

## CBSC\_2015\_SET-1 CHEMISTRY\_SOLUTION

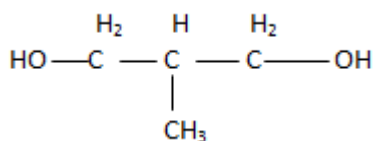
- Lyophobic colloids can be coagulated by the electrophoresis method. The colloidal particles move towards the oppositely charged electrodes, get discharged and precipitated.
- Suppose the number of atoms Y in hcp lattice = n As the number of tetrahedral voids is double the number of atoms in close packing, the number of tetrahedral voids = 2n As atoms X occupy  $\frac{2}{3}$ <sup>rd</sup> of the tetrahedral voids, the number of atoms X in the lattice

$$\frac{2}{3} \times 2n = \frac{4n}{3}$$

$$\therefore \text{Ratio of X:Y} = \frac{4n}{3} : n = \frac{4}{3} : 1 = 4:3$$

Hence, the formula of the compound is  $X_4Y_3$ .

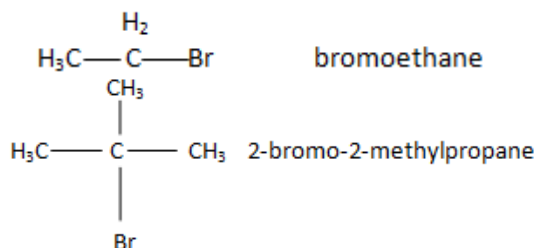
- White phosphorus is less stable and therefore more reactive than the other solid phases under normal conditions because of the angular strain in the  $P_4$  molecule where the angles are only  $60^\circ$ . Red phosphorus is much less reactive than white phosphorus.
- 



IUPAC name : 2-methylpropane-1,3-diol

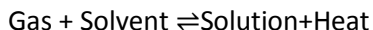
- Carbocations are the intermediates in the  $S_N1$  reaction. Greater the stability of the carbocations, more easily will the product be formed and hence faster will be the rate of the reaction. Because the stability of the carbocations decreases in the order:  $3^\circ$  carbocation >  $2^\circ$  carbocation >  $1^\circ$  carbocation >  $CH_3^+$ . Therefore, the reactivity of alkyl halides towards  $S_N1$  reactions decreases in the same order, i.e.  $3^\circ$  alkyl halides >  $2^\circ$  alkyl halides >  $1^\circ$  alkyl halides > methyl halides.

The two structures are



Bromoethane is a primary alkyl halide which forms a  $1^\circ$  carbocation intermediate in the  $S_N1$  reaction. The other compound is 2-bromo-2-methylpropane which is a tertiary alkyl halide which forms a tertiary carbocation intermediate in the  $S_N1$  reaction. Hence, 2-bromo-2-methylpropane undergoes an  $S_N1$  reaction faster than bromoethane.

6. Henry's law: The mass of a gas dissolved in a given volume of the liquid at constant temperature is directly proportional to the pressure of the gas present in equilibrium with the liquid. Or The solubility of a gas in a liquid at a particular temperature is directly proportional to the pressure of the gas in equilibrium with the liquid at that temperature. The dissolution of a gas in a liquid is an exothermic process, that is, it is accompanied by the evolution of heat. Thus,



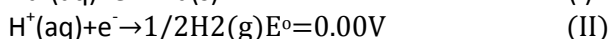
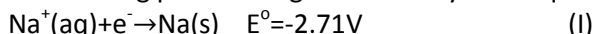
Applying Le Chatelier's principle, the increase of temperature would shift the equilibrium in the backward direction, that is, solubility would decrease. Therefore, gases always tend to be less soluble in liquids as the temperature is raised

OR

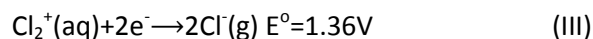
Raoult's law: In a solution, the vapour pressure of a component at a given temperature is equal to the mole fraction of that component in the solution multiplied by the vapour pressure of that component in the pure state.

Ideal Solution	Non-ideal Solution
1. An ideal solution of the components A and B is defined as the solution in which the intermolecular interactions between the components (A-B attractions) are of the same magnitude as the intermolecular interactions found in the pure components (A-A attractions and B-B attractions).	1. A non-ideal solution of the components A and B is defined as the solution in which the intermolecular interactions between the components (A-B attractions) are of different magnitude as the intermolecular interactions found in the pure components (A-A attractions and B-B attractions).
2. $\Delta_{\text{mix}}H = 0$ and $\Delta_{\text{mix}}V = 0$ .	2. $\Delta_{\text{mix}}H \neq 0$ and $\Delta_{\text{mix}}V \neq 0$ .

