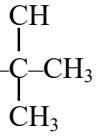
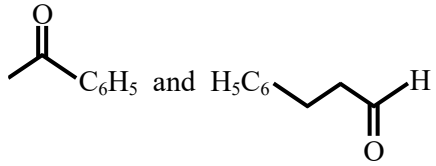
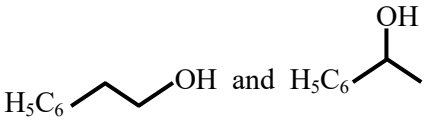
CHEMISTRY

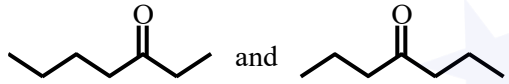
SECTION-A

1. Which one of the following pairs of isomers is an example of metamerism ?

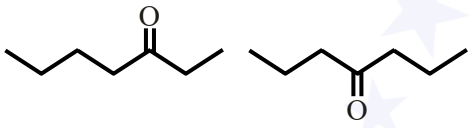
(1) $CH_3CH_2CH_2CH_2CH_3$ and 

(2) 

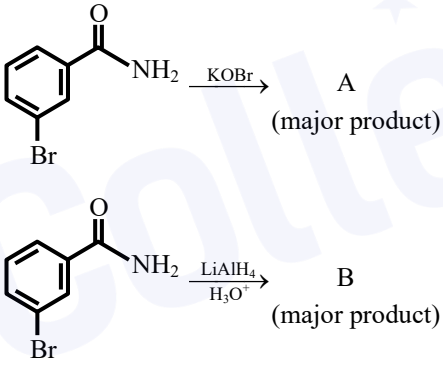
(3) 

(4) 

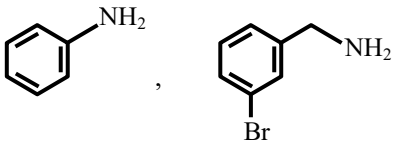
Official Ans. by NTA (4)

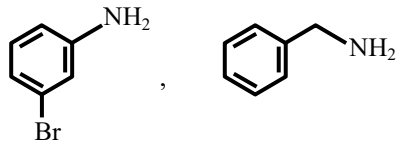
Sol. 

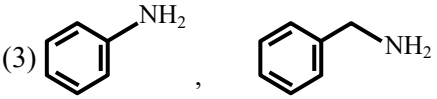
are metamers.

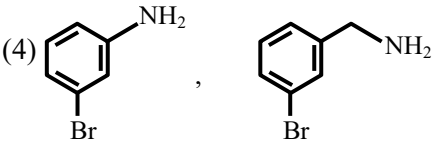
2. 

In the above reactions, product A and product B respectively are :

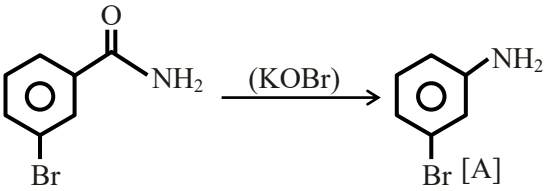
(1) 

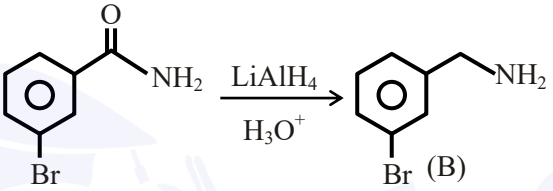
(2) 

(3) 

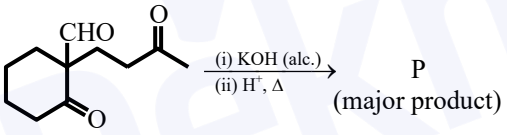
(4) 

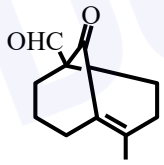
Official Ans. by NTA (4)

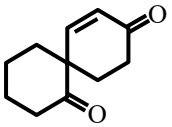
Sol. 

