

Solution

CHEMISTRY

JEE main - Chemistry

CHEMISTRY (Section-A)

1.

(b) 2 : 3

Explanation:

$$r = 0.529 \frac{n^2}{Z} \text{ \AA}$$

For Li^{2+} ,

$$(r_{\text{Li}^{2+}})_{n=4} - (r_{\text{Li}^{2+}})_{n=3} = \frac{0.529}{3} [4^2 - 3^2] = \Delta R_1$$

For He^+ ,

$$(r_{\text{He}^+})_{n=4} - (r_{\text{He}^+})_{n=3} = \frac{0.529}{2} [4^2 - 3^2] = \Delta R_2$$

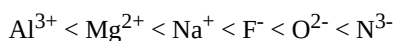
$$\frac{\Delta R_1}{\Delta R_2} = \frac{2}{3}$$

2. (a) $\text{Al}^{3+} < \text{Mg}^{2+} < \text{Na}^+ < \text{F}^- < \text{O}^{2-} < \text{N}^{3-}$

Explanation:

All are isoelectronic species, so more is the Z_{eff} less will be the ionic size.

\therefore Correct order of ionic radii is



3.

(d) decreases by 3 units

Explanation:

$$\Delta [\text{H}^+] = 1000$$

$$\Delta \text{pH} = -\log \Delta [\text{H}^+] = -\log 10^3$$

= -3; (-ve) sign indicates decrease in pH.

4.

(c) $C_p \ln \left[\frac{(T_1+T_2)^2}{4T_1T_2} \right]$

Explanation:

At the thermal equilibrium,

$$\text{final temperature } T_f = \frac{T_1+T_2}{2}$$

$$\Rightarrow \text{for the 1st block, } \Delta S_I = C_p \ln \frac{T_f}{T_1}$$

$$\Rightarrow \text{for the 2nd block, } \Delta S_{II} = C_p \ln \frac{T_f}{T_2}$$

When brought in contact with each other,

$$\Delta S = \Delta S_I + \Delta S_{II} = C_p \ln \frac{T_f}{T_1} + C_p \ln \frac{T_f}{T_2}$$

$$= C_p \ln \left(\frac{T_f}{T_1} \times \frac{T_f}{T_2} \right) = C_p \ln \left[\frac{T_f^2}{T_1T_2} \right]$$

$$= C_p \ln \left[\frac{\left(\frac{T_1+T_2}{2} \right)^2}{T_1T_2} \right] = C_p \ln \left[\frac{(T_1+T_2)^2}{4T_1T_2} \right]$$

5.

(b) 9.6

Explanation:

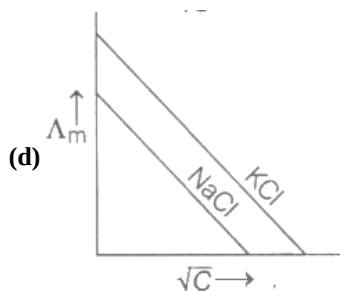
Given at 330 K, $K_w = 10^{-13.6}$

$$pK_w = pH + pOH \Rightarrow 13.6 = pH + pOH$$

$$pOH = -\log 10^{-4} \Rightarrow pOH = 4$$

$$\therefore pH = 13.6 - 4 = 9.6$$

6.



Explanation:

NaCl and KCl are strong electrolytes. So, the study of their molar conductances (λ_m) can be experimentally verified by Debye-Huckel Onsagar equation,

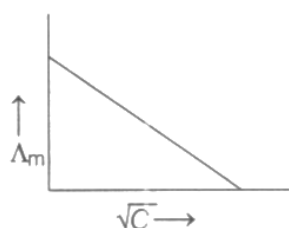
$$\Lambda_m^c = \Lambda_m^0 - B\sqrt{C}$$

Λ_m^c = molar conductance at concentration.

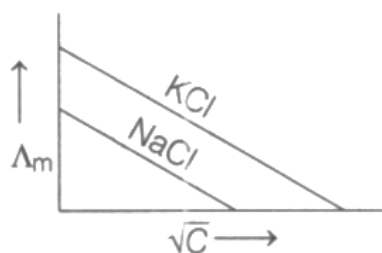
Λ_m^0 = molar conductance at infinite dilution, i.e. $C \rightarrow 0$

B = Debye-Huckel Onsagar constant.

