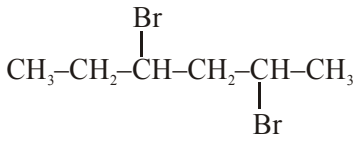
FINAL JEE–MAIN EXAMINATION – FEBRUARY, 2021

(Held On Wednesday 24th February, 2021) TIME : 9 : 00 AM to 12 : 00 NOON

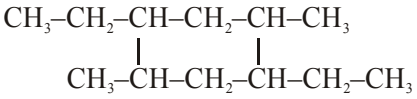
CHEMISTRY — TEST PAPER WITH SOLUTION

SECTION-A

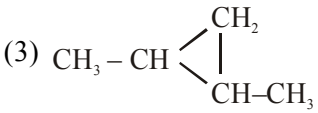
1. The product formed in the first step of the reaction of

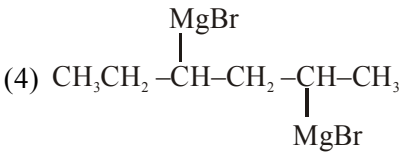


with excess $Mg/Et_2O(Et = C_2H_5)$ is :

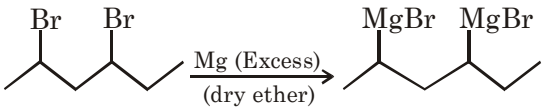
(1) 

(2) 

(3) 

(4) 

Official Ans. by NTA (4)

Sol. 

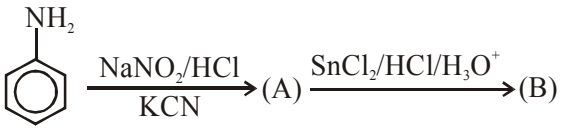
2. Consider the elements Mg. Al, S, P and Si, the correct increasing order of their first ionization enthalpy is :

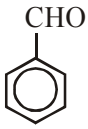
(1) Mg < Al < Si < S < P
(2) Al < Mg < Si < S < P
(3) Mg < Al < Si < P < S
(4) Al < Mg < S < Si < P

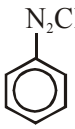
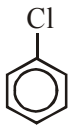
Official Ans. by NTA (2)

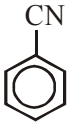
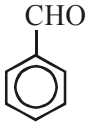
Sol. In general from left to right in a period, ionistion enthalpy increases due to effective nuclear charge increases.
but due to extra stability of half filled and full filled electronic configuration, required ionisation enthalpy is more from neighbouring elements.
i.e. first ionisation enthalpy order is
Al < Mg < Si < S < P

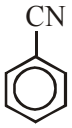
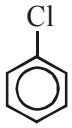
3. 'A' and 'B' in the following reactions are :



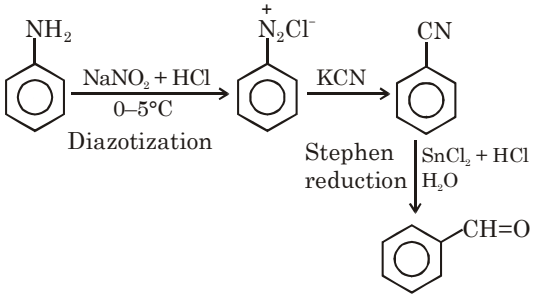
(1) (A) :  (B) : 

(2) (A) :  (B) : 

(3) (A) :  (B) : 

(4) (A) :  (B) : 

Official Ans. by NTA (3)

Sol. 

4. Which of the following ore is concentrated using group 1 cyanide salt ?

(1) Sphalerite (2) Calamine
(3) Siderite (4) Malachite

Official Ans. by NTA (1)

Sol. Sphalerite ore : ZnS
Calamine ore : $ZnCO_3$
Siderite ore : $FeCO_3$
Malachite ore : $Cu(OH)_2.CuCO_3$
It is possible to separate two sulphide ores by adjusting proportion of oil to water or by using 'depressants'. In case of an ore containing ZnS and PbS, the depressant used is NaCN.

