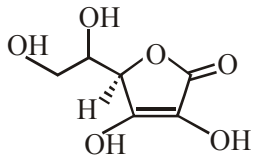
Picric acid

(C)



Asprine

(D)



Ascorbic acid

3. The rate constant of a reaction increases by five times on increase in temperature from 27°C to 52°C. The value of activation energy in kJ mol^{-1} is _____ (Rounded-off to the nearest integer)

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

Official Ans. by NTA (52)

Sol. $T_1 = 300K$, $T_2 = 325K$, $K_2 = 5K$,

$$\ln\frac{K_2}{K_1} = \frac{Ea}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

or, $$\ln 5 = \frac{Ea}{8.314}\left[\frac{1}{300} - \frac{1}{325}\right]$$

or, $Ea = 0.7 \times 2.303 \times 8.314 \times 12 \times 325$

$= 52271 \text{ J} = 52.271 \text{ kJ}$

Nearest integer answer will be 52 kJ

4. Among the following, number of metal/s which can be used as electrodes in the photoelectric cell is _____ (Integer answer)

(A) Li (B) Na

(C) Rb (D) Cs

Official Ans. by NTA (1)

Sol. Cs is used as electrodes in the photoelectric cell.

5. The spin only magnetic moment of a divalent ion in aqueous solution (atomic number 29) is _____ BM.

Official Ans. by NTA (2)

Sol. Z = 29 (Cu)

Cu^{2+} form $[Cu(H_2O)_4]^{2+}$ complex ion with H_2O.

$[Cu(H_2O)_4]^{2+} \Rightarrow Cu^{2+}$ [Ar]$3d^9$, $H_2O \rightarrow$ WFL

Cu^{2+} $\underset{3d}{\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{1}}$

number of unpaired e^- = 1

$\mu = \sqrt{1(1+2)}$ B.M.

$\mu = \sqrt{3} \Rightarrow 1.73$ B.M. $\Rightarrow$ round off ans. $\Rightarrow 2$

6. Electromagnetic radiation of wavelength 663 nm is just sufficient to ionise the atom of metal A. The ionization energy of metal A in kJ mol^{-1} is _____. (Rounded-off to the nearest integer)

[h = 6.63 × 10^{-34} Js, c = 3.00 × 10^8 ms^{-1}, N_A = 6.02 × 10^{23} mol^{-1}]

Official Ans. by NTA (180)

Sol. $E = \frac{hc}{\lambda} \times \frac{N_A}{1000}$

$= \frac{6.63\times10^{-34}\times3\times10^{8}\times6.02\times10^{23}}{663\times10^{-9}\times1000}$

$= 3 \times 6.02 \times 10$ kJ

$= 180.6$ kJ

7. Consider titration of NaOH solution versus 1.25M oxalic acid solution. At the end point following burette readings were obtained.

(i) 4.5 mL (ii) 4.5 mL

(iii) 4.4 mL (iv) 4.4 mL

(v) 4.4 mL

If the volume of oxalic acid taken was 10.0 mL then the molarity of the NaOH solution is _____M. (Rounded-off to the nearest integer)

Official Ans. by NTA (6)

Sol. V_{NaOH} = 4.4 ml

eq. of NaOH = eq. of $H_2C_2O_4$

or, M × 4.4 × 1 = 1.25 × 10 × 2

or, M = 5.68 M

$\therefore$ Nearest integer answer is 6

8. Five moles of an ideal gas at 293 K is expanded isothermally from an initial pressure of 2.1 MPa to 1.3 MPa against at constant external pressure 4.3 MPa. The heat transferred in this process is _____ kJ mol^{-1}. (Rounded-off to the nearest integer) [Use R = 8.314 J $mol^{-1}K^{-1}$]

Official Ans. by NTA (15)

Sol. n = 5, T = 293K = const, $\Delta U = 0$,

P_1 = 2.1 MPa, P_2 = 1.3 MPa

P_{ext} = 4.3 MPa = const.

