CHEMISTRY

SECTION-A

1. According to the valence bond theory the hybridization of central metal atom is dsp^2 for which one of the following compounds?

(1) $NiCl_2.6H_2O$ (2) $K_2[Ni(CN)_4]$

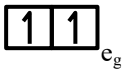
(3) $[Ni(CO)_4]$ (4) $Na_2[NiCl_4]$

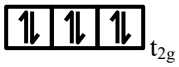
Official Ans. by NTA (2)

Sol. 1) $NiCl_2.6H_2O$

$Ni^{+2} \rightarrow [Ar]_{18}3d^8 4s^0$

C.N. = 6 octahedral

splitting  Hybridisation sp^3d^2



2) $K_2[Ni(CN)_4]$

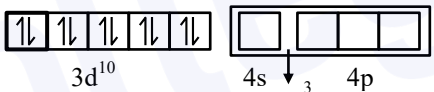
C.N. 4 $Ni^{+2} \rightarrow [Ar]_{18}3d^8 4s^0$

$CN^- \rightarrow$ Strong field ligand  Hybridisation dsp^2

Square planar splitting 

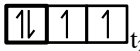
3) $Ni(CO)_4$

CO - Strong field ligand

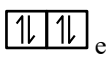
$Ni \rightarrow [Ar]_{18}$ 

Hybridisation

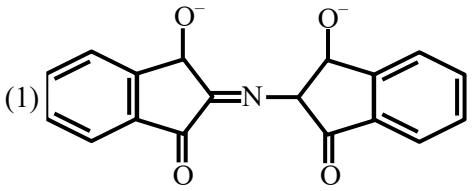
4) $Na_2[NiCl_4]$ $Ni \rightarrow [Ar]_{18}3d^8 4s^0$

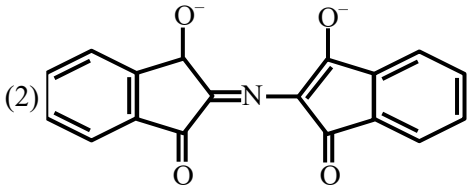
$Cl^{\ominus} \rightarrow$ weak field ligand  Hybridisation sp^3

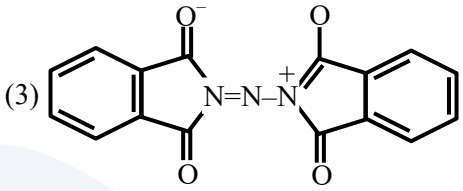
C.N. 4

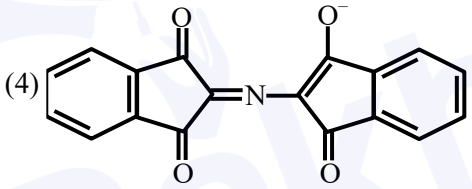
tetrahedral splitting 

2. The correct structure of Rhumann's Purple, the compound formed in the reaction of ninhydrin with proteins is :

(1) 

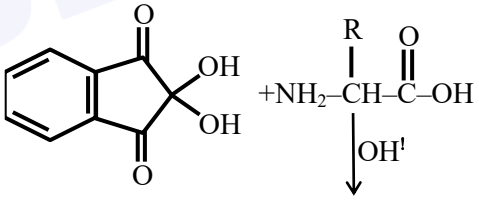
(2) 

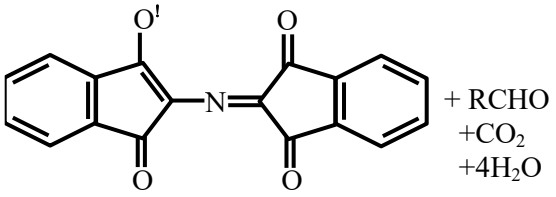
(3) 

(4) 

Official Ans. by NTA (4)

Sol.