5. Al_2O_3 was leached with alkali to get X. The solution of X on passing of gas Y, forms Z. X, Y and Z respectively are :

(1) X = $Na[Al(OH)_4]$, Y = SO_2, Z = Al_2O_3

(2) X = $Na[Al(OH)_4]$, Y = CO_2, Z = $Al_2O_3.xH_2O$

(3) X = $Al(OH)_3$, Y = CO_2, Z = Al_2O_3

(4) X = $Al(OH)_3$, Y = SO_2, Z = $Al_2O_3.xH_2O$

Official Ans. by NTA (2)

Sol. $Al_2O_{3(s)} + 2NaOH_{(aq.)} + 3H_2O_{(\ell)}$

$\downarrow$

$2Na[Al(OH)_4]_{(aq.)}$ (X)

$\downarrow$ CO_2 (Y)

$Al_2O_3.xH_2O_{(s)} + 2NaHCO_{3(aq.)}$

(Z)

So

X : $Na[Al(OH)_4]$

Y : CO_2

Z : $Al_2O_3.xH_2O$

6. Which of the following are isostructural pairs ?

A. SO_4^{2-} and CrO_4^{2-}

B. $SiCl_4$ and $TiCl_4$

C. NH_3 and NO_3^-

D. BCl_3 and $BrCl_3$

BCl_3 and $BrCl_3$

(1) C and D only

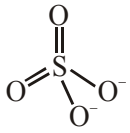
(2) A and B only

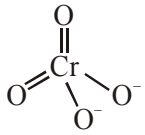
(3) A and C only

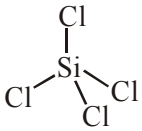
(4) B and C only

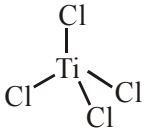
Official Ans. by NTA (2)

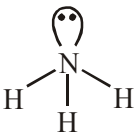
Sol. Isostructural means same structure

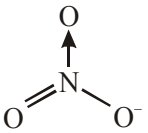
(A) SO_4^{2-}  : Tetrahedral

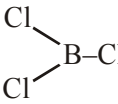
CrO_4^{2-}  : Tetrahedral

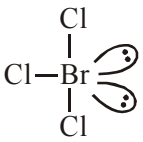
(B) $SiCl_4$  : Tetrahedral

$TiCl_4$  : Tetrahedral

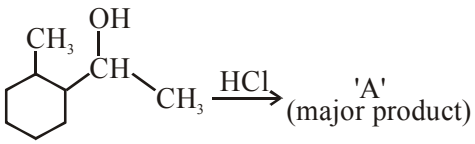
(C) NH_3  : Triagonal pyramidal

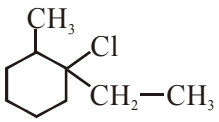
NO_3^-  : Triagonal planar

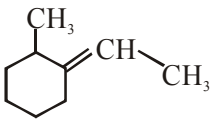
(D) BCl_3  : Triagonal planar

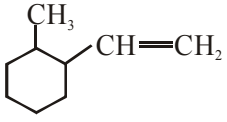
$BrCl_3$  : T-shape

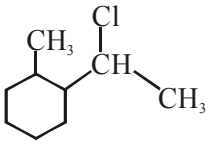
7. What is the final product (major) 'A' in the given reaction ?



(1) 

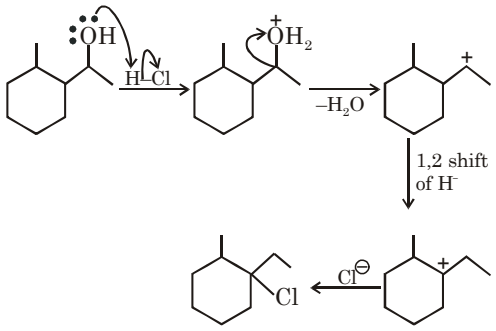
(2) 

(3) 

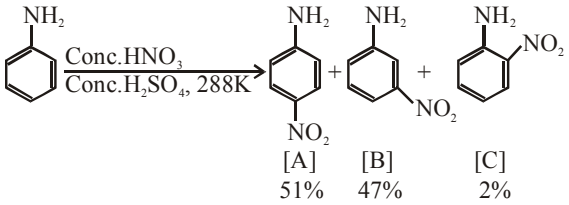
(4) 

Official Ans. by NTA (1)

Sol.



