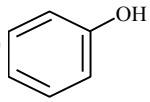
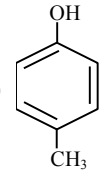
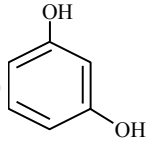
FINAL JEE–MAIN EXAMINATION – AUGUST, 2021
Held On Thrusday 26th August, 2021
TIME: 3:00 PM to 06:00 PM

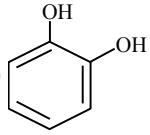
SECTION-A

1. Which one of the following phenols does not give colour when condensed with phthalic anhydride in presence of conc. H_2SO_4 ?

(1) 

(2) 

(3) 

(4) 

Official Ans. by NTA (2)

Sol. Only p-methyl, phenol does not give any colour with phthalic anhydroxide with cons. H_2SO_4.

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

Assertion (A) : Photochemical smog causes cracking of rubber.

Reason (R) : Presence of ozone, nitric oxide, acrolein, formaldehyde and peroxyacetyl nitrate in photochemical smog makes it oxidizing.

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

(1) Both **(A)** and **(R)** are true but **(R)** is not the true explanation of **(A)**

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

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

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

Official Ans. by NTA (4)

Sol. Photochemical smog causes cracking of rubber, the common component of photochemical smog are ozone, nitric oxide, acrolein, formaldehyde and peroxyacetyle nitrate (PAN).

3. The interaction energy of London forces between two particles is proportional to r^x, where r is the distance between the particles. The value of x is :

(1) 3 (2) –3

(3) –6 (4) 6

Official Ans. by NTA (3)

Sol. For london dispersion forces.

$$E \propto \frac{1}{r^6}$$

Hence x = –6

4. The number of non-ionisable hydrogen atoms present in the final product obtained from the hydrolysis of PCl_5 is :

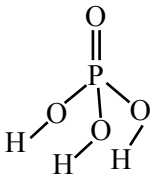
(1) 0 (2) 2 (3) 1 (4) 3

Official Ans. by NTA (1)

Sol. $PCl_5 + H_2O \rightarrow POCl_3 + 2HCl$

$\downarrow + 3H_2O$

$H_3PO_4 + 3HCl$

In  + HCl

all hydrogens are ionisable

$\therefore$ Ans is zero.

5. The bond order and magnetic behaviour of O_2^- ion are, respectively :

(1) 1.5 and paramagnetic

(2) 1.5 and diamagnetic

(3) 2 and diamagnetic

(4) 1 and paramagnetic

Official Ans. by NTA (1)

Sol. $O_2^- = (\sigma_{1s})^2(\sigma_{1s}^*)^2(\sigma_{2s})^2(\sigma_{2s}^*)^2(\sigma_{2p_z})^2$

$\left(\pi_{2p_x}^2 = \pi_{2p_y}^2\right)\left(\pi_{2p_x}^{*2} = \pi_{2p_y}^{*1}\right)$

Bond order $= \frac{10-7}{2} = 1.5$

and paramagnetic

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

Assertion (A) : Sucrose is a disaccharide and a non-reducing sugar.

Reason (R) : Sucrose involves glycosidic linkage between C_1 of β-glucose and C_2 of α-fructose.

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

(1) Both **(A)** and **(R)** are true but **(R)** is not the true explanation of **(A)**

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

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

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

Official Ans. by NTA (3)

Sol. Surcrose is example of disaccharide & non reducing sugar

Assertion : correct

Sucrose involves glycosidic linkage between C_1 of α-D-glucose C_2 of β-D-fructose

Reason : Incorrect

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

List-I (Chemical Reaction)	**List-II (Reagent used)**
(a) $CH_3COOCH_2CH_3 \rightarrow CH_3CH_2OH$	(i) CH_3MgBr / H_3O^+ (1.equivalent)
(b) $CH_3COOCH_3 \rightarrow CH_3CHO$	(ii) H_2SO_4 / H_2O
(c) $CH_3C \equiv N \rightarrow CH_3CHO$	(iii) DIBAL-H/H_2O
(d) $CH_3C \equiv N \rightarrow CH_3{-}C(=O){-}CH_3$	(iv) $SnCl_2$, HCl/H_2O

Choose the most appropriate match :

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

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

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

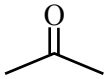
(4) a-iii, b-ii, c-i, d-iv

Official Ans. by NTA (3)

Sol. $CH_3{-}C(=O){-}O{-}CH_2CH_3 \xrightarrow{H_3O^+} CH_3CO_2H + CH_3CH_2OH$

$CH_3{-}C(=O){-}O{-}CH_3 \xrightarrow[-78^\circ C]{DIBALH/H_2O} CH_3CHO$

$CH_3{-}CN \xrightarrow[/H_2O]{SnCl_2+HCl} CH_3CH{=}O$

$CH_3{-}C{\equiv}N \xrightarrow[/H_3O^+]{CH_3MgBr\ (1eq)}$ 

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

Assertion (A) : Barium carbonate is insoluble in water and is highly stable.

