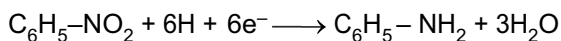


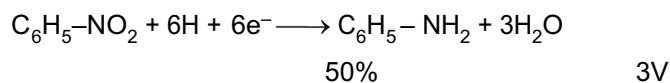
CHEMISTRY

11. (a) 12.3 g of nitrobenzene is reduced to aniline



if the current efficiency for the process is 50% And the potential drop across the cell is 3V, how much energy will be consumed in kJ. [molecular weight of nitrobenzene = 123] [F = 96500 cb]

12.3



[molecular weight of nitrobenzene = 123] [F = 96500 cb]

- (b) If an electron moving with a velocity 600 m s^{-1} which is accurate up to 0.005% then calculate uncertainty in its position.

600 m s^{-1} 0.005%

[$h = 6.63 \times 10^{-34} \text{ J s}$]

[mass of electron = $9.1 \times 10^{-31} \text{ kg}$] ($m = 9.1 \times 10^{-31} \text{ kg}$)

- Sol. (a) $\text{C}_6\text{H}_5\text{NO}_2 + 6\text{H}^+ + 6\text{e}^- \longrightarrow \text{C}_6\text{H}_5\text{-NH}_2 + 3\text{H}_2\text{O}$

Moles of $\text{C}_6\text{H}_5\text{NO}_2 = \frac{12.3}{123} = 0.1 \text{ mol}$

\therefore 1 mol $\text{C}_6\text{H}_5\text{NO}_2$ requires 6F charge to reduce into aniline

\therefore 0.1 mol $\text{C}_6\text{H}_5\text{NO}_2$ requires 0.6 F charge to reduce into aniline

$Q = 0.6 F = 0.6 \times 96500 \text{ cb}$

Current efficiency of process is 50%

\therefore required charge = $2 \times (0.6 \times 96500) \text{ c}$
= 115800 cb

Energy consumed in the process = $Q \times V$

= $115800 \times 3 \text{ J}$

= 347400 J

= 347.4 KJ

- (b) Given velocity of electron = 600 m s^{-1}

uncertainty in velocity (ΔV) = $600 \times \frac{0.005}{100} = 30 \times 10^{-3} \text{ m s}^{-1}$

According to Heisenberg's principle,

$$\Delta x \cdot \Delta V \geq \frac{h}{4\pi m} \quad \Delta x \geq \frac{h}{4\pi m \cdot \Delta V}$$

$$\Delta x \geq \frac{6.63 \times 10^{-34} \text{ J s}}{4 \times 3.14 \times 9.1 \times 10^{-31} \text{ kg} \times 30 \times 10^{-3} \text{ m s}^{-1}}$$

$$\Delta x \geq 1.9 \times 10^{-3} \text{ m}$$

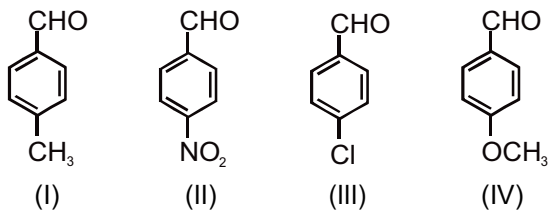
12. (a) Applying Bohr's model when H atom comes from $n = 4$ to $n = 2$, calculate its wavelength. In this process write whether energy released or absorbed? Also write the range of radiation?

[$R_H = 2.18 \times 10^{-28} \text{ J}$, $h = 6.63 \times 10^{-18} \text{ J}$]

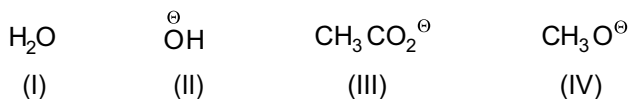
H $n = 4$ $n = 2$

[$R_H = 2.18 \times 10^{-28} \text{ J}$, $h = 6.63 \times 10^{-18} \text{ J}$]

(ii) Arrange the following in decreasing order of electrophilicity.