Ninhydrin Test

3. Green chemistry in day–to–day life is in the use of:

(1) Chlorine for bleaching of paper

(2) Large amount of water alone for washing clothes

(3) Tetrachloroethene for laundry

(4) Liquified CO_2 for dry cleaning of clothes

Official Ans. by NTA (4)

Sol. Chlorine gas was used earlier for bleaching paper. These days, hydrogen peroxide (H_2O_2) with suitable catalyst.

Tetra chlroroethene ($Cl_2C=CCl_2$) was earlier used as solvent for dry cleaning. The compound contaminates the ground water and is also a suspected carcinogen. Replacement of halogenated solvent by liquid CO_2 will result in less harm to groundwater.

Hence given statement (4) is correct.

4. The correct order of intensity of colors of the compounds is :

(1) $[Ni(CN)_4]^{2-} > [NiCl_4]^{2-} > [Ni(H_2O)_6]^{2+}$

(2) $[Ni(H_2O)_6]^{2+} > [NiCl_4]^{2-} > [Ni(CN)_4]^{2-}$

(3) $[NiCl_4]^{2-} > [Ni(H_2O)_6]^{2+} > [Ni(CN)_4]^{2-}$

(4) $[NiCl_4]^{2-} > [Ni(CN)_4]^{2-} > [Ni(H_2O)_6]^{2+}$

Official Ans. by NTA (3)

Sol. $[NiCl_4]^{2-} > [Ni(H_2O)_6]^{2+} > [Ni(CN)_4]^{2-}$

Splitting $\Delta_t < \Delta_0 < \Delta_{sq}$ energy order

absorbed $[NiCl_4]^{2-} < [Ni(H_2O)_6]^{2+} < [Ni(CN)_4]^{2-}$ energy order

intensity of $[NiCl_4]^{2-} > [Ni(H_2O)_6]^{2+} > [Ni(CN)_4]^{2-}$ colour of compound

5. The set in which compounds have different nature is :

(1) $B(OH)_3$ and H_3PO_3

(2) $B(OH)_3$ and $Al(OH)_3$

(3) NaOH and $Ca(OH)_2$

(4) $Be(OH)_2$ and $Al(OH)_3$

Official Ans. by NTA (2)

Sol. 1) $B(OH)_3$ acidic and H_3PO_3 acidic

2) $B(OH)_3$ acidic and $Al(OH)_3$ amphoteric

3) NaOH basic and $Ca(OH)_2$ basic

4) $Be(OH)_2$ amphoteric and $Al(OH)_3$ amphoteric

6. The species given below that does NOT show disproportionation reaction is :

(1) BrO_4^- (2) BrO^-

(3) BrO_2^- (4) BrO_3^-

Official Ans. by NTA (1)

Sol. In $BrO_4^{\ominus}$, Br is in highest oxidation state (+7), So it cannot oxidise further hence it cannot show disproportionation reaction.

7. Given below are two statements. One is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : Sharp glass edge becomes smooth on heating it upto its melting point.

Reason R : The viscosity of glass decreases on melting.

Choose the most appropriate answer from the options given below.

(1) **A** is true but **R** is false

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

(3) **A** is false but **R** is true.

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

Official Ans. by NTA (2)

Sol. Hence given statement (A) is not correct

But statement (B) is correct

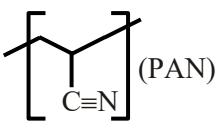
8. Orlon fibres are made up of :

(1) Polyacrylonitrile (2) Polyesters

(3) Polyamide (4) Cellulose

Official Ans. by NTA (1)

Sol. → orlon fibers are made up of Polyacrylonitrile



(PAN)

9. Given below are two statements : One is labelled as **Assertion A** and other is labelled as **Reason R**.

Assertion A : The dihedral angles in H_2O_2 in gaseous phase is 90.2° and in solid phase is 111.5°.

Reason R : The change in dihedral angle in solid and gaseous phase is due to the difference in the intermolecular forces.

Choose the most appropriate answer from the options given below for **A** and **R**.