7. A redox reaction is feasible only if the species with high reduction potential is reduced (accepts an electron) and the species with lower standard reduction potential is oxidised (loses an electron). For a reaction to occur, it is necessary that the species with a greater tendency to lose an electron, loses its electron, which is gained by the species with a greater tendency to gain the electron. The reactions taking place during the electrolysis of aqueous sodium chloride solution are



One more reaction which takes place during the electrolysis of aqueous sodium chloride solution is

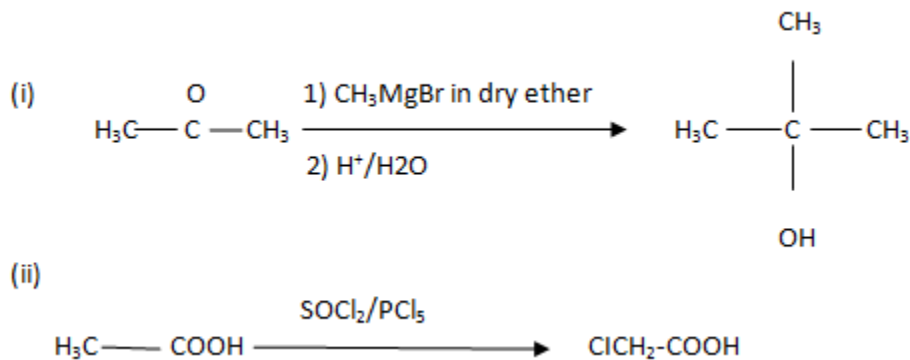


From the above three reactions, we observe that the standard reduction potential sodium (reaction I) is negative, while the standard reduction potential for chlorine (reaction III) is positive. Hence, reaction III is feasible at the cathode.

OR

- A mercury cell consists of a zinc container as the anode, a carbon rod as the cathode and a paste of mercuric oxide mixed with KOH as the electrolyte.
- In this cell, the overall cell reaction does not involve any ion whose concentration may change.
- Therefore, this cell gives a constant potential of 1.5 V throughout its life.
- However, these cells should be reprocessed for mercury recovery or treated to prevent mercury or mercury compounds from entering the atmosphere and causing pollution.

8. Transition metals have high effective nuclear charge, greater number of valence electrons and some unpaired electrons. They thus have strong metal–metal bonding. Hence, transition metals have high enthalpies of atomisation. In the 3d series, from Sc to Zn, only zinc has filled valence shells. The valence shell electronic configuration of Zn is  $3d^{10}4s^2$ . Due to the absence of unpaired electrons in ns and (n–1)d shells, the interatomic electronic bonding is the weakest in zinc. Consequently, zinc has the least enthalpy of atomisation in the 3d series of transition elements.
9. (i)  $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)](\text{NO}_3)_2$  IUPAC name: Pentaamminenitrocobalt (III) nitrate (ii) Potassium tetracyanonickelate (II) Formula of the complex:  $\text{K}_2[\text{Ni}(\text{CN})_4]$
- 10.



11. Given:
- |                                         |   |               |
|-----------------------------------------|---|---------------|
| Molar mass of $\text{CaCl}_2$ ( $M_B$ ) | = | 111 g/mol     |
| Weight of water ( $W_A$ )               | = | 500 g         |
| $K_f$ for water                         | = | 1.86 K kg/mol |
| $\Delta T_f$                            | = | 2 K           |

$$\text{Formula: } \Delta T_f = \frac{K_f \times w_B \times 1000}{w_A \times M_B}$$

Solution:

$$\Delta T_f = \frac{K_f \times w_B \times 1000}{w_A \times M_B}$$

$$2 = \frac{1.86 \times w_B \times 1000}{500 \times 111}$$

$$w_B = \frac{2 \times 500 \times 111}{1.86 \times 1000} = 59.68$$

Amount of  $\text{CaCl}_2$  required = 59.68 g

12. Given:
- |                 |   |                       |
|-----------------|---|-----------------------|
| Density (D)     | = | 10 g/cm <sup>3</sup>  |
| Edge length (a) | = | $3 \times 10^{-8}$ cm |
| Atomic mass     | = | 81 g/mol              |