For (both NaCl and KCl) a strong binary electrolyte like AB, the nature of the plot of Λ_m vs \sqrt{C} will be



Size of Na^{\oplus} is being smaller than K^{\oplus} and Na^{\oplus} will remain in the more hydrated state, i.e. larger sized in aqueous solution. As a result, ionic mobility as well as ionic conductance of Na^{\oplus} (or NaCl as Cl^{\ominus} is common to NaCl and KCl) will be lower than K^{\oplus} (or KCl). Thus, the plot of Λ_m vs \sqrt{C} for NaCl and KCl is as follows:

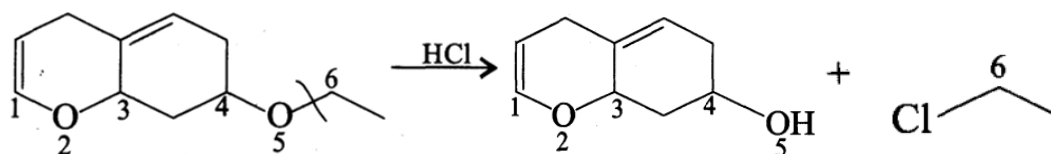


7. (a) O5-C6

Explanation:

The lone pair of electrons on O2 is involved in resonance with $C = C$. Hence O2 will not be protonated.

The lone pair of electrons on O5 is not involved in resonance with $C = C$. Hence, O5 will be protonated. Chloride ion will then attack least substituted C atom (C6).



8. (a) CrO_2Cl_2

Explanation:

Let x be the oxidation state of Mn in MnO_4^- .

Since the overall charge on the complex is -1 , the sum of oxidation states of all elements in it should be equal to -1 .

Therefore, $x + 4(-2) = -1$

or, $x = +7$

Hence, the oxidation state of Mn in MnO_4^- is $+7$.

Similarly,

The oxidation state of Cr in $[Cr(CN)_6]^{3-}$, Ni in NiF_6^{6-} and Cr in CrO_2Cl_2 is $+3$, $+4$ and $+6$ respectively.

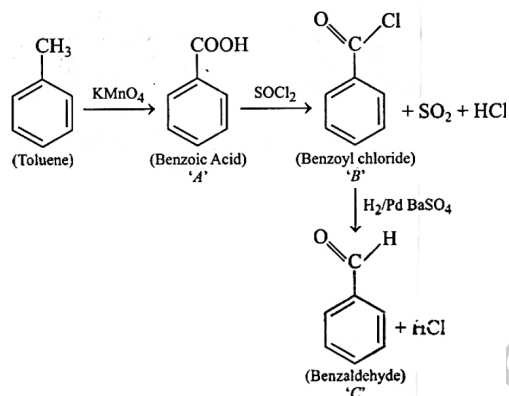
Hence, the species with an atom in $+6$ oxidation state is CrO_2Cl_2 .

9.

(b) C_6H_5CHO

Explanation:

Toluene undergoes oxidation with $KMnO_4$, forms benzoic acid. In this conversion, alkyl part of toluene converts into carboxylic group. Further, benzoic acid reacts with thionyl chloride ($SOCl_2$) to give benzoyl chloride which upon reduction with H_2/Pd or $BaSO_4$ forms benzaldehyde (Rosenmund reduction) The conversion looks like,



10.

(b) 3A

Explanation:

Given, Freezing point of 4% aqueous solution of X.

= Freezing point of 12% aqueous solution of Y

or $(\Delta T_f)_X = (\Delta T_f)_Y$ $[\because \Delta T_f = T_f^\circ - T_f]$

$K_f \times m_X = K_f m_Y$

where, m_X and m_Y are molality of X and Y, respectively.

or $m_X = m_Y$

Now, molality = $\frac{\text{Number of moles of solute } (n)}{\text{Mass of solvent (in kg)}}$

$$n = \frac{\text{Weight}}{\text{Molecular mass}} = \frac{w_X}{M_X}$$

$$\frac{w_X}{M_X \times (w_{\text{solvent}})_1} = \frac{w_Y}{M_Y \times (w_{\text{solvent}})_2}$$

Given, $w_X = 4$ and $w_{(\text{solvent})_1} = 96$

$w_Y = 12$ and $w_{(\text{solvent})_2} = 88$

$M_X = A$

$$\therefore \frac{4 \times 1000}{M_X \times 96} = \frac{12 \times 1000}{M_Y \times 88}$$

$$\text{Thus, } M_Y = \frac{12 \times 1000 \times M_X \times 96}{4 \times 1000 \times 88}$$

$$= \frac{96 \times 12}{4 \times 88} \times A = 3.27A \approx 3A$$

11.