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

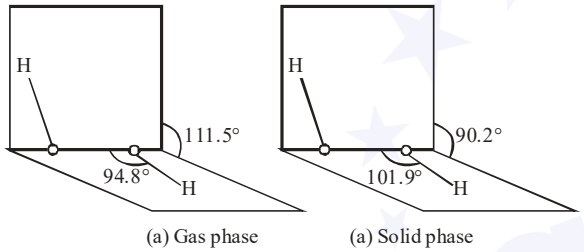
(2) Both **A** and **R** are correct but R is not the correct explanation of A.

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

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

Official Ans. by NTA (4)

Sol.



(a) Gas phase (a) Solid phase

(a) H_2O_2 structure in gas phase, dihedral angle is 111.5°. (b) H_2O_2 structure in solid phase at 110K, dihedral angle is 90.2°.

Hence given statement (A) is not correct But statement (B) is correct.

10. Chemical nature of the nitrogen oxide compound obtained from a reaction of concentrated nitric acid and P_4O_{10} (in 4 : 1 ratio) is :

(1) acidic (2) basic

(3) amphoteric (4) neutral

Official Ans. by NTA (1)

Sol. $4HNO_3 + P_4O_{10}$

$\downarrow$

$2N_2O_5 + (HPO_3)_4$

Ans. N_2O_5 is acidic in nature.

11. An inorganic Compound 'X' on treatment with concentrated H_2SO_4 produces brown fumes and gives dark brown ring with $FeSO_4$ in presence of concentrated H_2SO_4. Also Compound 'X' gives precipitate 'Y', when its solution in dilute HCl is treated with H_2S gas. The precipitate 'Y' on treatment with concentrated HNO_3 followed by excess of NH_4OH further gives deep blue coloured solution, Compound 'X' is:

(1) $Co(NO_3)_2$ (2) $Pb(NO_2)_2$

(3) $Cu(NO_3)_2$ (4) $Pb(NO_3)_2$

Official Ans. by NTA (3)

Sol. $\underset{\text{(Anion)}}{\underset{X}{NO_3^-}} + \underset{\text{(Conc.)}}{H_2SO_4} \rightarrow \underset{\text{Brown fumes}}{NO_2\uparrow} + H_2O$

$\underset{Sol^n}{FeSO_4} + \underset{\text{conc.}}{H_2SO_4} + \underset{X}{NO_3^-}$

$\downarrow$

$[Fe(H_2O)_5(NO)]SO_4$

(Dark brown ring)

Cu^{2+} + (dil HCl + H_2S)

$\underset{\text{(cation)}}{X}$ (Group-II reagent)

$\downarrow$

CuS↓

(Black ppt)

(Y)

$\underset{(Y)}{CuS} \xrightarrow[HNO_3]{\text{Conc}^n} \overset{\text{Soluble}}{Cu(NO_3)_2} + NO_2 + S + H_2O$

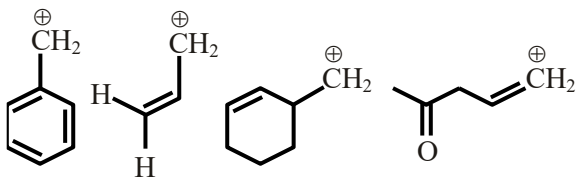
$\downarrow$ Excess NH_4OH Sol^n.

$[Cu(NH_3)_4]^{2+}$

Deep blue colour solution.

$\therefore X \rightarrow Cu(NO_3)_2$

12.



(A) (B) (C) (D)

Among the given species the Resonance stabilised carbocations are:

(1) (C) and (D) only

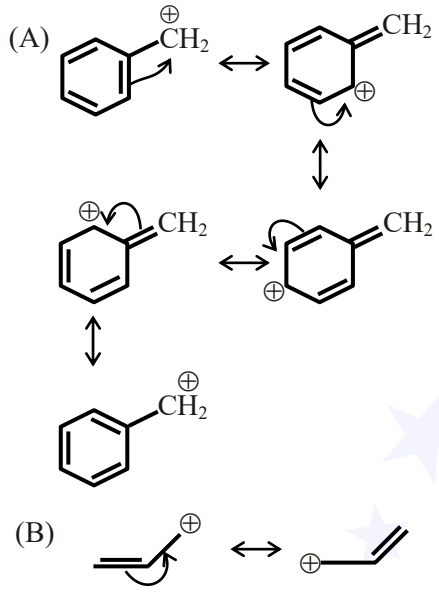
(2) (A), (B) and (D) only

(3) (A) and (B) only

(4) (A), (B) and (C) only

Official Ans. by NTA (3)