Reason (R) : The thermal stability of the carbonates increases with increasing cationic size.

(1) Both **(A)** and **(R)** are true but **(R)** is the true explanation of **(A)**

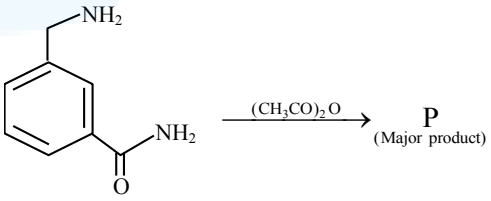
(2) **(A)** is true but **(R)** is false

(3) Both **(A)** and **(R)** are true and **(R)** is not the true explanation of **(A)**

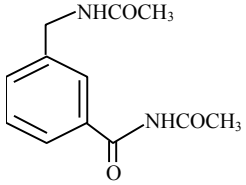
(4) **(A)** is false but **(R)** is true.

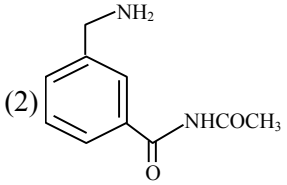
Official Ans. by NTA (1)

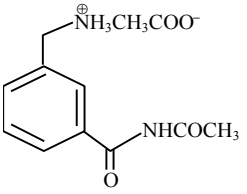
Sol. In IIA group on moving down the group size of cation increases and show thermal stability of carbonate increases.

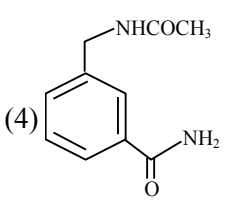
9. 

The major product in the above reaction is :

(1) 

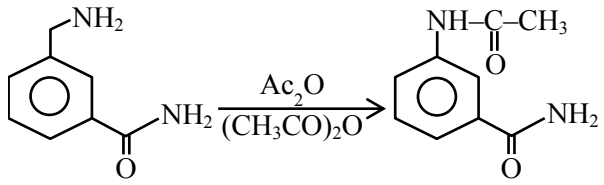
(2) 

(3) 

(4) 

Official Ans. by NTA (4)

Sol.



10. Indicate the complex/complex ion which did not show any geometrical isomerism :

(1) $[CoCl_2(en)_2]$ (2) $[Co(CN)_5(NC)]^{3-}$

(3) $[Co(NH_3)_3(NO_2)_3]$ (4) $[Co(NH_3)_4Cl_2]^+$

Official Ans. by NTA (2)

Sol. (1) $[CoCl_2(en)_2]$ show
Cis-trans isomerism

(2) $[Co(CN)_5(NC)]^{-3}$ can't
Show G.I.

(3) $[Co(NH_3)_3(NO_2)_3]$
Show fac & mer isomerism

(4) $[Co(NH_3)_4Cl_2]^{\oplus}$ show cis & trans isomerism

11. The sol given below with negatively charged colloidal particles is :

(1) $FeCl_3$ added to hot water

(2) KI added to $AgNO_3$ solution

(3) $AgNO_3$ added to KI solution

(4) $Al_2O_3.xH_2O$ in water

Official Ans. by NTA (3)

Sol.

12. Given below are two statements :

Statement I : Sphalerite is a sulphide ore of zinc and copper glance is a sulphide ore of copper.

Statement II : It is possible to separate two sulphide ores by adjusting proportion of oil to water or by using 'depressants' in a froth flotation method.

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 true.

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

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

Official Ans. by NTA (2)

Sol. Sphalerite-ZnS, copper glance - Cu_2S two sulphide ores can be separated by adjusting proportions of oil to water or by using ' Depressants '

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

Assertion (A) : Heavy water is used for the study of reaction mechanism.

Reason (R) : The rate of reaction for the cleavage of O - H bond is slower than that of O-D bond.

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

(1) Both **(A)** and **(R)** are true but **(R)** is not the true explanation of **(A)**.