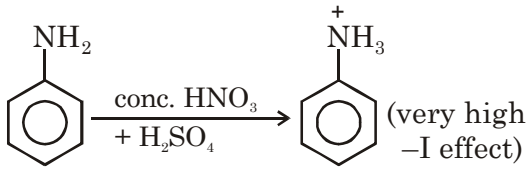
8. In the following reaction the reason why meta-nitro product also formed is :



(1) low temperature
(2) $-NH_2$ group is highly meta-directive
(3) Formation of anilinium ion
(4) $-NO_2$ substitution always takes place at meta-position

Official Ans. by NTA (3)

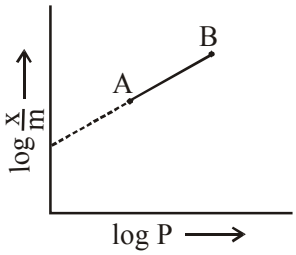
Sol.



(Anilinium ion)

Aniline on protonation gives anilinium ion which is meta directing. So considerable amount of meta product is formed.

9. In Freundlich adsorption isotherm, slope of AB line is :



(1) log n with (n > 1)
(2) n with (n, 0.1 to 0.5)
(3) $\log\frac{1}{n}$ with $(n<1)$
(4) $\frac{1}{n}$ with $\left(\frac{1}{n}=0 \text{ to } 1\right)$

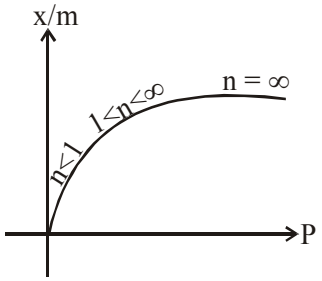
Official Ans. by NTA (4)

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

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

$y = c + mx$

$m = 1/n$ so slope will be equal to 1/n.



Hence $\boxed{0\le\frac{1}{n}\le 1}$

10. (A) $HOCl + H_2O_2 \rightarrow H_3O^+ + Cl^- + O_2$

(B) $I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$

Choose the correct option.

(1) H_2O_2 acts as reducing and oxidising agent respectively in equation (A) and (B)

(2) H_2O_2 acts as oxidising agent in equation (A) and (B)

(3) H_2O_2 acts as reducing agent in equation (A) and (B)

(4) H_2O_2 act as oxidizing and reducing agent respectively in equation (A) and (B)

Official Ans. by NTA (3)

(A) $HOCl + H_2O_2 \rightarrow H_3O^+ + Cl^- + O_2$

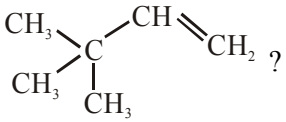
In this equation, H_2O_2 is reducing chlorine from +1 to –1.

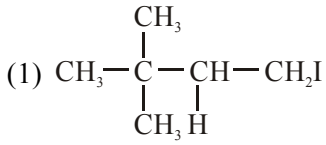
(B) $I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$

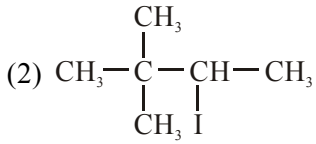
In this equation, H_2O_2 is reducing iodine from 0 to –1.

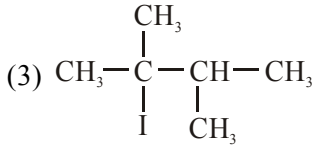
Sol. In (A) reduction of HOCl occurs so it will be a oxidising agent hence H_2O_2 will be a reducing agent.

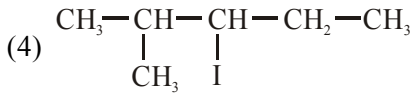
In(B) reduction of I_2 occurs so it will be a oxidising agent and H_2O_2 will be a reducing agent.

11. What is the major product formed by HI on reaction with  ?

(1) 

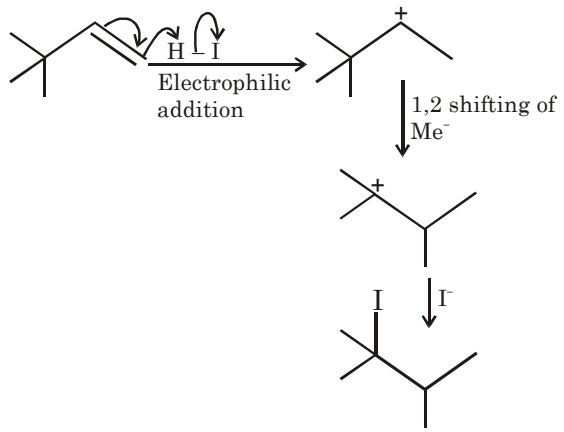
(2) 

(3) 

(4) 

Official Ans. by NTA (3)

11. Official Ans. by NTA ( )

Sol. 