Sol. (A) and (B) only in Resonance



13. A s-block element (M) reacts with oxygen to form an oxide of the formula MO_2. The oxide is pale yellow in colour and paramagnetic. The element (M) is:

(1) Mg (2) Na (3) Ca (4) K

Official Ans. by NTA (4)

Sol. (A) $2Mg + O_2 \rightarrow 2MgO$ (Diamagnetic)

(B) $2Na + O_2 \rightarrow Na_2O$ (Diamagnetic)

$2Na + \underset{(excess)}{O_2} \rightarrow Na_2O_2$ (Diamagnetic)

(C) $2Ca + O_2 \rightarrow 2CaO$ (Diamagnetic)

$Ca + O_2 \rightarrow CaO_2$(Diamagnetic)

(D) $K + \underset{(excess)}{O_2} \rightarrow KO_2$ (Paramagnetic)

14. In the given reaction 3-Bromo-2, 2-dimethyl butane $\xrightarrow{C_2H_5OH}$ $\underset{(Major\ Product)}{'A'}$ Product A is:

(1) 2-Ethoxy-3, 3-dimethyl butane

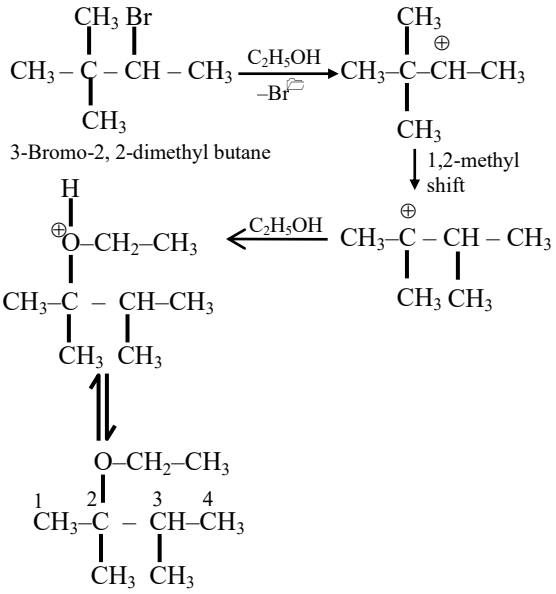
(2) 1-Ethoxy-3, 3-dimethyl butane

(3) 2-Ethoxy-2, 3-dimethyl butane

(4) 2-Hydroxy-3, 3-dimethyl butane

Official Ans. by NTA (3)

Sol.



3-Bromo-2, 2-dimethyl butane

2 Ethoxy –2,3–dimethyl butane

15. The metal that can be purified economically by fractional distillation method is:

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

Official Ans. by NTA (2)

Sol. Zinc can be purified economically by fractional distillation.

16. Compound A is converted to B on reaction with $CHCl_3$ and KOH. The compound B is toxic and can be decomposed by C. A, B and C respectively are :

(1) primary amine, nitrile compound, conc. HCl

(2) secondary amine, isonitrile compound, conc. NaOH

(3) primary amine, isonitrile compound, conc. HCl

(4) secondary amine, nitrile compound, conc. NaOH

Official Ans. by NTA (3)

Sol.

$$\underset{\text{1° amine}}{\underset{(A)}{R-NH_2}} \xrightarrow{CHCl_3} \underset{(Isonitrile)}{\underset{(B)}{R-N\equiv C}} \xrightarrow[(HCl)]{H_3O^{\oplus}} \underset{(C)}{R\text{-}NH_2} + HCOOH$$

17. The conditions given below are in the context of observing Tyndall effect in colloidal solutions:

(A) The diameter of the colloidal particles is comparable to the wavelength of light used.