Formula: 
$$\text{Density} = \frac{Z \times M}{a^3 \times N_0}$$

$$10 = \frac{Z \times M}{a^3 \times N_0}$$

$$Z = \frac{10 \times (3 \times 10)^3 \times 6.022 \times 10^{23}}{81} = 2.0073$$

$$\therefore Z = 2$$

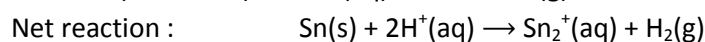
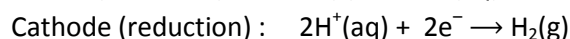
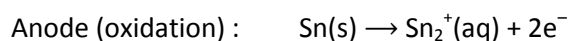
The unit cell contains 2 atoms, so it is a body-centred cubic unit cell.

13. According to Nernst equation,

$$E_{\text{cell}} = E_{\text{cell}}^0 - \frac{0.0592}{n} \log \frac{[P]}{[R]}$$

$$\begin{aligned} E_{\text{cell}}^0 &= E_{\text{Oxi(anode)}}^0 - E_{\text{Oxi(cathode)}}^0 \\ &= E_{\text{Sn|Sn}^{2+}}^0 - E_{\text{H}_2|\text{2H}^{2+}}^0 \\ &= -0.14 - 0.0 \\ &= -0.14 \end{aligned}$$

Reactions :



$$\therefore n = 2$$

$$[P] = [\text{Sn}_2^+] = 0.001 \text{ M}$$

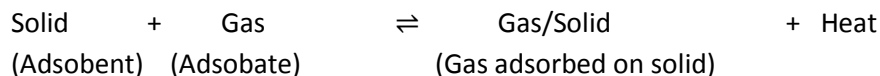
$$[R] = [\text{H}^+] = 0.01 \text{ M}$$

So, putting the above values in the formula,

$$E_{\text{cell}} = -0.14 - \frac{0.0592}{2} \log \frac{[0.001]}{[0.01]^2}$$

$$E_{\text{cell}} = -0.1696 \text{ V}$$

14. (i) Physisorption is exothermic in nature:

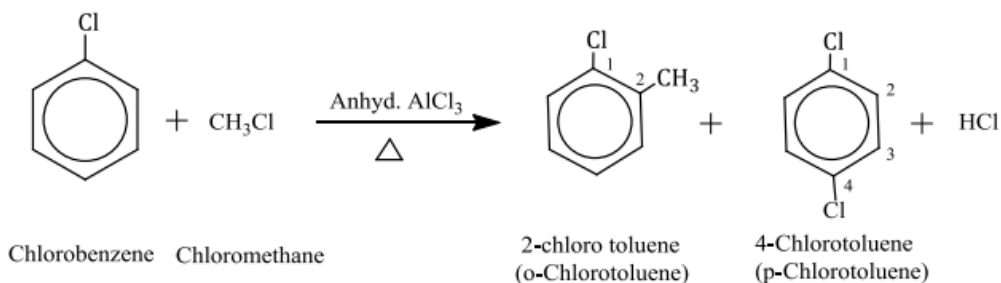


In accordance with Le Chatelier's principle, physisorption decreases with an increase in temperature. Because the equilibrium will shift in the backward direction, gas will be released from the adsorbed surface.

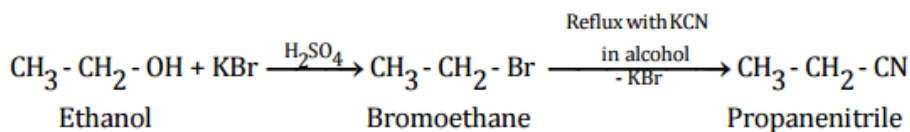
(ii) In water purification, alum acts as a good coagulant. A coagulant binds extremely fine and small particles of impure water to large particles which are easily removable by filtration or settling. So, anyone can remove unwanted colour and turbidity from water.

(iii) Brownian motion counters the force of gravity acting on the colloidal particles and hence helps in providing stability to the colloidal sols by not allowing them to settle.