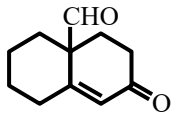


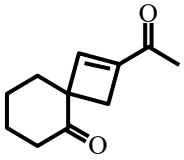
3. The major product (P) in the following reaction is :



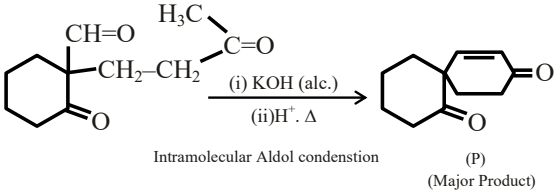
(1) 

(2) 

(3) 

(4) 

Official Ans. by NTA (2)

Sol. 

4. The single largest industrial application of dihydrogen is :

(1) Manufacture of metal hydrides

(2) Rocket fuel in space research

(3) In the synthesis of ammonia

(4) In the synthesis of nitric acid

Official Ans. by NTA (3)

Sol. Informative, according to ncert uses of di hydrogen.

In fact NH_3 largest production in used to manufacture nitrogenous fertilisers.

5. Consider two chemical reactions (A) and (B) that take place during metallurgical process :

(A) $ZnCO_{3(s)} \xrightarrow{\Delta} ZnO_{(s)} + CO_{2(g)}$

(B) $2ZnS_{(s)} + 3O_{2(g)} \xrightarrow{\Delta} 2ZnO_{(s)} + 2SO_{2(g)}$

The **correct** option of names given to them respectively is :

(1) (A) is calcination and (B) is roasting

(2) Both (A) and (B) are producing same product so both are roasting

(3) Both (A) and (B) are producing same product so both are calcination

(4) (A) is roasting and (B) is calcination

Official Ans. by NTA (1)

Sol. (A) $ZnCO_3$ (S) $\xrightarrow{\Delta}$ ZnO(s) + CO_2(g)

Heating in absence of oxygen in calcination.

(B) $2Zns(s) + 3O_2(g) \rightarrow 2ZnO(g) + 2SO_2(g)$

heating in presence of oxygen in roasting

Hence (A) is calcination while (B) in roasting.

6. A solution is 0.1 M in Cl^- and 0.001 M in CrO_4^{2-}. Solid $AgNO_3$ is gradually added to it

Assuming that the addition does not change in volume and $K_{sp}(AgCl) = 1.7 \times 10^{-10}$ M^2 and $K_{sp}(Ag_2CrO_4) = 1.9 \times 10^{-12}$ M^3.

Select **correct** statement from the following :

(1) AgCl precipitates first because its K_{sp} is high.

(2) Ag_2CrO_4 precipitates first as its K_{sp} is low.

(3) Ag_2CrO_4 precipitates first because the amount of Ag^+ needed is low.

(4) AgCl will precipitate first as the amount of Ag^+ needed to precipitate is low.

Official Ans. by NTA (4)

Sol. **(i)** $[Ag^+]$ required to ppt AgCl(s)

$Ksp = IP = [Ag^+]\,[Cl^-] = 1.7 \times 10^{-10}$

$[Ag^+] = 1.7 \times 10^{-9}$

(ii) $[Ag^+]$ required to ppt Ag_2CrO_4(s)

$Ksp = IP = [Ag+]^2\,[CrO_4^{-2}] = 1.9 \times 10^{-12}$

$[Ag^+] = 4.3 \times 10^{-5}$

$[Ag^+]$ required to ppt AgCl is low so AgCl will ppt 1st.

7. Outermost electronic configuration of a group 13 element, E, is $4s^2$, $4p^1$. The electronic configuration of an element of p-block period-five placed diagonally to element, E is :

(1) [Kr] $3d^{10}$ $4s^2$ $4p^2$ (2) [Ar] $3d^{10}$ $4s^2$ $4p^2$

(3) [Xe] $5d^{10}$ $6s^2$ $6p^2$ (4) [Kr] $4d^{10}$ $5s^2$ $5p^2$

Official Ans. by NTA (4)

Sol. The element E is Ga and the diagonal element of 5th period is $_{50}Sn$ having outer electronic configuration will be [Kr] $5s^2$ $4d^{10}$ 5 p^2.