(B) The diameter of the colloidal particles is much smaller than the wavelength of light used.

(C) The diameter of the colloidal particles is much larger than the wavelength of light used.

(D) The refractive indices of the dispersed phase and the dispersion medium are comparable.

(E) The dispersed phase has a very different refractive index from the dispersion medium.

Choose the most appropriate conditions from the options given below:

(1) (A) and (E) only (2) (C) and (D) only

(3) (A) and (D) only (4) (B) and (E) only

Official Ans. by NTA (1)

Sol. The phenomenon of scattering of light by colloidal particles as a result of which the path of the beam becomes visible is called a tyndall effect.

smaller the diameter and similar the magnitude of refractive indices, lesser is the scattering and hence the tyndall effect and viced-versa.

The diameter of the dispersed phase particle should not be smaller than the wavelength of light used because they won't be able to scatter the light so, therefore, the diameter of the dispersed particles should be equal or not much smaller than the wavelength of the light used.

2. The refractive indies (i.e. the ratio of the velocity of light in vacuum to the velocity of light in any medium) of the dispersed phase and the dispersion medium should differ greatly in magnitude than only the particles will be able to scatter the light and tyndall effect will be obersved. On the other hand, if the refractive indices of the dispersed phase and dispersion medium are almost similar in magnitude, then there will be no scattering of light and hence, therefore, no tyndall effect effect is observed.

Hence answer A and E are correct.

18. Identify the incorrect statement from the following

(1) Amylose is a branched chain polymer of glucose

(2) Starch is a polymer of α-D glucose

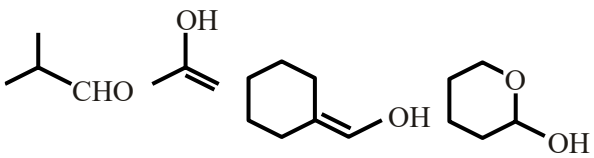
(3) β-Glycosidic linkage makes cellulose polymer

(4) Glycogen is called as animal starch

Official Ans. by NTA (1)

Sol. Amylose is a linear chain polymer of α-D-glucose while amylopectine is branched chain polymer of α-D-glucose.

19.



(I) (II) (III) (IV)

Which among the above compound/s does/do not form Silver mirror when treated with Tollen's reagent?

(1) (I), (III) and (IV) only

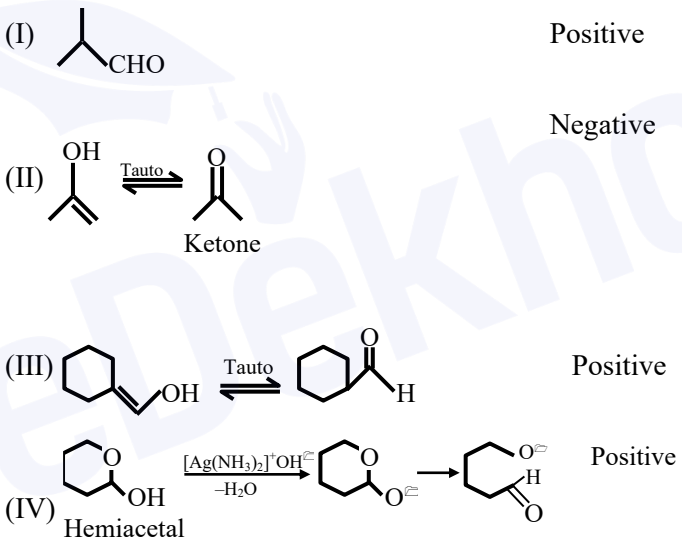
(2) Only (IV)

(3) Only (II)

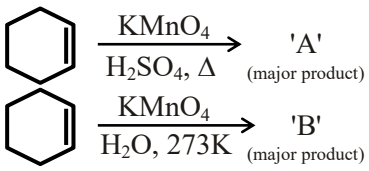
(4) (III) and (IV) only

Official Ans. by NTA (3)

Sol. Aldehydes give ⊕ve Tollen's Test (Silver mirror test)



20.