(d) 150 g

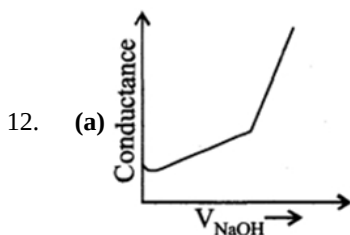
Explanation:

Molar mass of octane = 114 g/mol

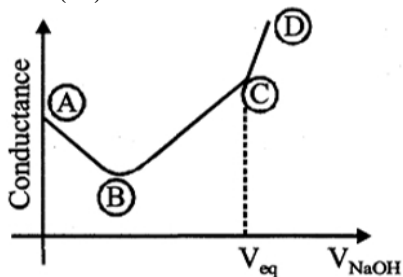
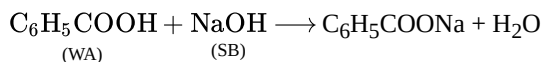
From the lowering of vapour pressure we have,

$$\frac{\Delta P}{P} = \frac{\frac{W_2}{M_2}}{\frac{W_2}{M_2} + \frac{W_1}{M_1}}; \frac{75}{100} = \frac{\frac{50 \text{ g/mol}}{W_2}}{\frac{50 \text{ g/mol}}{W_2} + \frac{114 \text{ g}}{114 \text{ g/mol}}}$$

$$\Rightarrow W_2 = 150 \text{ g}$$



Explanation:



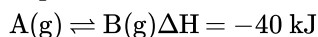
From (A) → (B); Free H⁺ ions are replaced by Na⁺ which decreases conductance.

From (B) → (C); Un-dissociated benzoic acid reacts with NaOH and forms salt which increases ions & conductance increases.

From (C) → (D); After equivalence point at (3), NaOH added further increases Na⁺ and OH⁻ ions which further increases the conductance.

13. (a) E_f = 80 kJ/mol; E_b = 120 KJ/mol

Explanation:



If activation energy of the reaction = x

since, $\frac{E_f}{E_b} = \frac{2}{3}$, therefore, $E_f = \frac{2x}{5}$ and $E_b = \frac{3x}{5}$

$$E_b - E_f = -\Delta H = +40 \Rightarrow \frac{3x}{5} - \frac{2x}{5} = 40 \Rightarrow x = 200$$

Therefore,

$$E_b = \frac{3x}{5} = \frac{3 \times 200}{5} = 120 \text{ kJ mol}^{-1}$$

$$E_f = \frac{2x}{5} = \frac{2 \times 200}{5} = 80 \text{ kJ mol}^{-1}$$

- 14.

(d) -384

Explanation:

$$\Delta G^\circ = -nFE^\circ_{\text{cell}}$$

$$= -2 \times (96000) \times 2V = -384000 \text{ J/mol} = -384 \text{ kJ/mol}$$

15. (a) less than 300 K

Explanation:

At room temperature, water is liquid and has boiling point 373 K due to hydrogen bonding. Whereas H₂S is a gas and it has no hydrogen bonding. Hence the boiling point of H₂S is less than 300 K (boiling point of H₂S is -60°C).

- 16.

(d) C₂O₄²⁻, ethylene diammine, H₂O

Explanation:

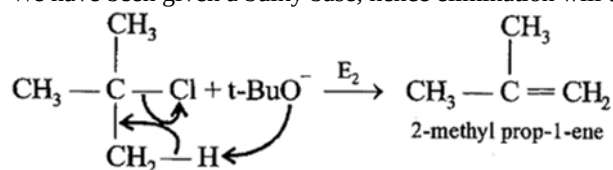
Ambidentate ligand are the ligand which has two different donor atoms. For example NO₂⁻ and NCS⁻

17.

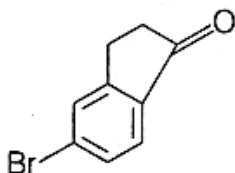
(d) 2-Methyl prop-1-ene

Explanation:

We have been given a bulky base, hence elimination will take place & not substitution.

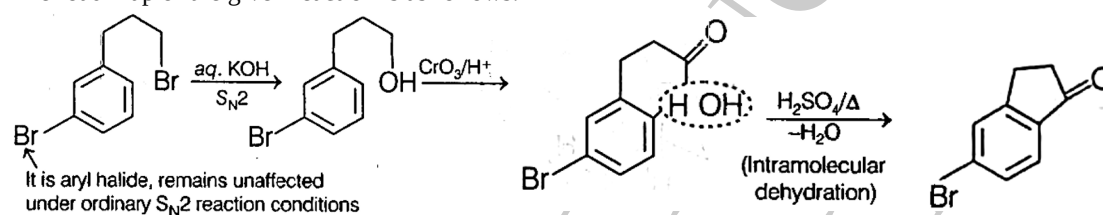


18. (a)



Explanation:

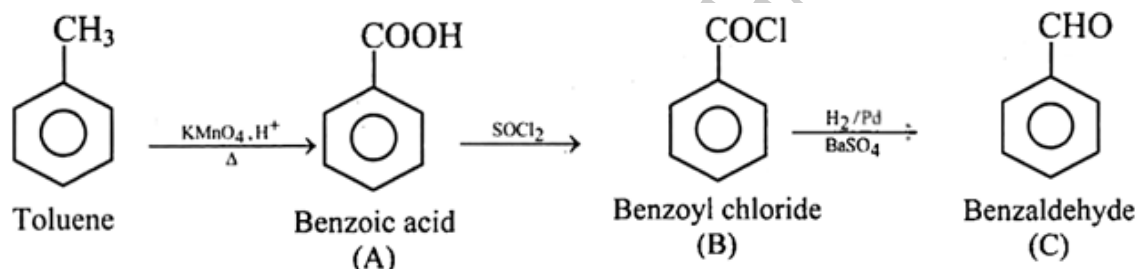
The road map of the given reaction is as follows:



19.

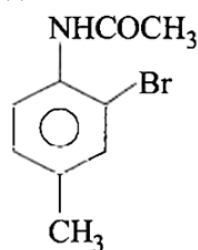
(b) C₆H₅CHO

Explanation:

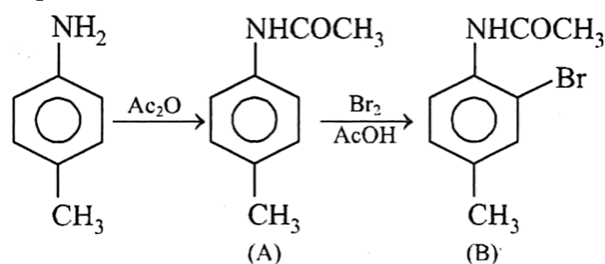


20.

(c)



Explanation:



21. 6

Explanation:

d-broglie wave-length of electron:

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

$$\lambda = \frac{h}{\sqrt{2mqV}} = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 16 \times 10^{-19} \times 9.1 \times 10^{-31} \times 40 \times 10^3}}$$

$$= 0.614 \times 10^{-11} \text{ m} = 6.14 \times 10^{-12} \text{ m}$$

22. 623.0

Explanation:

For first order section

$$t = \frac{2.303}{k} \log \frac{[A]_0}{[A]_t} = \frac{2.303}{2.011 \times 10^{-3}} \log \frac{7}{2}$$

$$= \frac{2.303 \times 0.544}{2.011 \times 10^{-3}} = 622.989 \approx 623$$

23. 1.0

Explanation:

Spin magnetic moment of $[\text{Cr}(\text{CN})_6]^{3-} (t_{2g}^3 e_g^0)$

$$\mu_1 = \sqrt{3(3+2)} = \sqrt{15} \text{ BM (Considering it as an outer orbital complex)}$$

Spin magnetic moment of $[\text{Cr}(\text{H}_2\text{O})_6]^{3+} (t_{2g}^3 e_g^0)$

$$\mu_2 = \sqrt{3(3+2)} = \sqrt{15} \text{ BM}$$

$$\frac{\mu_1}{\mu_2} = \frac{\sqrt{15}}{\sqrt{15}} = 1$$

24. 46

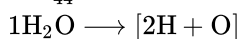
Explanation:

Mole of CO_2 = Moles of C

$$= \frac{\text{Weight of } \text{CO}_2}{\text{Molar mass of } \text{CO}_2} = \frac{0.793}{44}$$

Weight of 'C' = moles \times molar mass of carbon

$$= \frac{0.793}{44} \times 12 = 0.216 \text{ g}$$



1 mole of H_2O = 2 moles of hydrogen.

$$\text{Moles of } \text{H}_2\text{O} = \frac{\text{Weight}}{\text{Molar mass}} = \frac{0.442}{18}$$

$$\text{Moles of 'H'} = \frac{0.442}{18} \times 2$$

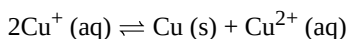
$$\text{Weight of 'H'} = \frac{0.442}{18} \times 2 \times 1 = 0.049 \text{ g}$$

$$\therefore \text{Weight of 'O'} = 0.492 - 0.216 - 0.049 = 0.227 \text{ g}$$

$$\% \text{ of 'O'} = \frac{0.227}{0.492} \times 100 = 46.13\%$$

25. 144

Explanation:



$$E_{\text{cell}}^{\circ} = E_{\text{Cu}^+/\text{Cu}}^{\circ} - E_{\text{Cu}^{2+}/\text{Cu}^+}^{\circ} = 0.52 - 0.16 = 0.36\text{V}$$

$$E_{\text{cell}}^{\circ} = \frac{RT}{nF} \ln K_{eq}$$

$$\Rightarrow 0.36 = \frac{0.025}{1} \ln K$$

$$\Rightarrow \ln K = 14.4 = 144 \times 10^{-1}$$