$W = -P_{ext}(V_2 - V_1) = -P_{ext}\left(\frac{nRT}{P_2} - \frac{nRT}{P_1}\right)$

or, $W = -P_{ext}\, nRT\left(\frac{1}{P_2} - \frac{1}{P_1}\right)$

$= -4.3 \times 5 \times 8.314 \times 293\left(\frac{1}{1.3} - \frac{1}{2.1}\right)$

$= -4.3 \times 5 \times 8.314 \times 293\left(\frac{2.1-1.3}{1.3\times2.1}\right)$

$= -15347.7$J

or, W = –15.35 kJ

$\Delta U^0 = q + W$

$\therefore \quad q = -W$

or, q = 15.35 kJ (for 5 moles)

$\therefore \quad q/\text{mole} = \frac{15.35}{5} = 3\text{kJ mol}^{-1}$

9. Copper reduces NO_3^- into NO and NO_2 depending upon the concentration of HNO_3 in solution. (Assuming fixed $[Cu^{2+}]$ and $P_{NO} = P_{NO_2}$), the HNO_3 concentration at which the thermodynamic tendency for reduction of NO_3^- into NO and NO_2 by copper is same is 10^x M. The value of 2x is _____. (Rounded-off to the nearest integer)

[Given, $E^o_{Cu^{2+}/Cu}$ = 0.34 V, $E^o_{NO_3^-/NO}$ = 0.96 V, $E^o_{NO_3^-/NO_2}$ = 0.79 V and at 298 K, $\frac{RT}{F}(2.303) = 0.059$]

Official Ans. by NTA (1)

Sol. If the partial pressure of NO and NO_2 gas is taken as 1 bar, then Answer is 4, else the question is bonus.

$$NO_3^- + 4H^+ + 3e^- \longrightarrow NO + 2H_2O$$

$$E^o_{NO_3^-/NO} = 0.96V$$

$$NO_3^- + 2H^+ + e^- \longrightarrow NO_2 + H_2O$$

$$E^o_{NO_3^-/NO_2} = 0.79$$

Let $[HNO_3] = y \Rightarrow [H^+] = y$ and $[NO_3^-] = y$ for same thermodynamic tendency

$$E_{NO_3^-/NO} = E_{NO_3^-/NO_2}$$

$$\text{or, } E^o_{NO_3^-/NO} - \frac{0.059}{3}\log\frac{P_{NO}}{y \times y^4}$$

$$= E^o_{NO_3^-/NO_2} - \frac{0.059}{1}\log\frac{P_{NO_2}}{y \times y^2}$$

$$\text{or, } 0.96 - \frac{0.059}{3}\log\frac{P_{NO}}{y^5} = 0.79 - \frac{0.059}{1}\log\frac{P_{NO_2}}{y^3}$$

$$\text{or, } 0.17 = -\frac{0.059}{1}\log\frac{P_{NO_2}}{y^3} + \frac{0.059}{3}\log\frac{P_{NO}}{y^5}$$

$$0.17 = -\frac{0.0591}{1}\log\frac{P_{NO_2}}{y^3} + \frac{0.0591}{3}\log\frac{P_{NO}}{y^5}$$

$$0.17 = -\frac{0.0591}{3}\log\frac{P^3_{NO_2}}{y^9} + \frac{0.0591}{3}\log\frac{P_{NO}}{y^5}$$

$$0.17 = \frac{0.0591}{3}\left[\log\frac{P_{NO}}{y^5} - \log\frac{P^3_{NO_2}}{y^9}\right]$$

$$0.17 = \frac{0.0591}{3}\left[\log\frac{P_{NO}}{y^5} \times \frac{y^9}{P^3_{NO_2}}\right]$$

Assume $P_{NO} \simeq P_{NO_2} = 1$ bar

$$\frac{0.17 \times 3}{0.059} = \log y^4 = 8.644$$

$$\log y = \frac{8.644}{4}$$

$\log y = 2.161$

$y = 10^{2.16}$

$\therefore 2x = 2 \times 2.161 = 4.322$

Answer (4)

10. The unit cell of copper corresponds to a face centered cube of edge length 3.596 Å with one copper atom at each lattice point. The calculated density of copper in kg/m^3 is _____. [Molar mass of Cu : 63.54 g ; Avogadro Number = 6.022 $\times 10^{23}$]

Official Ans. by NTA (9077)

Sol. FCC,

$$d = \frac{Z \times M}{N_A \times a^3} = \frac{4 \times 63.54}{1000 \times 6.022 \times 10^{23} \times (3.596 \times 10^{-10})^3}$$

$= 9076 \text{ kg/m}^3$