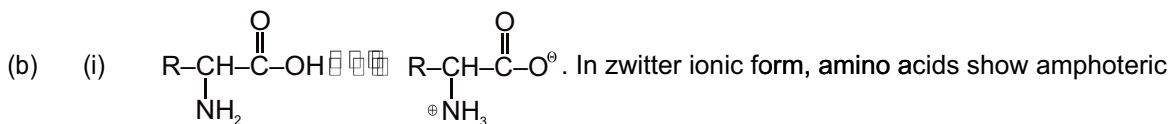


(iii) Arrange the following in decreasing order of basic strength



- (b) (i) Why amino acid is amphoteric in nature explain. ()
 (ii) Name the polymer formed by adipic acid and hexamethylenediamine.

Sol. (a) (i) I > IV > III > II (ii) II > III > I > IV (iii) IV > II > III > I



(Zwitter ion) behaviour as they react both with acids and bases.

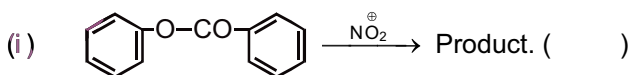
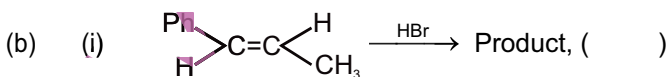
(ii) Nylon - 66

15. Explain the following ()

- (a) (i) Hydrolysis of CH_3COCl is faster than CH_3CONH_2
 CH_3COCl CH_3ONH



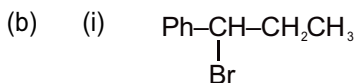
- (iii) $\text{CH}_2=\overset{\ominus}{\text{C}}\text{H}$ is better nucleophile than $\text{CH}\equiv\text{C}^\ominus$ ($\text{CH}_2=\overset{\ominus}{\text{C}}\text{H}$, $\text{CH}\equiv\text{C}^\ominus$) ()

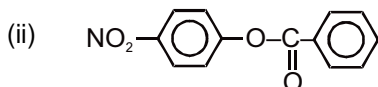


Sol. (a) (i) Cl^\ominus is better leaving group than NH_2^\ominus .

(ii) Keto form is more stable of while enol form of is more stable due to aromatic nature.

(iii) $\text{CH}_2=\overset{\ominus}{\text{C}}\text{H}$ is stronger base than $\text{HC}\equiv\text{C}^\ominus$ and stronger base is better nucleophile.





16. (a) Cu metal crystallizes in face centred cubic lattice with cell edge, $a = 361.6 \text{ pm}$. What is the density of Cu crystal (Mwt. of Cu = 63.5 amu $N_A = 6.023 \times 10^{23}$)
- (b) Complete the following reaction
- (i) $\text{O}_3 + \text{I}^- \longrightarrow$
- (ii) $\text{CaH}_2 + \text{H}_2\text{O} \longrightarrow$

Sol.

- (a) Number of atoms in Cu unit cell (n) = 4
 Mwt. of Cu = 63.5 amu
 volume of unit cell (v) = $a^3 = (3.616 \times 10^{-8} \text{ cm})^3$

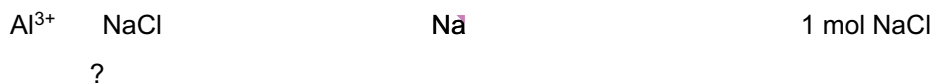
$$\text{Crystal density} = \frac{n \times \text{Mwt.}}{v \times N_A} = \frac{4 \times 63.5 \text{ g}}{(3.616 \times 10^{-8} \text{ cm})^3 (6.023 \times 10^{23})} = 8.919 \text{ g/cm}^3$$

- (b) (i) $\text{H}_2\text{O} + \text{O}_3 + \text{I}^- \longrightarrow \text{I}_2 + 2\text{OH}^- + \text{O}_2$
 (ii) $\text{CaH}_2 + 2\text{H}_2\text{O} \longrightarrow \text{Ca(OH)}_2 + 2\text{H}_2 \uparrow$

- 17 (a) (i) What is the arrangement of atoms in the lattice structure of diamond and give contribution of each C atom?

?

- (ii) If Al^{3+} replaces Na^+ at the edge centre of NaCl lattice then calculate vacancies in 1 mol NaCl.