8. Metallic sodium does not react normally with :

(1) gaseous ammonia (2) But-2-yne

(3) Ethyne (4) tert-butyl alcohol

Official Ans. by NTA (2)

Sol. Metallic sodium does not react with 2-butyne because 2-butyne does not have acidic hydrogen.

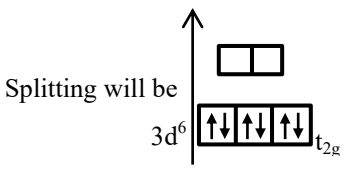
9. Spin only magnetic moment of an octahedral complex of Fe^{2+} in the presence of a strong field ligand in BM is :

(1) 4.89 (2) 2.82 (3) 0 (4) 3.46

Official Ans. by NTA (3)

Sol. In presence of SFL $\Delta_0 > P$ means pairing occurs therefore

For $Fe^{+2} \rightarrow 3d^6$



$\therefore$ No of unpaired e^- (s) = 0

$\therefore$ $\mu = \sqrt{n(n+2)}$ BM = 0

[n = No of unpaired e^-(s)]

In $NiCl_2$ Ni^{+2} is having configuration $3d^8$

$\therefore$ Number of unpaired electron = 2

After formation of oxidised product

$[Ni(CN)_6]^{-2}$ Ni^{+4} is obtained

$Ni^{+4} \Rightarrow 3d^6$ and CN^- is strong field ligand

$\therefore$ number of unpaired electrons = 0

$\therefore$ The charge is $2 - 0 = 2$

10. Which one of the following species **doesn't** have a magnetic moment of 1.73 BM, (spin only value) ?

(1) O_2^+ (2) CuI

(3) $[Cu(NH_3)_4]Cl_2$ (4) O_2^-

Official Ans. by NTA (2)

Sol. Species must not contain single unpaired

(1)$O_2^+ \rightarrow$

$$\sigma_{1s}^2 < \sigma_{1s}^{*2} < \sigma_{2s}^2 < \sigma_{2s}^{*2} < \sigma_{2pz}^2 < \pi_{2px}^2 = \pi_{2py}^2 < \pi_{2px}^{*1} = \pi_{2py}^{*}$$

unpaired $e^- = 1$ $\therefore$ $\mu = 1.73$ BM

(1) Cu^+I^- $Cu^+ \rightarrow [Ar]3d^{10}$ $\therefore$ unpaired $e^- = 0$

$I^- \rightarrow [Xe]$ $\therefore$ unpaired $e^- = 0$

therefore $\mu = 0$

3. $[Cu(NH_3)_4]Cl_2$

$Cu \rightarrow [A]\ 3d^3$ $\therefore$ unpaired = 1 $\therefore$ $\mu = 1.73$ BM

4. $O_2^- \rightarrow$ d

$$\sigma_{1s}^2 < \sigma_{1s}^{*2} < \sigma_{2s}^2 < \sigma_{2s}^{*2} < \sigma_{2px}^2 < \pi_{2px}^2 = \pi_{2py}^2 < \pi_{2px}^{*1} = \pi_{2py}^{*}$$

($11e^-$)

$\therefore$ unpaired $\therefore$ $\mu = 1.73$ BM

11. Which one of the following statements is not true about enzymes ?

(1) Enzymes are non-specific for a reaction and substrate.

(2) Almost all enzymes are proteins.

(3) Enzymes work as catalysts by lowering the activation energy of a biochemical reaction.

(4) The action of enzymes is temperature and pH specific

Official Ans. by NTA (1)

Sol. Fact

12. The hybridisations of the atomic orbitals of nitrogen in NO_2^-, NO_2^+ and NH_4^+ respectively are.

(1) sp^3, sp^2 and sp

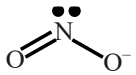
(2) sp, sp^2 and sp^3

(3) sp^3, sp and sp^2

(4) sp^2, sp and sp^3

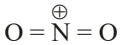
Official Ans. by NTA (4)

Sol.