12. Which of the following reagent is used for the following reaction ?

$$CH_3CH_2CH_3 \xrightarrow{?} CH_3CH_2CHO$$

(1) Manganese acetate
(2) Copper at high temperature and pressure
(3) Molybdenum oxide
(4) Potassium permanganate

Official Ans. by NTA (3)

Sol. $CH_3–CH_2–CH_3 \xrightarrow{MO_2O_3} CH_3–CH_2–CH=O$

The reagent used will be MO_2O_3

13. Given below are two statements :

Statement I : Colourless cupric metaborate is reduced to cuprous metaborate in a luminous flame.

Statement II : Cuprous metaborate is obtained by heating boric anhydride and copper sulphate in a non-luminous flame.

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) 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 (2)

Sol.

(i) Blue cupric metaborate is reduced to colourless cuprous metaborate in a luminous flame

$$2Cu(BO_2)_2 + 2NaBO_2 + C \xrightarrow{\text{Luminous flame}} 2CuBO_2 + Na_2B_4O_7 + CO$$

(ii) Cupric metaborate is obtained by heating boric anhydride and copper sulphate in a non luminous flame.

$$CuSO_4 + B_2O_3 \xrightarrow[\text{Flame}]{\text{Non-luminous}} Cu(BO_2)_2 + SO_3$$

Cupric metaborate (Blue-green)

14. Out of the following, which type of interaction is responsible for the stabilisation of α-helix structure of proteins ?

(1) Ionic bonding

(2) Hydrogen bonding

(3) Covalent bonding

(4) vander Waals forces

Official Ans. by NTA (2)

Sol. Hydrogen bonding is responsible for the stacking of α-helix structure of protein.

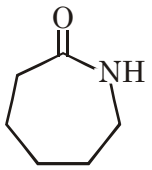
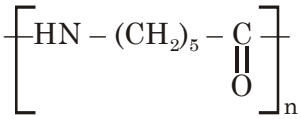
15. Match List I with List II.

List I (Monomer Unit)	List II (Polymer)
(a) Caprolactum	(i) Natural rubber
(b) 2-Chloro-1,3-butadiene	(ii) Buna-N
(c) Isoperene	(iii) Nylon 6
(d) Acrylonitrile	(iv) Neoprene

Choose the correct answer from the options given below :

(1) (a) → (iv), (b) → (iii), (c) → (ii), (d) → (i)
(2) (a) → (ii), (b) → (i), (c) → (iv), (d) → (iii)
(3) (a) → (iii), (b) → (iv), (c) → (i), (d) → (ii)
(4) (a) → (i), (b) → (ii), (c) → (iii), (d) → (iv)

Official Ans. by NTA (3)

Sol. (a)  Caprolactum is the monomeric unit of polymer Nylon-6 

(b) 2-Chlorobuta-1, 3-diene is the monomeric unit of polymer neoprene.

(c) 2-Methylbuta-1, 3-diene is the monomeric unit of polymer natural rubber.

(d) $CH_2 = CH - CN$ (Acrylonitrile) is the one of the monomeric unit of polymer Buna-N

16. The gas released during anaerobic degradation of vegetation may lead to :

(1) Ozone hole
(2) Acid rain
(3) Corrosion of metals
(4) Global warming and cancer

Official Ans. by NTA (4)

Sol. The gas CH_4 evolved due to anaerobic degradation of vegetation which causes global warming and cancer.

17. The major components in "Gun Metal" are :

(1) Cu, Zn and Ni (2) Cu, Sn and Zn
(3) Al, Cu, Mg and Mn (4) Cu, Ni and Fe

Official Ans. by NTA (2)

The major components in "Gun Metal" are
Cu : 87%
Zn : 3%
Sn : 10%

18. The electrode potential of M^{2+} / M of 3d-series elements shows positive value of :

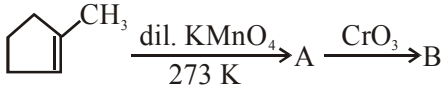
(1) Zn (2) Fe (3) Co (4) Cu

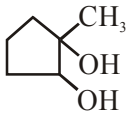
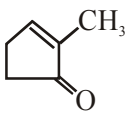
Official Ans. by NTA (4)

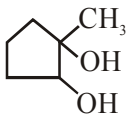
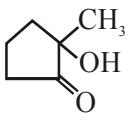
Sol. Only copper shows positive value for electrode potential of M^{2+}/M of 3d-series elements.