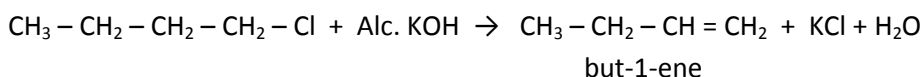


(iii)

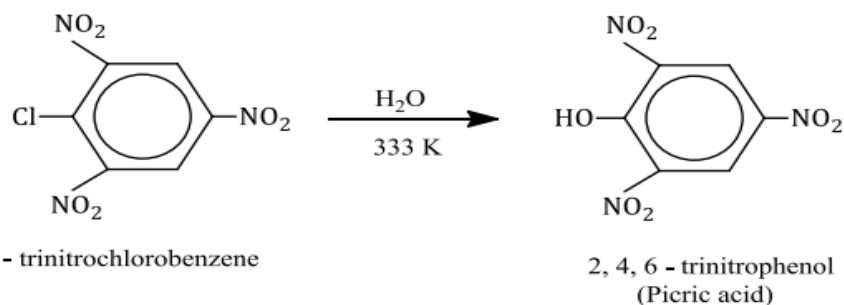


OR

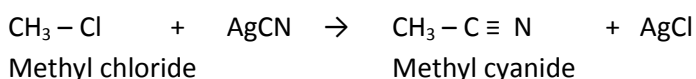
(i) When n-butyl chloride is treated with alcoholic KOH, but-1-ene is formed.



(ii) 2, 4, 6-trinitrochlorobenzene under mild hydrolysis conditions ( $\text{H}_2\text{O}/323\text{ K}$ ) gives 2, 4, 6-trinitrophenol or picric acid.



(iii) When methyl chloride is treated with AgCN, methyl cyanide is formed.

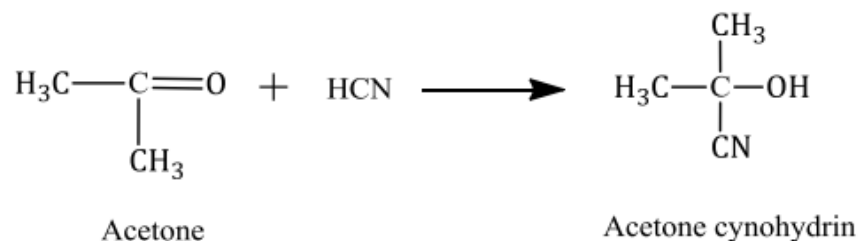


19. (i) The nitro group ( $-\text{NO}_2$ ) is an electron-withdrawing group. It decreases the density in the O-H bond. Thus, the proton can be easily lost. With the presence of an electron-withdrawing group, the phenoxide ion is more stabilised. Due to the high stability of the phenoxide ion, the acidic nature increases. On the other hand, the methoxy group is an electron-releasing group. It increases the density in the O-H bond. Thus, the proton cannot be given out easily. Thus, the phenoxide ion is less stabilised. Due to this, o-nitrophenol is more acidic than omethoxyphenol.
- (ii) Butan-1-ol has a higher boiling point because it contains a hydroxyl group which is capable of hydrogen bonding. Molecules of diethyl ether are incapable of forming hydrogen bonds with each other.
- (iii)  $(\text{CH}_3)_3\text{C-O-CH}_3$  is an ether with two different alkyl groups, of which  $(\text{CH}_3)_3\text{C-}$ , tertiary alkyl group, on reaction with hydrogen halide (HI) forms a tertiary halide. This occurs as the

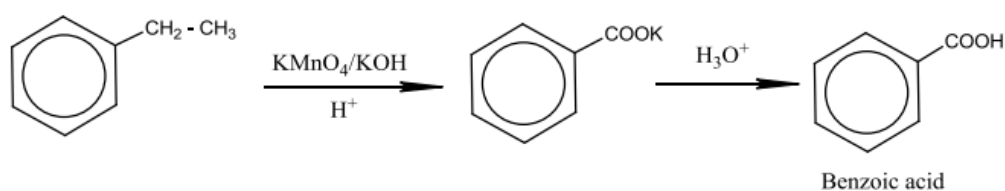
reaction is an  $S_N1$  reaction. The reaction involves the formation of a stable carbocation. If the ether has a primary alkyl group, then the reaction follows the  $S_N2$  mechanism.

20.