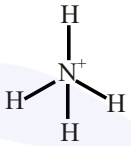
$2\sigma + 1$ lp

$\therefore$ sp^2



$2\sigma + 0$ lp

$\therefore$ sp



$4\sigma + 0$

$\therefore$ sp^3

13. Bakelite is a cross-linked polymer of formaldehyde and :

(1) PHBV (2) Buna-S (3) Novolac (4) Dacron

Official Ans. by NTA (3)

Sol. Novolac (phenol formaldehyde Resin) $\rightarrow$ Bakelite

14. Benzene on nitration gives nitrobenzene in presence of HNO_3 and H_2SO_4 mixture, where :

(1) both H_2SO_4 and HNO_3 act as a bases

(2) HNO_3 acts as an acid and H_2SO_4 acts as a base

(3) both H_2SO_4 and HNO_3 act as an acids

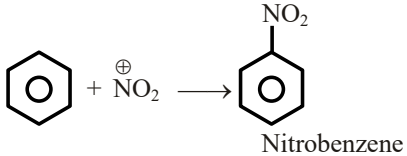
(4) HNO_3 acts as a base and H_2SO_4 acts as an acid

Official Ans. by NTA (4)

Sol. Reagent for nitration of Benzene

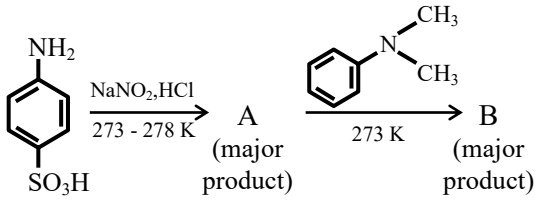
$$\underset{\text{(Acid)}}{H_2SO_4} + \underset{\text{(Base)}}{HNO_3} \rightleftarrows HSO_4^{\ominus} + H_2\overset{\oplus}{N}O_3$$

$$H_2\overset{\oplus}{N}O_3 \rightleftarrows H_2O + \overset{\oplus}{N}O_2$$

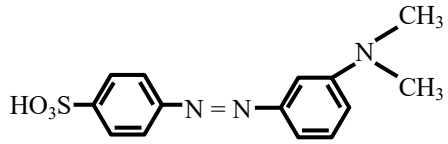


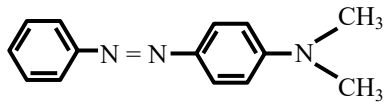
Nitrobenzene

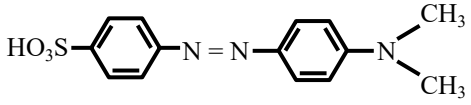
15.

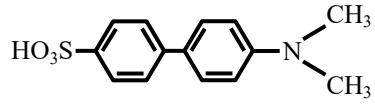


Consider the above reaction, compound B is :

(1) 

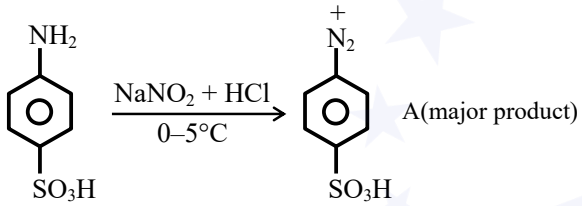
(2) 

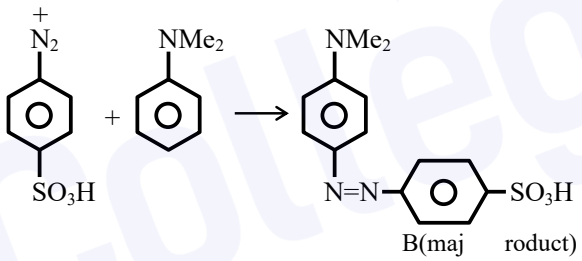
(3) 

(4) 

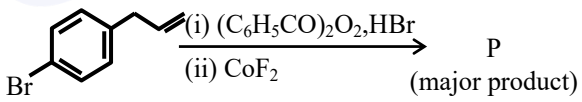
Official Ans. by NTA (3)

Sol.

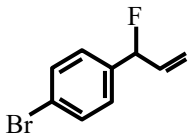


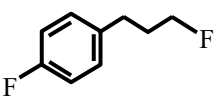


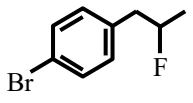
16.