$E^{\ominus} / V_{(Cu^{2+}/Cu)} : +0.34$

19. Identify products A and B :

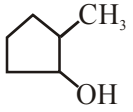
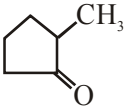


(1) A :  B : 

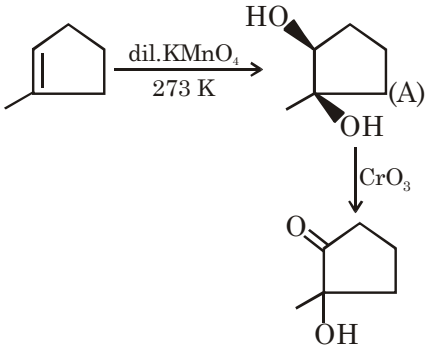
(2) A :  B : 

(3) A : 

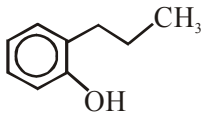
B : 

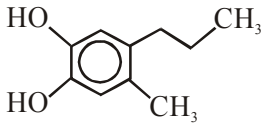
(4) A :  (4) 

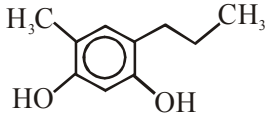
Official Ans. by NTA (2)

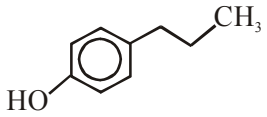
Sol. 

20. Which of the following compound gives pink colour on reaction with phthalic anhydride in conc. H_2SO_4 followed by treatment with NaOH ?

(1) 

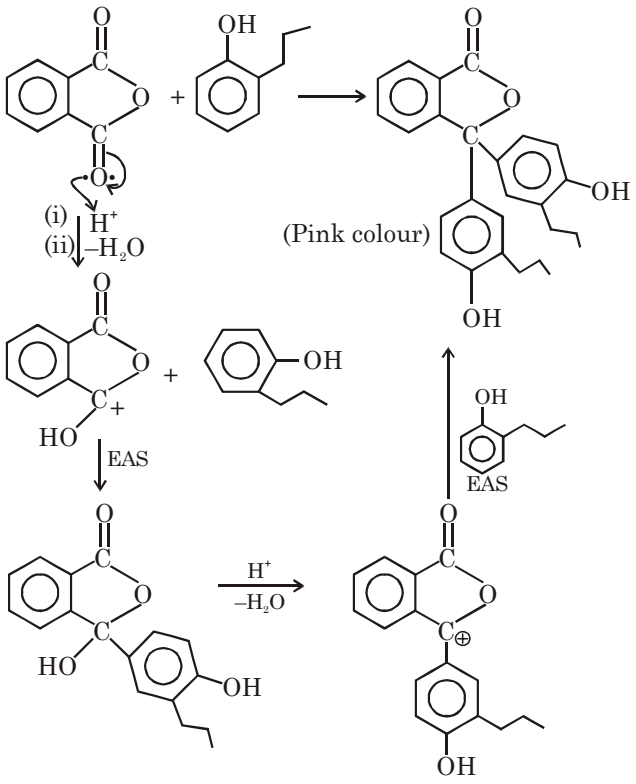
(2) 

(3) 

(4) 

Official Ans. by NTA (1)

Sol.



SECTION-B

1. When 9.45 g of $ClCH_2COOH$ is added to 500 mL of water, its freezing point drops by 0.5°C. The dissociation constant of $ClCH_2COOH$ is $x \times 10^{-3}$. The value of x is _____. (Rounded off to the nearest integer)

$\left[K_{f(H_2O)} = 1.86\,K\,kg\,mol^{-1}\right]$

Official Ans. by NTA (35)

Official Ans. by ALLEN (36)