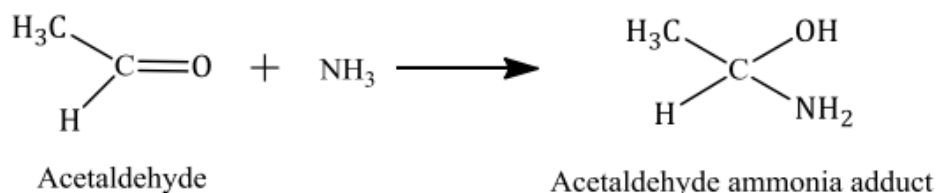
(i)



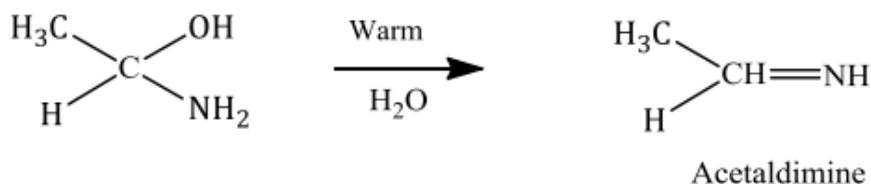
(ii)



(iii) Acetaldehyde reacts with ammonia to form an acetaldehyde ammonia adduct.

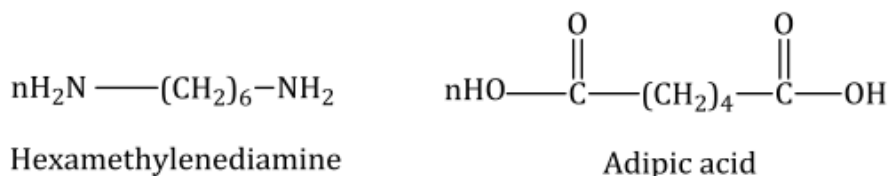


On warming with water, the adduct decomposes to give acetaldimine.

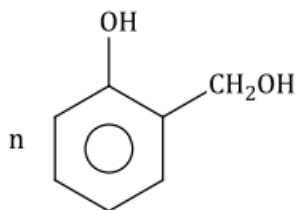


21. (i) The monomer units of nylon-6,6 are hexamethylenediamine and adipic acid.

(ii)

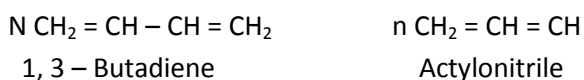


(iii) The monomer unit of Novolac is o-hydroxybenzyl alcohol.

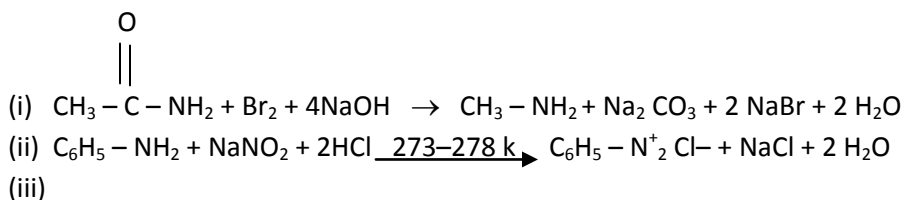


n - Hydroxybenzyl alcohol

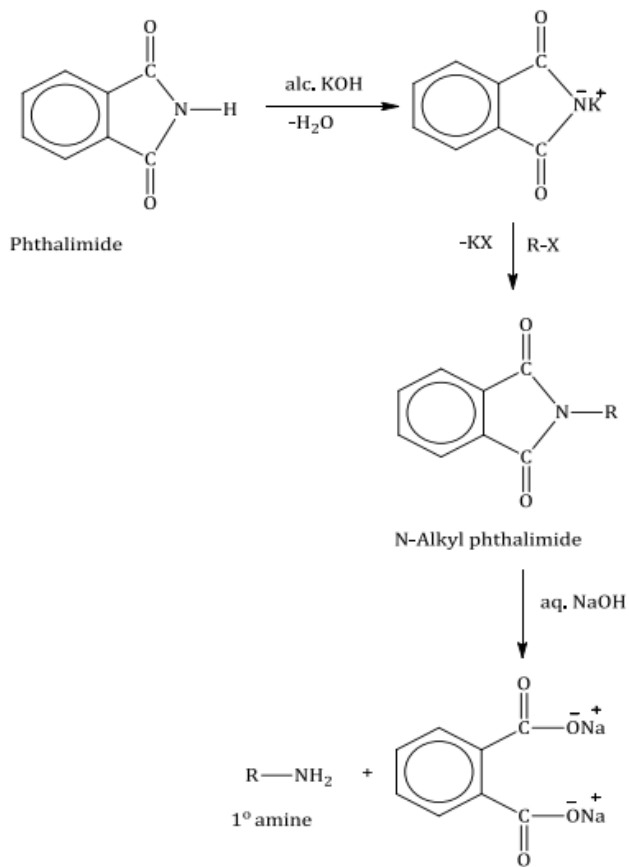
(iv) The monomer units of Buna-N are 1, 3-butadiene and acrylonitrile.