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

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

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

Official Ans. by NTA (4)

Sol. D_2O in used for the study of reaction mechanism.
Rate of reaction for the cleavage of O–H bond > O-D bond.

14. Arrange the following Cobalt complexes in the order of increasing Crystal Field Stabilization Energy (CFSE) value.

Complexes : $\underset{A}{[CoF_6]^{3-}}, \underset{B}{[Co(H_2O)_6]^{2+}}, \underset{C}{[Co(NH_3)_6]^{3+}}$ and $[Co(en)_3]^{3+}$

Choose the **correct** option :

(1) A < B < C < D (2) B < A < C < D

(3) B < C < D < A (4) C < D < B < A

Official Ans. by NTA (2)

Sol. (i) CFSE $\propto$ charge or oxidation no. of central metal ion.

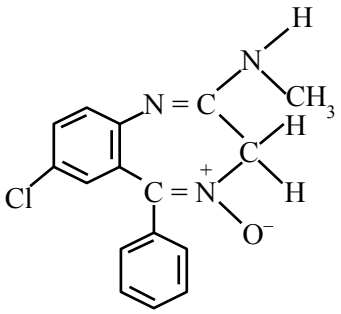
(ii) CFSE $\propto$ strength of ligand

en > NH_3 > H_2O > F^-

$\therefore$ order of CFSE

$$\overset{III}{[Co(en)_3]^{+3}} > \overset{III}{Co(NH_3)_6]^{+3}} > \overset{III}{[CoF_6]^{-3}} > \overset{II}{[Co(H_2O)_6]^{+2}}$$

15.



Chlordiazepoxide

The class of drug to which chlordiazepoxide with above structure belongs is :

(1) Antacid (2) Analgesic

(3) Tranquilizer (4) Antibiotic

Official Ans. by NTA (3)

Sol. The drug named chlordiate poxide is example of tranquilizer.

16. Chalcogen group elements are :

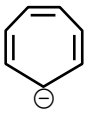
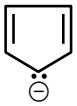
(1) Se, Tb and Pu. (2) Se, Te and Po.

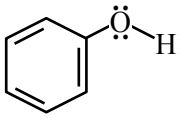
(3) S, Te and Pm. (4) O, Ti and Po.

Official Ans. by NTA (2)

Sol. Group 16/oxygen family is known as Chalcogens the members are O, S, Se, Te, Po

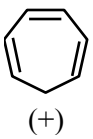
17. Which one of the following compounds is not aromatic ?

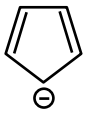
(1)  (2) 

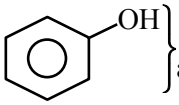
(3)  (4) 

Official Ans. by NTA (3)

Sol.  : Non aromatic


(+)

; 

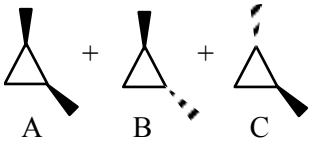
;  All are aromatic

18. The number of stereoisomers possible for 1,2-dimethyl cyclopropane is :

(1) One (2) Four

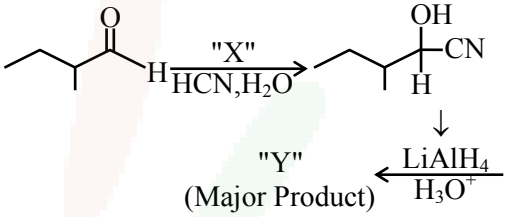
(3) Two (4) Three

Official Ans. by NTA (4)

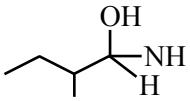
Sol. 

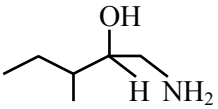
A B C

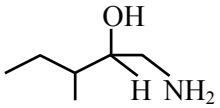
19.

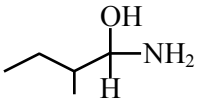


Consider the given reaction, Identify **'X'** and **'Y'** :

(1) X – NaOH Y – 

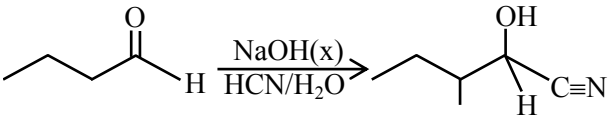
(2) X – HNO_3 Y – 

(3) X – NaOH Y – 

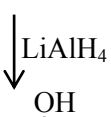
(4) X – HNO_3 Y – 

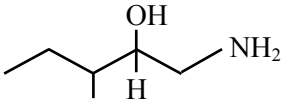
Official Ans. by NTA (3)

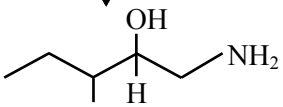
Sol.