Sol. $ClCH_2COOH \rightleftharpoons ClCH_2COO^{\ominus} + H^+$

$i = 1 + (2 - 1)\,\alpha$

$i = 1 + \alpha$

$\Delta T_f = ik_fm$

$$0.5 = (1+\alpha)(1.86)\left(\frac{\left(\frac{9.45}{94.5}\right)}{\left(\frac{500}{1000}\right)}\right)$$

$$\frac{5}{3.72} = 1+\alpha \quad \Rightarrow \alpha = \frac{1.28}{3.72}$$

$$\alpha = \frac{32}{93}$$

$ClCH_2COOH \rightleftharpoons ClCH_2\,COO^{\ominus} + H^+$

$C - C\alpha \qquad\qquad C\alpha \qquad\quad C\alpha$

$$K_a = \frac{(C\alpha)^2}{C - C\alpha} = \frac{C\alpha^2}{1-\alpha} \qquad C = \frac{0.1}{500/1000} = 0.2$$

$$K_a = \frac{0.2(32/93)^2}{(1 - 32/93)} = \frac{0.2 \times (32)^2}{93 \times 61}$$

$= 0.036$

$K_a = 36 \times 10^{-3}$

2. 4.5 g of compound A (MW = 90) was used to make 250 mL of its aqueous solution. The molarity of the solution in M is $x \times 10^{-1}$. The value of x is _____. (Rounded off to the nearest integer)

Official Ans. by NTA (2)

Sol. $$M = \frac{4.5/90}{250/1000} = 0.2$$

$= 2 \times 10^{-1}$

3. At 1990 K and 1 atm pressure, there are equal number of Cl_2 molecules and Cl atoms in the reaction mixture. The value K_P for the reaction $Cl_{2(g)} \rightleftharpoons 2Cl_{(g)}$ under the above conditions is $x \times 10^{-1}$. The value of x is _____. (Rounded of to the nearest integer)

Official Ans. by NTA (5)

Sol. $Cl_2 \rightleftharpoons 2Cl$

Let mol of both of Cl_2 and Cl is x

$$P_{Cl} = \frac{x}{2x} \times 1 = \frac{1}{2}$$

$$P_{Cl_2} = \frac{x}{2x} \times 1 = \frac{1}{2}$$

$$K_p = \frac{\left(\frac{1}{2}\right)^2}{\frac{1}{2}} = \frac{1}{2} = 0.5 \Rightarrow 5 \times 10^{-1}$$

4. Number of amphoteric compound among the following is _____

(A) BeO (B) BaO

(C) $Be(OH)_2$ (D) $Sr(OH)_2$

Official Ans. by NTA (2)

Sol. Both compounds BeO and $Be(OH)_2$ are amphoteric in nature.

and both compounds BaO and $Sr(OH)_2$ are basic in nature.

5. The reaction of sulphur in alkaline medium is the below:

$$S_{8(s)} + a\ OH^-_{(aq)} \rightarrow b\ S^{2-}_{(aq)} + c\ S_2O_3^{2-}{}_{(aq)} + d\ H_2O_{(\ell)}$$

The values of 'a' is _____. (Integer answer)

Official Ans. by NTA (12)

Sol.

$$16e^{\ominus} + S_8 \longrightarrow 8S^{2-}$$

$$12H_2O + S_8 \longrightarrow 4S_2O_3^{2-} + 24H^+ + 16e^{\ominus}$$

$$2S_8 + 12\ H_2O \longrightarrow 8S^{2-} + 4S_2O_3^{2-} + 24\ H^+$$

for balancing in basic medium add equal number of $OH^{\ominus}$ that of H^+

$$2S_8 + 12H_2O + 24OH^{\ominus} \longrightarrow 8S^{2-} + 4\ S_2O_8^{2-} + 24H_2O$$

$$2S_8 + 24OH^{\ominus} \rightarrow 8S^{2-} + 4S_2O_8^{2-} + 12\ H_2O$$

$$S_8 + 12\ OH^{\ominus} \rightarrow 4S^{2-} + 2S_2O_8^{2-} + 6\ H_2O$$

a = 12

6. For the reaction $A_{(g)} \rightarrow (B)_{(g)}$, the value of the equilibrium constant at 300 K and 1 atm is equal to 100.0. The value of $\Delta_r G$ for the reaction at 300 K and 1 atm in J mol^{-1} is – xR, where x is _____ (Rounded of to the nearest integer) (R = 8.31 J mol^{-1} K^{-1} and ln 10 = 2.3)

Official Ans. by NTA (1380)

6. $\Delta G^o = -RT\ \ln Kp$

$= -R(300)\ (2)\ \ln(10)$

$= -R(300 \times 2 \times 2.3)$

$\Delta G^o = -1380\ R$

7. A proton and a Li^{3+} nucleus are accelerated by the same potential. If λ_{Li} and λ_P denote the de Broglie wavelengths of Li^{3+} and proton respectively, then the value of $\frac{\lambda_{Li}}{\lambda_P}$ is $x \times 10^{-1}$. The value of x is _____.