For above chemical reactions, identify the correct statement from the following:

(1) Both compound 'A' and compound 'B' are dicarboxylic acids

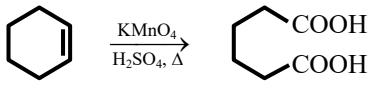
(2) Both compound 'A' and compound 'B' are diols

(3) Compound 'A' is diol and compound 'B' is dicarboxylic acid

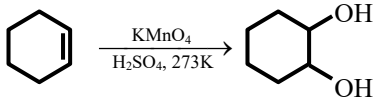
(4) Compound 'A' is dicarboxylic acid and compound 'B' is diol

Official Ans. by NTA (4)

Sol.



dicarboxylic acid
(A)



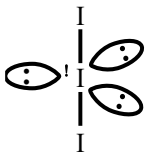
Diol
(B)

SECTION-B

1. The number of lone pairs of electrons on the central I atom in I_3^- is _____.

Official Ans. by NTA (3)

Sol. I_3^- :



The number of lone pairs of electron on the central atom is 3.

2. 250 mL of 0.5 M NaOH was added to 500 mL of 1 M HCl. The number of unreacted HCl molecules in the solution after complete reaction is _____ $\times 10^{21}$. (Nearest integer)

($N_A = 6.022 \times 10^{23}$)

Official Ans. by NTA (226)

Sol. We known that no. of moles = $V_{litre} \times$ Molarity

& No. of millimoles = $V_{ml} \times$ Molarity

so millimoles of NaOH = 250×0.5

$= 125$

Millimoles of HCl = $500 \times 1 = 500$

Now reaction is

$$NaOH + HCl \rightarrow NaCl + H_2O$$

t = 0	125	500	0	0
t = t	0	375	125	125

so millimoles of HCl left = 375

Moles of HCl = 375×10^{-3}

No. of HCl molecules = $6.022 \times 10^{23} \times 375 \times 10^{-3}$

$= 225.8 \times 10^{21}$

$\simeq 0^{21} = 226$

3. The Azimuthal quantum number for the valence electrons of Ga^+ ion is _____.

(Atomic number of Ga = 31)

Official Ans. by NTA (0)

Sol. $Ga^+ : Is^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2$

The azimuthal quantum number for the valence electrons (4s-subshell) of Ga+ ion is zero(0).

4. The spin-only magnetic moment value for the complex $[Co(CN)_6]^{4-}$ is _____ BM.

[At. no. of Co = 27]

Official Ans. by NTA (2)

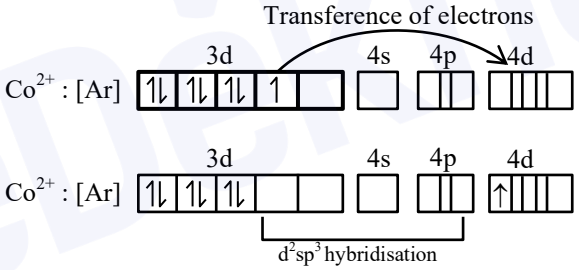
Sol. $[Co(CN)_6]^{4-}$

$x + 6 \times (-1) = -4$

$\boxed{x = +2}$

$Co^{2+} : [Ar]\ 3d^7$

and CN^- is a strong field ligand which can pair electron of central atom.



It has one unpaired electron (n) in 4d-subshell.

So spin only magnetic moment (μ) = $\sqrt{n(n+2)}$ B.M

where n = number of unpaired electrons.