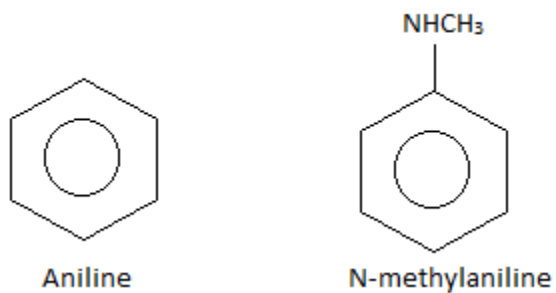
22. (i) Starch is a polysaccharide bonded by glycosidic linkages.  
 (ii) In a biological system, a protein is found to have a unique 3-dimensional structure and a protein with unique biological activity is called a native protein. However, when the native protein is subjected to physical or chemical changes, its hydrogen bonds are disturbed. This disturbance unfolds the globules and uncoils the helix. As a result, the protein loses its biological activity. This type of protein is called a denatured protein.  
 (iii) Vitamin K is responsible for the coagulation of blood
23. (i) Care for the health of the students and selfless service for mankind are some of the key values displayed by Mr Lugani.  
 (ii) Awareness regarding diabetes and depression among students can be spread by organising and conducting seminars, health camps, discussions and debates, distribution of brochures and pamphlets, organising workshops by doctors emphasising the need to follow healthy eating habits and practising regular physical exercise.  
 (iii) Antidepressant drugs are chemical compounds used to treat major depressive disorders and several other conditions such as chronic pain, anxiety disorders and dysmenorrhoea. Example: Clomipramine  
 (iv) Saccharin is the sweetening agent used in the preparation of sweets for a diabetic patient.
24. (a)







(b) (i) Aniline is a primary amine and N-methylaniline is a secondary amine.

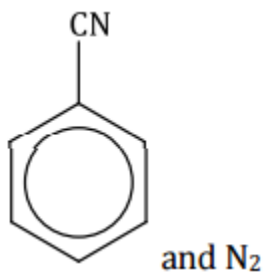


(ii) (CH<sub>3</sub>)<sub>2</sub>NH is a secondary amine and (CH<sub>3</sub>)<sub>3</sub>N is a tertiary amine.

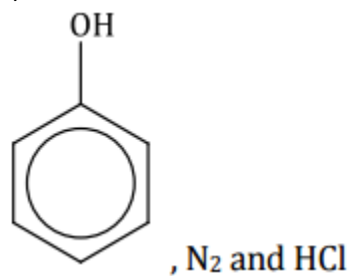
OR

(a)

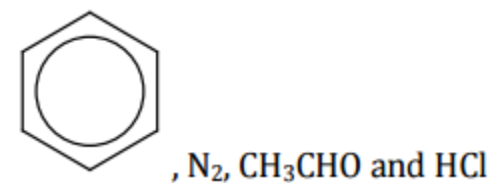
(i)



(ii)



(iii)



(b)

(i)  $(CH_3)_3N < C_2H_5NH_2 < C_2H_5OH$

(ii) p-nitroaniline < Aniline < p-methylaniline

25. (a) Rate of reaction may be defined as the change in any one of the reactants or products per unit time.

Concentration of reactants, temperature and catalyst affect the rate of reaction.