(Rounded off to the nearest integer) (Mass of Li^{3+} = 8.3 mass of proton)

Official Ans. by NTA (2)

Sol. $\lambda = \frac{h}{\sqrt{2mqV}}$

$$\frac{\lambda_{Li}}{\lambda_p} = \sqrt{\frac{m_p(e)V}{m_{Li}(3e)(V)}} \qquad m_{Li} = 8.3\,m_p$$

$$\frac{\lambda_{Li}}{\lambda_p} = \sqrt{\frac{1}{8.3\times 3}} = \frac{1}{5} = 0.2 = 2\times 10^{-1}$$

8. The stepwise formation of $[Cu(NH_3)_4]^{2+}$ is given below

$$Cu^{2+} + NH_3 \overset{K_1}{\rightleftharpoons} [Cu(NH_3)]^{2+}$$

$$[Cu(NH_3)]^{2+} + NH_3 \overset{K_2}{\rightleftharpoons} [Cu(NH_3)_2]^{2+}$$

$$[Cu(NH_3)_2]^{2+} + NH_3 \overset{K_3}{\rightleftharpoons} [Cu(NH_3)_3]^{2+}$$

$$[Cu(NH_3)_3]^{2+} + NH_3 \overset{K_4}{\rightleftharpoons} [Cu(NH_3)_4]^{2+}$$

The value of stability constants K_1, K_2, K_3 and K_4 are 10^4, 1.58×10^3, 5×10^2 and 10^2 respectively. The overall equilibrium constants for dissociation of $[Cu(NH_3)_4]^{2+}$ is $x \times 10^{-12}$. The value of x is _____. (Rounded off to the nearest integer)

Official Ans. by NTA (1)

Sol. $Cu^{2+} + NH_3 \overset{K_1}{\rightleftharpoons} [Cu(NH_3)]^{2+}$

$$[Cu(NH_3)]^{2+} + NH_3 \overset{K_2}{\rightleftharpoons} [Cu(NH_3)_2]^{2+}$$

$$[Cu(NH_3)_2]^{2+} + NH_3 \overset{K_3}{\rightleftharpoons} [Cu(NH_3)_3]^{2+}$$

$$[Cu(NH_3)_3]^{2+} + NH_3 \overset{K_4}{\rightleftharpoons} [Cu(NH_3)_4]^{2+}$$

$$Cu^{2+} + 4NH_3 \overset{K}{\rightleftharpoons} [Cu(NH_3)_4]^{2+}$$

So

$K = K_1 \times K_2 \times K_3 \times K_4$

$= 10^4 \times 1.58 \times 10^3 \times 5 \times 10^2 \times 10^2$

$K = 7.9 \times 10^{11}$

Where K $\rightarrow$ Equilibrium constant for formation of $[Cu(NH_3)_4]^{2+}$

So equilibrium constant (K') for dissociation of $[Cu(NH_3)_4]^{2+}$ is $\frac{1}{K}$

$$K' = \frac{1}{K}$$

$$K' = \frac{1}{7.9\times 10^{11}}$$

$= 1.26 \times 10^{-12} = (x \times 10^{-12})$

So the value of x = 1.26

OMR Ans = 1 (After rounded off to the nearest integer)

9. The coordination number of an atom in a body-centered cubic structure is _____.

[Assume that the lattice is made up of atoms.]

Official Ans. by NTA (8)

Sol. 8

10. Gaseous cyclobutene isomerizes to butadiene in a first order process which has a 'k' value of $3.3 \times 10^{-4} s^{-1}$ at 153°C. The time in minutes it takes for the isomerization to proceed 40 % to completion at this temperature is _____. (Rounded off to the nearest integer)

Official Ans. by NTA (26)

Sol. $\square \longrightarrow H_2C = HC-CH = CH_2$

$$Kt = \ell n \frac{[A]_0}{[A]_t}$$

$$3.3\times 10^{-4} \times t = \ell n\left(\frac{100}{60}\right)$$

t = 1547.956 sec

t = 25.799 min

26 min