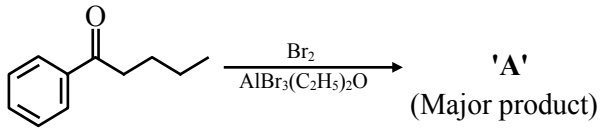
X ⇒ NaOH



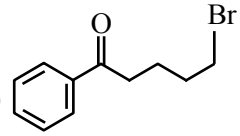
Y ⇒ 

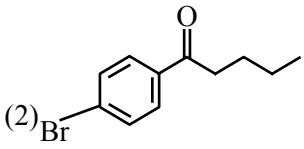


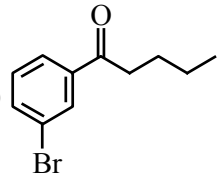
γ(major product)

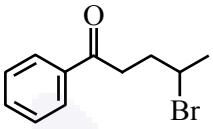
20. 

Consider the given reaction, the product **A** is :

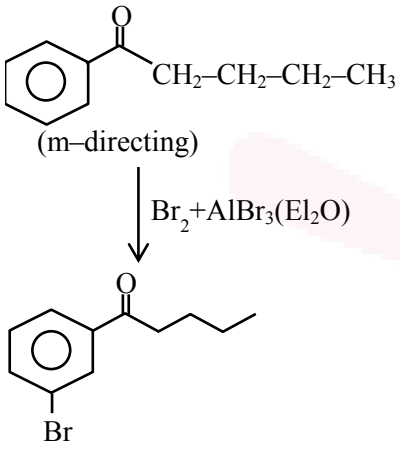
(1) 

(2) 

(3) 

(4) 

Official Ans. by NTA (3)

Sol. 

SECTION-B

1. In the sulphur estimation, 0.471 g of an organic compound gave 1.44 g of barium sulphate. The percentage of sulphur in the compound is _____%. (Nearest integer)

(Atomic Mass of Ba = 137 u)

Official Ans. by NTA (42)

Sol. Molecular mass of $BaSO_4$ = 233 g

$\because$ 233 $BaSO_4$ contain $\rightarrow$ 32 g sulphur

$\therefore$ 1.44 g $BaSO_4$ contain $\rightarrow \dfrac{32}{233} \times 1.44$ g sulphur

given : 0.471 g of organic compound

$$\% \text{ of S} = \frac{32 \times 1.44}{233 \times 0.471} \times 100 = 41.98\% \approx 42\%$$

OR

$$\underset{W_{OC}=0.471\,g}{\boxed{O.C.}} \longrightarrow \underset{1.44\,g}{BaSO_4}$$

$$\Rightarrow n_s = n_{BaSO_4} = \frac{1.44}{233}$$

$$\Rightarrow w_s = \frac{1.44}{233} \times 32g$$

$$\text{therefore } \%S = \frac{W_s}{W_{O.C.}} \times 100 = \frac{1.44 \times 32}{233 \times 0.471} \times 100$$

$$= \frac{46.08}{109.743} \times 100 = 41.98 \simeq 42$$

2. The equilibrium constant K_c at 298 K for the reaction $A + B \rightleftharpoons C + D$ is 100. Starting with an equimolar solution with concentrations of A, B, C and D all equal to 1M, the equilibrium concentration of D is_____ $\times 10^{-2}$ M. (Nearest integer)

Official Ans. by NTA (182)

Sol. $A + B \rightleftharpoons C + D : K_{eq} = 100$

1M 1M 1M 1M

First check direction of reversible reaction.

Since $Q_C = \dfrac{[C][D]}{[A][B]} = 1 < K_{eq.} \Rightarrow$ reaction will move in forward direction to attain equilibrium state.