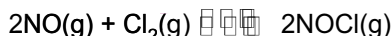
- (b) (i) $2\text{N}_2\text{O(g)} + \text{O}_2\text{(g)} \rightleftharpoons 4\text{NO(g)}$; $\Delta H > 0$

What will be the effect on equilibrium when ()

(1) Volume of the vessel increases ()

(2) Temperature decreases ()

- (ii) For the reaction ()



If the partial pressure $P_{\text{NOCl}} = 0.32 \text{ atm}$, $P_{\text{NO}} = 0.22 \text{ atm}$ and $P_{\text{Cl}_2} = 0.11 \text{ atm}$ then find K_p ?

$$P_{\text{NOCl}} = 0.32 \text{ atm}, P_{\text{NO}} = 0.22 \text{ atm} \quad P_{\text{Cl}_2} = 0.11 \text{ atm} \quad K_p$$

?

- Sol.** (a) (i) The diamond lattice consist of a face centred cubic bravias point lattice which contains two identical atoms per lattice point.

At every corner of unit cell = $8 \times \frac{1}{8} = 1 \text{ atom}$

At every face centre of unit cell = $6 \times \frac{1}{2} = 3 \text{ atoms}$

At alternative tetrahedral voids = 4 atoms, So total no. of atoms in an unit cell = 8 atoms

- (ii) Since in 1 unit cell of NaCl, 3 Na^+ ions are present at the edge centres

So, 1 Al^{3+} will replace 3 Na^+ ions.

i.e. $\frac{3}{4}$ mol of Na^+ ions will replaces by $\frac{1}{4}$ mol of Al^{3+} (for electrically neutral)

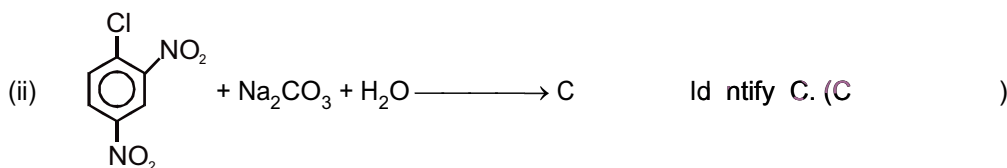
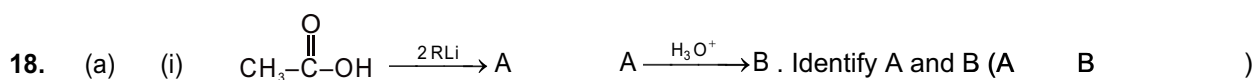
and the remaining Na^+ ions in crystal are $\frac{1}{4}$ mol

So in crystal $\frac{1}{2}$ mol of lattice sites will occupy by $\frac{1}{2}$ mol ($\frac{1}{4}$ mol Al^{+3} + $\frac{1}{4}$ mol Na^+) of cations,

therefore vacant sites (No. of cationic vacancies) = $\frac{1}{2}$ mol = $\frac{1}{2} \times 6.023 \times 10^{23} = 3.0125 \times 10^{23}$

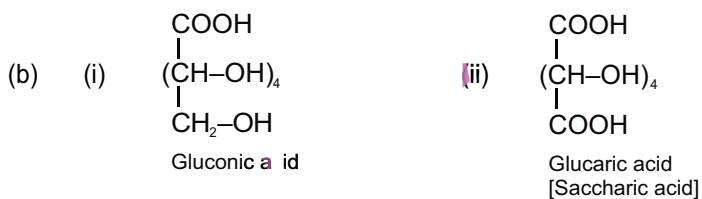
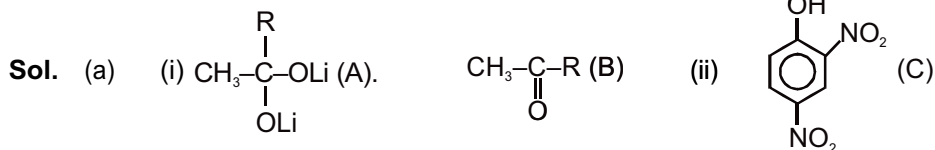
- (b) (i) (1) Equilibrium will be shifted in forward direction.
 (2) Equilibrium will be shifted in backward direction.
 (ii) According to Law of mass action,

$$K_p = \frac{P_{\text{NOCl}}^2}{P_{\text{NO}}^2 P_{\text{Cl}_2}} = \frac{(0.32)^2}{(0.22)^2 (0.11)} = 19.23$$