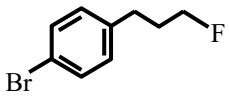


Major product P of above reaction, is :

(1) 

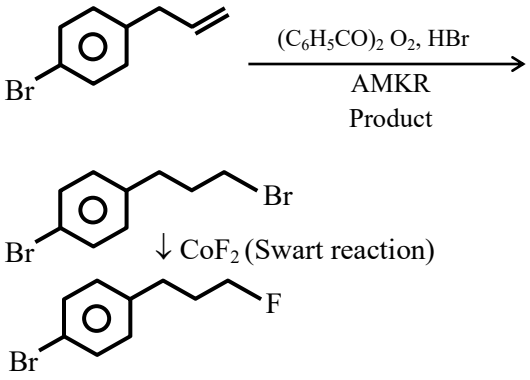
(2) 

(3) 

(4) 

Official Ans. by NTA (4)

Sol.



17. Cu^{2+} salt reacts with potassium iodide to give

(1) Cu_2I_2 (2) Cu_2I_3

(3) CuI (4) $Cu(I_3)_2$

Official Ans. by NTA (1)

Sol. $2Cu^{+2} + 4I^- \longrightarrow Cu_2I_2(s) + I_2$

$2Cu^{+2} + 3I^- \longrightarrow 2CuI + I_2$

18. In Carius method, halogen containing organic compound is heated with fuming nitric acid in the presence of :

(1) HNO_3 (2) $AgNO_3$ (3) $CuSO_4$ (4) $BaSO_4$

Official Ans. by NTA (2)

Sol. Organic compound is heated with fuming nitric acid in the presence of silver nitrate in carius method.

Lunar caustic ($AgNO_3$) is used as reagent hare to distinguish Cl^-, Br and I^- respectively as follows.

$Cl^-(aq) \xrightarrow{AgNO_3} AgCl\downarrow_{ppt}$ white

$Br^-(aq) \xrightarrow{AgNO_3} AgBr\downarrow_{ppt}$ pale yellow

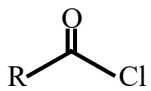
$I^-(aq) \xrightarrow{AgNO_3} AgI\downarrow_{ppt}$ Dark yellow

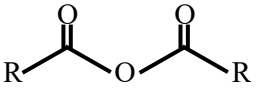
19. Which one of the following gases is reported to retard photosynthesis ?

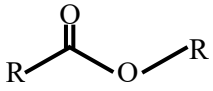
(1) CO (2) CFCs (3) CO_2 (4) NO_2

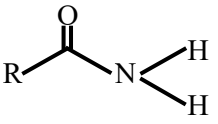
Official Ans. by NTA (4)

Sol. According to NCERT only NO_2 from the given options can retard the photosynthesis process in plants.

20. (A) 

(B) 

(C) 

(D) 

The **correct** order of their reactivity towards hydrolysis at room temperature is :

(1) (A) > (B) > (C) > (D)

(2) (D) > (A) > (B) > (C)

(3) (D) > (B) > (A) > (C)

(4) (A) > (C) > (B) > (D)

Official Ans. by NTA (1)

Sol. $\underset{\underset{O}{\|}}{R-C-Cl} > \underset{\underset{O}{\|}}{R-C-O-}\underset{\underset{O}{\|}}{C-R} > \underset{\underset{O}{\|}}{R-C-OR} > \underset{\underset{O}{\|}}{R-C-NH_2}$

Reactivity towards Hydrolysis

A > B > C > D

SECTION-B

1. For a given chemical reaction A $\rightarrow$ B at 300 K the free energy change is –49.4 kJ mol^{-1} and the enthalpy of reaction is 51.4 kJ mol^{-1}. The entropy change of the reaction is _____ J K^{-1} mol^{-1}.