$\Rightarrow A + B \rightleftharpoons C + D : K_{eq} = 100$

to 1 1 1 1

$t_{eq.}$ 1–x 1–x 1+x 1+x

$$\text{Now : } K_{eq} = 100 = \frac{(1+x)(1+x)}{(1-x)(1-x)}$$

$$\Rightarrow \boxed{100 = \left(\frac{1+x}{1-x}\right)^2}$$

(i) $10 = \left(\dfrac{1+x}{1-x}\right)$

$\Rightarrow 10 - 10x = 1+x$

$\Rightarrow 11x = 9$

$\Rightarrow \boxed{x = \dfrac{9}{11}}$

(ii) $-10 = \dfrac{1+x}{1-x}$

$\Rightarrow -10 + 10x = 1 + x$

$\Rightarrow -9x = -11$

$\Rightarrow \boxed{x = \frac{11}{9}}$

$\rightarrow$ 'x' cannot be more than one, therefore not valid.

therefore equation concretion of (D) = 1 + x

$$= 1 + \frac{9}{11} = \frac{20}{11}$$
$$= 1.8181 = 181.81 \times 10^{-2}$$
$$\simeq 182 \times 10^{-2}$$

3. For water Δ_{vap} H = 41 kJ mol^{-1} at 373 K and 1 bar pressure. Assuming that water vapour is an ideal gas that occupies a much larger volume than liquid water, the internal energy change during evaporation of water is_____kJ mol^{-1}

[Use : R = 8.3 J mol^{-1} K^{-1}]

Official Ans. by NTA (38)

Sol. Given equation is

$$H_2O(\ell) \longrightarrow H_2O(g) : \Delta H = 41 \ \frac{kJ}{mol}$$

$\Rightarrow$ From the relation : $\Delta H = \Delta U + \Delta n_g RT$

$$\Rightarrow 41 \frac{kJ}{mol} = \Delta U + (1) \times \frac{8.3}{1000} \times 373$$

$\Rightarrow$ DU = 41 – 3.0959

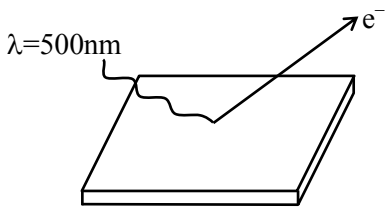
= 38 kJ/mol

4. A metal surface is exposed to 500 nm radiation. The threshold frequency of the metal for photoelectric current is 4.3 × 10^{14} Hz. The velocity of ejected electron is _____× 10^5 ms^{-1} (Nearest integer)

[Use : h = 6.63 × 10^{-34} Js, m_e = 9.0 × 10^{-31} kg]

Official Ans. by NTA (5)

Sol.



υ : speed of electron having max. K.E.

$\Rightarrow$ from Einstein equation : $E = \phi + K.E._{max}$

$$\Rightarrow \frac{hc}{\lambda} = h\upsilon_0 + \frac{1}{2}mv^2$$

$$\Rightarrow \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{500 \times 10^{-9}} = 6.63 \times 10^{-34} \times 4.3 \times 10^{14} + \frac{1}{2}mv^2$$

$$\Rightarrow \frac{6.63 \times 30 \times 10^{-20}}{5} = 6.63 \times 4.3 \times 10^{-20} + \frac{1}{2}mv^2$$

$$\Rightarrow 11.271 \times 10^{-20} \text{ J} = \frac{1}{2} \times 9 \times 10^{-31} \times \upsilon^2$$

$$\Rightarrow \boxed{\upsilon = 5 \times 10^5 \text{ m/sec.}}$$

5. For the galvanic cell,

$Zn(s) + Cu^{2+}$ (0.02 M) $\rightarrow Zn^{2+}$ (0.04 M) + Cu(s),

E_{cell} =_____ × 10^{-2} V. (Nearest integer)

[Use : $E^0_{Cu/Cu^{2+}}$ = –0.34 V, $E^0_{Zn/Zn^{2+}}$ =+0.76 V, $\frac{2.303\ RT}{F}$ = 0.059 V]

Official Ans. by NTA (109)

Sol. Galvanic cell:

$$Zn_{(s)} + \underset{0.02M}{Cu^{+2}_{(aq.)}} \rightarrow \underset{0.04M}{Zn^{+2}} + Cu(s)$$

Nernst equation = $F_{cell} = E^\circ_{cell} - \frac{0.059}{2}\log\frac{[2n^{+2}]}{[Cu^{+2}]}$

$$\Rightarrow E_{cell}\left[E^\circ_{cell} - E^\circ_{Zn^{+2}/Zn}\right] - \frac{0.059}{2}\log\frac{0.04}{0.02}$$

$$\Rightarrow E_{cell}\left[0.34 - (-0.76)\right] - \frac{0.059}{2}\log^2$$

$$\Rightarrow E_{cell}\,1 - 1 - \frac{0.059}{2} \times 0.3010$$
$$= 1.0911 = 109.11 \times 10^{-2}$$
$$= 109$$

6. 100 mL of Na_3PO_4 solution contains 3.45 g of sodium. The molarity of the solution is _____×10^{-2} mol L^{-1} . (Nearest integer)

[Atomic Masses - Na : 23.0 u, O : 16.0 u, P : 31.0 u]

Official Ans. by NTA (50)

Sol.