(b) Given :

$$k_1 = 4 \times 10^{-2}$$

$$k_2 = 8 \times 10^{-2}$$

$$T_1 = 300 \text{ K}$$

$$T_2 = 310 \text{ K}$$

Solution:

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

$$\log\left(\frac{8 \times 10^{-2}}{4 \times 10^{-2}}\right) = \frac{E_a}{2.303R} \left[ \frac{T_2 - T_1}{T_1 T_2} \right]$$

$$0.301 = \frac{E_a}{2.303 \times 8.314 \text{ JK}^{-1} \text{ mol}^{-1}} \left[ \frac{310 - 300}{310 \times 300} \right]$$

$$E_a = \frac{0.301 \times 2.303 \times 8.314 \times 93000}{10}$$

$$E_a = 53598.5 \text{ J}$$

OR

(a)

(i) For a reaction,  $A + B \rightarrow P$ 

$$\text{Rate}_1 = k[A][B]^2$$

If the concentration of B is doubled,

$$\text{Rate}_2 = k[A][2B]^2$$

$$\frac{\text{Rate}_1}{\text{Rate}_2} = \frac{k[A][2B]^2}{k[A][2B]^2}$$

$$\text{Rate}_2 = k[A][2B]^2$$

$$\frac{\text{Rate}_1}{\text{Rate}_2} = \frac{B^2}{4B^2}$$

$$\text{Rate}_2 = 4\text{Rate}_1$$

The rate of reaction will be four times the initial rate.

(ii) If A is present in large excess, then the rate of the reaction will be independent of A and will depend only on the concentration of B. The overall rate of the reaction will be 2.

(b) Solution :

Let us first calculate k.

$$t_{1/2} = 23.1 \text{ min}$$

$$t_{1/2} = \frac{0.693}{k}$$

$$k = \frac{0.693}{23.1}$$

$$k = 0.03$$

Now let us calculate the time required to complete 75% reaction.

$$k = \frac{2.303}{t} \log \frac{[R_0]}{[R]}$$

$$0.03 = \frac{2.303}{t} \log \frac{100}{2.5}$$

$$0.03 = \frac{2.303}{t} \log 4$$

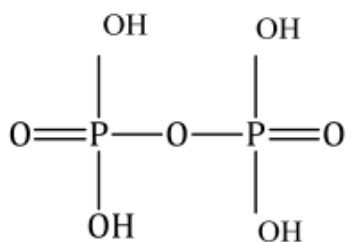
$$t = \frac{2.303}{0.03} \log 4$$

$$t = 46.22 \text{ mins}$$

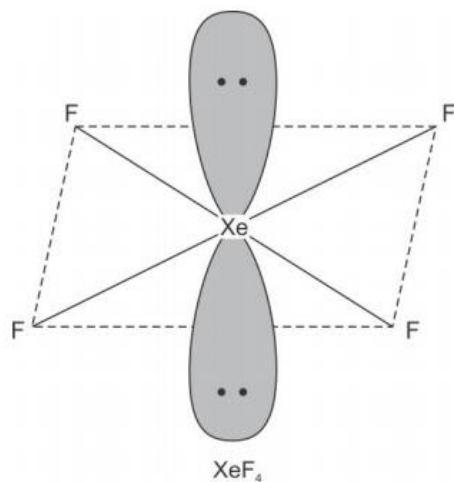
26. (a) (i) This is because the covalent bond between dissimilar atoms (X-X') in interhalogen compounds is weaker than that between similar atoms (X-X or X'-X') in halogens except the F-F bond.
- (ii) N<sub>2</sub> is less reactive at room temperature because its molecule is very small and the bond dissociation enthalpy of the molecule is high.
- (iii) The reducing character depends on the stability of the hydride. The greater the instability of a hydride, the greater is its reducing character. Because the stability decreases from NH<sub>3</sub> to BiH<sub>3</sub>, the reducing character increases.

(b)

(i) H<sub>4</sub>P<sub>2</sub>O<sub>7</sub> (pyrosulphuric acid)

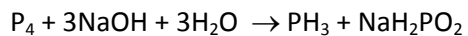


(ii) XeF<sub>4</sub>



OR

(a) On heating with caustic soda solution, white phosphorus forms poisonous gas phosphine.



(b) Helium has the lowest boiling point.

(c) The oxidising power of halogens decreases as we go down the group. The electrode potential of  $F_2$  is +2.87 V, while that of  $Cl_2$  is +1.36 V. This means that fluorine can be reduced more easily than chlorine. Therefore, fluorine is the strongest oxidising agent.

(d) On heating,  $H_3PO_3$  decomposes into phosphoric acid and phosphine.



(e)  $PbS + 4O_3 \rightarrow PbSO_4 + O_2$