Official Ans. by NTA (360)

Sol. Given chemical reaction:

$A \xrightarrow[T\ 300K]{} B \quad [\Delta G]_{P,T} = -49.4\ kJ/mol$

$\Delta H_{rxn} = 51.4\ kJ/mol$

$\Delta S_{rxn} = ?$

$\Rightarrow$ From the relation $[\Delta G]_{P,T} = \Delta H - T\Delta S$

$$\Rightarrow \Delta S_{rxn} = \frac{\Delta H_{rxn} - [\Delta G]_{P,T}}{T}$$

$$= \frac{[51.4 - (-49.4)] \times 1000}{300} \frac{J}{mol\,K}$$

$$\Rightarrow \Delta S_{rxn} = 336\ \frac{J}{mol\,K}$$

2. The wavelength of electrons accelerated from rest through a potential difference of 40 kV is $x \times 10^{-12}$ m. The value of x is _____. (Nearest integer)

Given : Mass of electron = 9.1×10^{-31} kg

Charge on an electron = 1.6×10^{-19} C

Planck's constant = 6.63×10^{-34} Js

Official Ans. by NTA (6)

Sol. De-broglie-wave length of electron:

$$\lambda_e = \frac{h}{\sqrt{2m(KE)}} \begin{cases} \because e^- \text{ is accelerated from rest} \\ \Rightarrow KE = q \times V \end{cases}$$

$$\lambda = \frac{h}{\sqrt{2mqv}}$$

$$= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 1.6 \times 10^{-19} \times 9.1 \times 10^{-31} \times 40 \times 10^3}}$$

$= 0.614 \times 10^{-11}$ m

$= 6.14 \times 10^{-12}$ m

Nearest integer = 6

OR

$$\lambda = \frac{12.3}{\sqrt{V}}\ \text{Å}$$

$$= \frac{12.3}{200} = 6.15 \times 10^{-12}\ m$$

Ans. is 6

3. The vapour pressures of A and B at 25°C are 90 mm Hg and 15 mm Hg respectively. If A and B are mixed such that the mole fraction of A in the mixture is 0.6, then the mole fraction of B in the vapour phase is $x \times 10^{-1}$. The value of x is _____. (Nearest integer)

Official Ans. by NTA (1)

Sol. Given $P_A^\circ = 90$ mm Hg, at 25°C

$P_B^\circ = 15$ mm Hg

and $\left.\begin{matrix} X_A = 0.6 \\ X_B = 0.4 \end{matrix}\right\} P_T = X_A P_A^o + X_B P_B^o$

$= (0.6 \times 90) + (0.4 \times 15)$

$= 54 + 6 = 60$ mm

Now mol fraction of B in the vapour phase

i.e. $Y_B = \frac{P_B}{P_T} = \frac{X_B P_B^o}{60} = 0.1 = 1 \times 10^{-1}$

therefore: x = 1

4. 4g equimolar mixture of NaOH and Na_2CO_3 contains x g of NaOH and y g of Na_2CO_3. The value of x is _____ g. (Nearest integer)

Official Ans. by NTA (1)

Sol. Total mass = 4g

Now

NaOH : a mol $\quad W_{NaOH} + W_{Na_2CO_3} = 4$

Na_2CO_3 : 'a' mol $\quad \Rightarrow 40a + 106\,a = 4$

$\Rightarrow a = \frac{4}{146}\text{mol}$

$\Rightarrow$ therefore mass of NaOH is : $\frac{4}{146}\times 40\text{g}$

$= 1.095 \approx 1$

5. When 0.15 g of an organic compound was analyzed using Carius method for estimation of bromine, 0.2397 g of AgBr was obtained. The percentage of bromine in the organic compound is _____. (Nearest integer)

[Atomic mass : Silver = 108, Bromine = 80]

Official Ans. by NTA (68)

Sol. Moles of Br = Moles of AgBr obtained

$\Rightarrow$ Mass of Br = $\frac{0.2397}{188}\times 80\text{g}$

therefore % Br in the organic compound

$$= \frac{W_{Br}}{W_T}\times 100$$

$$= \frac{0.2397\times 80}{188\times 0.15}\times 100 = 0.85\times 80$$

$= 68$

$\Rightarrow$ Nearest integer is '68'