(b) Write the products formed by the reaction of glucose with ()

- (i) Br_2 water (Br_2) (ii) (Con HNO_3 (HNO_3)



19. (a) An LPG (Liquified petroleum gas) cylinder weighs 14.8 kg when empty. When full, it weighs 29.0 kg and shows a pressure of 2.5 atm. In the course of use at 27°C, the weight of the full cylinder reduced to 23.2 kg. Find out the volume of n-butane in cubic meters used up at 27°C and 1 atm. [molecular weight of n-butane = 58]

LPG ()	14.8 kg
29.0 kg 2.5 atm	27°C
23.2 kg	n- 27°C 1
[n- = 58]	

(b) There is KI and sucrose solution with 0.1 M concentration, if the osmotic pressure of KI and sucrose solution is 0.465 atm and 0.245 atm respectively. Then find the van't Hoff factor of KI and its degree of dissociation.

0.1 M	KI	KI	
0.465	0.245	KI	?

Sol. (a) Weight of n-butane used up = 29 – 23.2 = 5.8 kg

$$\text{Moles of n-butane used up} = \frac{2.8 \times 10^3}{58} = 100 \text{ mol}$$

∴ Volume of n-butane used up

as $PV = nRT$ or $V = \frac{nRT}{P}$

$$V = \frac{100 \text{ mol} \times 0.0821 \text{ L-atm mol}^{-1} \times 300 \text{ K}}{1 \text{ atm}} = 2463 \text{ L} = 2.463 \text{ m}^3$$

(b) Osmotic pressure (π) = $iCRT$; i = Van't Hoff factor

For KI solution $0.465 = i \times 0.1 \times RT$ (1)

For sucrose solution $0.245 = 1 \times 0.1 \times RT$ (2) ($i = 1$)

Equation (1) is divided by equation (2) gives

$$\frac{0.465}{0.245} = i, \quad i = 1.897$$

For KI, degree of dissociation is –

$$\alpha = \frac{(i - 1)}{(n - 1)} \quad \text{or} \quad \alpha = \frac{1.879 - 1}{(2 - 1)} = 0.897 \quad \text{or} \quad \alpha = 89.7\%$$

20. (a) For first order reaction if rate constant at 17°C is $2.8 \times 10^{-5} \text{ s}^{-1}$ and at 27°C is $2.8 \times 10^{-4} \text{ s}^{-1}$

$$17^\circ\text{C} \qquad 2.8 \times 10^{-5} \text{ s}^{-1} \qquad 27^\circ\text{C} \text{ is } 2.8 \times 10^{-4} \text{ s}^{-1}$$

(i) Write the equation for calculation of activation energy

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

(ii) Calculate activation energy ($R = 8.3 \text{ J/mol. K}$) () ($R = 8.3 \text{ J/mol. K}$)

(b) Depression in freezing point of 0.10 molal solution of HF is -0.201°C . Calculate percentage degree of dissociation of HF ($K_f = 1.86 \text{ K kg mol}^{-1}$)

$$\text{HF} \quad 0.10 \qquad -0.201^\circ\text{C} \qquad \text{HF}$$

$$(K_f = 1.86 \text{ K kg mol}^{-1})$$

Sol. (a) (i) $\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$

(i) $\log \frac{2.8 \times 10^{-4} \text{ s}^{-1}}{2.8 \times 10^{-5} \text{ s}^{-1}} = \frac{E_a}{2.303 \times 8.3 \text{ J/mol K}} \times \left(\frac{1}{290 \text{ K}} - \frac{1}{300 \text{ K}} \right)$

$$\log 10 = \frac{E_a (300 - 290)}{2.303 \times 8.3 \times 290 \times 300} \text{ J/mol or } E_a = 166299.63 \text{ J/mol} = 166.299 \text{ kJ/mol.}$$

(b) $\Delta T_f = 0.201$

observed $\Delta T_f = i (\text{molality} \times K_f)$ or $0.201 = i (0.1 \times 1.86 - 1)$ or $i = 1.0806$

degree of dissociation of HF $\alpha = \frac{i - 1}{(n - 1)} = \frac{(1.0806)}{(2 - 1)} = 0.0806$ or $\alpha = 8.06\%$