$\mu = \sqrt{3}$ B.M

$\boxed{\mu = 1.73\,BM}$

5. $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

In an equilibrium mixture, the partial pressures are $P_{SO_3} = 43$ kPa ; $P_{O_2} = 530$ Pa and $P_{SO_2} = 45$ kPa. The equilibrium constant K_P = _____ $\times 10^{-2}$. (Nearest integer)

Official Ans. by NTA (172)

Sol. $2SO_{2(g)} + O_{2(g)} = 2SO_{3(g)}$

$$K_P = \frac{(pSO_{3(g)})^2}{pSO2(g)} \times pO_{2(g)}$$

$$= \frac{43 \times 43}{45 \times 45} \times 530 \text{ Pa}^{-1}$$

$= 172.28 \times 10^{-5}$ Pa^{-1}

$= 172.28$ atm

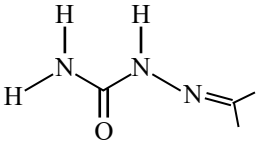
$= 17228 \times 10^{-2}$ atm

Ans is 17228

6. The number of nitrogen atoms in a semicarbazone molecule of acetone is _____.

Official Ans. by NTA (3)

Sol.

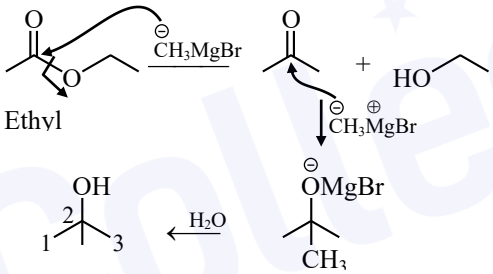


Semicarbazone molecule of acetone

7. To synthesise 1.0 mole of 2-methylpropan-2-ol from Ethylethanoate _____ equivalents of CH_3MgBr reagent will be required. (Integer value)

Official Ans. by NTA (2)

Sol.



Ethyl

2-Methylpropan-2-ol

8. The inactivation rate of a viral preparation is proportional to the amount of virus. In the first minute after preparation, 10% of the virus is inactivated. The rate constant for viral inactivation is _____ $\times 10^{-3}$ min^{-1}. (Nearest integer)

[Use : ln 10 = 2.303 ; $\log_{10} 3 = 0.477$;

property of logarithm : $\log x^y = y \log x$]

Official Ans. by NTA (106)

Sol. As the unit of rate constant is min^{-1} so it must be a first order reaction

$K \times t = 2.303 \log A_0/A_t$

in 1 min 10% is in activated so tabing

$A_0 = 100$ $A_t = 90$ in 1 min

$$\text{So } K \times 1 = 2.303 \times \log \frac{100}{90}$$

$= 2.303 \times (\log 10 - 2\log 3)$

$= 2.303 \times (1 - 2 \times 0.477)$

$= 0.10593$

$= 105.93 \times 10^{-3}$

≈ 106

9. An average person needs about 10000 kJ energy per day. The amount of glucose (molar mass = 180.0 g mol^{-1}) needed to meet this energy requirement is _____ g.

(Use : $\Delta_C H$(glucose) = –2700 kJ mol^{-1})

Official Ans. by NTA (667)

Sol. 1 mole glucose give 2700 kJ energy

so mole of glucose needed for 10^5 kJ energy

$$= \frac{10000}{2700} = 370 \text{ moles}$$

wt. of glucose $= 3.10 \times 180$

$= 666.666$

≈ 667 gm

$$\frac{Y_{\text{Benzene}}}{Y_{\text{M.B}}} = \frac{P_B^0 X_B}{P_{MB}^0 X_{MB}} = \frac{70 \times 1}{20 \times 1} = \frac{7}{2}$$

$$Y_{\text{Benzene}} = \frac{7}{9} = 77.77 \times 10^{-2}$$

$= 78 \times 10^{-12}$

10. At 20°C, the vapour pressure of benzene is 70 torr and that of methyl benzene is 20 torr. The mole fraction of benzene in the vapour phase at 20°C above an equimolar mixture of benzene and methyl benzene is _____ $\times 10^{-2}$. (Nearest integer)

Official Ans. by NTA (78)

Sol. $P_B^o = 40$ $P_T^o = 20$ $K_B = 0.5 = K_T$

Now $$y_B = \frac{K_B P_B^o}{K_B P_B^o + K_T P_T^o}$$

$$= \frac{70 \times 0.5}{70 \times 0.5 + 20 \times 0.5}$$