6. 100 ml of 0.0018% (w/v) solution of Cl^- ion was the minimum concentration of Cl^- required to precipitate a negative sol in one h. The coagulating value of Cl^- ion is _____ (Nearest integer)

Official Ans. by NTA (1)

7. $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$

In the above first order reaction the concentration of PCl_5 reduces from initial concentration 50 mol L^{-1} to 10 mol L^{-1} in 120 minutes at 300 K. The rate constant for the reaction at 300 K is x × 10^{-2} min^{-1}. The value of x is _____. [Given log5 = 0.6989]

Official Ans. by NTA (1)

Sol. $PCl_{5(g)} \xrightarrow[300K]{\text{I order}} PCl_{3(g)} + Cl_{2(g)}$

t = 0 $\quad$ 50 M

t = 120 min $\quad$ 10 M

$$\Rightarrow K = \frac{2.303}{t}\log\frac{[A_0]}{[A_t]}$$

$$\Rightarrow K = \frac{2.303}{120}\log\frac{50}{10}$$

$$\Rightarrow K = \frac{2.303}{120}\times 0.6989 = 0.013413\ min^{-1}$$

$= 1.3413 \times 10^{-2}\ min^{-1}$

1.34 $\Rightarrow$ Nearest integer = 1

8. Diamond has a three dimensional structure of C atoms formed by covalent bonds. The structure of diamond has face centred cubic lattice where 50% of the tetrahedral voids are also occupied by carbon atoms. The number of carbon atoms present per unit cell of diamond is _____.

Official Ans. by NTA (8)

Sol. Carbon atoms occupy FCC lattice points as well as half of the tetrahedral voids

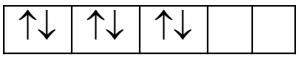
therefore number of carbon atoms atoms per unit cell = 8

9. An aqueous solution of $NiCl_2$ was heated with excess sodium cyanide in presence of strong oxidizing agent to form $[Ni(CN)_6]^{2-}$. The total change in number of unpaired electrons on metal centre is _____.

Official Ans. by NTA (2)

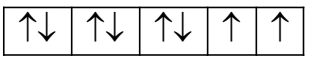
Sol. $[Ni(CN)_6]^{2-}$

$Ni^{+4} \rightarrow d^6$ strong field ligand



Pairing will be there zero unpaired electron

$NiCl_2 \rightarrow Ni^{2+} \rightarrow d^8$

 $\rightarrow$ two unpaired e^-

Change = 2

10. Potassium chlorate is prepared by electrolysis of KCl in basic solution as shown by following equation.

$6OH^- + Cl^- \rightarrow ClO_3^- + 3H_2O + 6e^-$

A current of xA has to be passed for 10h to produce 10.0g of potassium chlorate. the value of x is _____. (Nearest integer)

(Molar mass of $KClO_3$ = 122.6 g mol^{-1},

F = 96500 C)

Official Ans. by NTA (1)

Sol. Given balanced equation is

$$\overset{1}{6}0H + \overset{1}{Cl} \longrightarrow ClO_3^- + 3H_2O + 6e^-$$

$\rightarrow$ 10g $KClO_3 \Rightarrow \dfrac{10}{122.6}$ mol KCO_3 in obtained

$\rightarrow$ from the above reaction, it is concluded that by 6F charge 1 mol $KClO_3$ is obtained.

$\rightarrow$ By the passage of 6F charge = 1 mol $KClO_3$

$\therefore$ By the passage of $\dfrac{x \times 10 \times 60 \times 60}{96500}$ F charge

$$= \frac{1}{6} \times \frac{x \times 10 \times 60 \times 60}{96500}$$

Now $\dfrac{x \times 10 \times 60 \times 60}{6 \times 96500} = \dfrac{10}{122.6}$

$$\Rightarrow x = \frac{10 \times 965}{60 \times 122.6} = \frac{965}{735.6} = 1.311 \simeq 1$$

OR

$$W = \frac{E}{F} \times I \times t$$

$$10 = \frac{122.6}{96500 \times 6} \times x \times 10 \times 3600$$

X = 1.311

Ans.(1)