$\boxed{Na_3PO_4}$ 100ml Sol.

$$Na_3PO_4 \longrightarrow 3Na$$
$$\frac{1}{3} \times \frac{3.45}{23} \text{ mol} \qquad 3.45\text{g}$$
$$\frac{3.45}{23} \text{ mol}$$

therefore molarity of Na_3PO_4 Solution =

$$\frac{n_{Na_3PO_4}}{\text{volume of solution in L}}$$

$$= \frac{\frac{1}{3} \times \frac{3.45}{23} \text{mol}}{0.1 \text{L}}$$

$$= 0.5 = 50 \times 10^{-2}$$

7. The overall stability constant of the complex ion $[Cu(NH_3)_4]^{2+}$ is 2.1×10^{13}. The overall dissociations constant is $y \times 10^{-14}$. Then y is ____.(Nearest integer)

Official Ans. by NTA (5)

Sol. Given $k_f = 2.1 \times 10^{13}$

$$K_d = \frac{1}{k_f} = 4.7 \times 10^{-14}$$

$$\therefore y = 4.7 \approx 5$$

8. 83 g of ethylene glycol dissolved in 625 g of water. The freezing point of the solution is _____K. (Nearest integer)

[Use : Molal Freezing point depression constant of water = 1.86 K kg mol^{-1}]

Freezing Point of water = 273 K

Atomic masses : C : 12.0 u, O : 16.0 u, H : 1.0 u]

Official Ans. by NTA (269)

Sol. $k_f = 1.86$ k. kg/mol

$T_f^o = 273$ k

solvent : H_2O(625 g)

Solute : 83 g $\begin{pmatrix} CH_2 - CH_2 \\ | \quad\quad | \\ OH \quad\quad OH \end{pmatrix}$ $\Rightarrow$ Non dissociative solute

$$\Rightarrow \Delta T_f = k_f \times m$$

$$\Rightarrow \left(T_f^o - T_f^l\right) = 1.86 \times \frac{83/62}{624/1000}$$

$$\Rightarrow 273 - T_f^l = \frac{1.86 \times 83 \times 1000}{62 \times 625} = \frac{154380}{38750}$$

$$\Rightarrow 273 - T_f^l = 4$$

$$\Rightarrow \boxed{T_f^l = 259 \text{ K}}$$

9. The reaction rate for the reaction

$$[PtCl_4]^{2-} + H_2O \rightleftharpoons [Pt(H_2O)Cl_3]^- + Cl^-$$

was measured as a function of concentrations of different species. It was observed that

$$\frac{-d\left[[PtCl_4]^{2-}\right]}{dt} = 4.8 \times 10^{-5} \left[[PtCl_4]^{2-}\right] - 2.4 \times 10^{-3} \left[[Pt(H_2O)Cl_3]^-\right] \left[Cl^-\right].$$

where square brackets are used to denote molar concentrations. The equilibrium constant K_c=_____. (Nearest integer)

Official Ans. by NTA (50)

Sol. $[PtCl_4]^{-2} + H_2O \rightleftharpoons [Pt(H_2O)Cl_3]^- + Cl^-$

$$\frac{-d[Pt\ Cl_4]^{-2}}{dt} = 4.8 \times 10^{-5} [PtCl_4^{-2}] - 2.4 \times 10^3 [Pt(H_2O)Cl_3][\overset{o}{u}]$$

$$\Rightarrow K_{eq} = \frac{k_f}{k_b} = \frac{4.8 \times 10^{-5}}{2.4 \times 10^{-3}} = 0.02$$

10. A chloro compound "A".

(i) forms aldehydes on ozonolysis followed by the hydrolysis.

(ii) when vaporized completely 1.53 g of A, gives 448 mL of vapour at STP.

The number of carbon atoms in a molecule of compound **A** is _____.

Official Ans. by NTA (3)

Sol. 448 ml of A $\Rightarrow$ 1.53 gm A

22400 ml of A $\Rightarrow \frac{1.53}{445} \times 22400$ gm A = 7650

$$\underset{\text{It has 3 carbon atoms}}{H_3CHC{-}CH{-}Cl} \xrightarrow[Zn/H_2O]{O_3} \underset{\text{Aldehyde}}{CH_3{-}CH{=}O}$$

& mm is 36 + 5 + 35.5 = 76.5