# Sample Question Paper – A

**1.** 32 **1**

**2.** The stability of the molecule is directly proportional to the bond order. **1**

**3.** London forces. **1**

**4.** Hydrochloric acid. **1**

**5.** One **1**

**6.** Amount of $NaNO_3$ = 0·83 g ; Volume of solution = 50 $cm^3$

$$\text{Moles of } NaNO_3 = \frac{\text{Mass of } NaNO_3}{\text{Molar mass}} = \frac{0\cdot83}{85} = 0\cdot0097$$

$$\text{Molarity} = \frac{\text{Moles of } NaNO_3}{\text{Volume of solution}} \times 1000 = \frac{0\cdot0097}{50} \times 1000 = 0\cdot1940 \text{ M} \quad \textbf{2}$$

**7.**

| Element | Symbol | % by mass | Atomic mass | Molecules of the element (relative no. of moles) | Simplest molar ratio | Simplest whole number molar ratio | |
|---|---|---|---|---|---|---|---|
| Iron | Fe | 69·9 | 55·85 | 69·9/55·85 = 1·25 | 1·25/1·25 = 1 | 2 | ½ |
| Oxygen | O | 30·1 | 16·00 | 3·1/16·00 = 1·88 | 1·88/1·25 = 1·5 | 3 | ½ |

Empirical formula = $Fe_2O_3$

**8. (a)** pH of human muscle fluid = 6·83

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

$$6\cdot83 = -\log [H^+]$$

$$\log [H^+] = -6\cdot83$$

$$\therefore \quad [H^+] = \text{Antilog } 7\cdot17 = 1\cdot48 \times 10^{-7} \text{ M} \quad \textbf{1}$$

**(b)** Human stomach-fluid

$$-\log [H^+] = 1\cdot2$$

$$[H^+] = \text{antilog } 2\cdot8 = 6\cdot3 \times 10^{-2}$$

$$= 0\cdot063 \text{ M} \quad \textbf{1}$$

**9.** Four majour water pollutants :

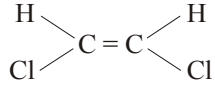
(i) Sewage and domestic wastes. ½

(ii) Industrial effluents. ½

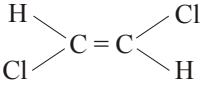
(iii) Agricultural discharges. ½

(iv) Thermal pollutants. ½

**10. (i)**

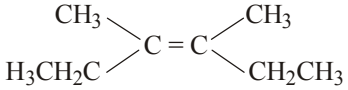


cis–1, 2-dichloro ethene

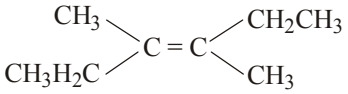


trans–1, 2-dichloro ethene **1**

**(ii)**



cis–3, 4-dimethylhex-3-ene



trans–3, 4-dimethylhex-3-ene **1**

**OR**

$FeCl_3$, $SnCl_4$ **2**

**11.** Wavelength, $= 242 \text{ nm}$

$= 242 \times 10^{-9} \text{ m}$

$$\text{Energy per photon (E)} = \frac{hc}{\lambda}$$

$$= \frac{6 \cdot 6 \times 10^{-34} \times \text{Js} \times 3 \times 10^{8} \text{ ms}^{-1}}{242 \times 10^{-9}}$$

$= 0 \cdot 821 \times 10^{-17} \text{ J}$ **1**

Since this energy is sufficient to cause ionization of one atom of Na.

$$\text{Ionisation energy for 1 mole} = \frac{0 \cdot 0821 \times 10^{-12} \times 6 \cdot 02 \times 10^{23}}{1000} \text{ kJ}$$

$= 494 \text{ kJ mol}^{-1}$ **2**

**12. (a)** $H^+ = 1s^2$ **1**

**(b)** $Na^+ = 1s^2, 2s^2\ 2p^6$ **1**

**(c)** $O^{2-} = 1s^2, 2s^2\ 2p^6$ **1**

**13. Octet rule—**The atoms of different elements combine with each other in order to complete their respective octets (*i.e.*, 8 electrons in their outermost shell) or duplet (*i.e.,* outermost shell having 2 electrons) in case of H, Li and Be to attain stable nearest noble gas configuration. **2**

**Significance of octet rule—**It helps to explain why different atoms combine with each other to form ionic compounds or covalent compounds. Octet rule cannot explain the formation of $BeCl_2$, $PCl_3$, $SF_6$ etc. **1**

**14. (a)** Let the oxidation number of O be *x*. Since Ca is an alkaline earth metal, therefore, its oxidation number is + 2. Thus,

$$\overset{+2}{\text{Ca}}\ \overset{x}{\text{O}_2} \qquad +2 + 2(x) = 0 \text{ or } x = -1$$

Thus, oxidation number of O in $CaO_2 = -1$ **1**

**(b)** In $NaBH_4$, H is present as hydride ion. Therefore, its oxidation number is –1. Thus,

$$\overset{+1}{\text{Na}}\ \overset{x}{\text{B}}\ \overset{-1}{\text{H}_4} \qquad 1\,(+1) + x + 4\,(-1) = 0 \text{ or } x = +3$$ **1**

Thus, the oxidation number of B in $NaBH_4 = +3$

**(c)**

$$\overset{+1}{\text{H}_2}\ \overset{x}{\text{S}_2}\ \overset{-2}{\text{O}_7} \qquad 2\,(+1) + 2(x) + 7\,(-2) = 0 \text{ or } x = +6$$ **1**

Thus, the oxidation number of S in $H_2S_2O_7 = +6$

**15.** In anhydrous $AlCl_3$, aluminium atom is linked with three chlorine atoms by covalent bond. However, when aluminium chloride is dissolved in water, it undergoes hydration as

$$Al_2Cl_6 + \text{water} \rightleftharpoons 2[Al(H_2O)_6]^{3+} + 6Cl^- + \text{Energy}$$

Hydration of $Al_2Cl_6$ is an exothermic reaction and the released energy is responsible for the removal of three electrons from Al to form $Al^{3+}$. Thus, $AlCl_3.6H_2O$ is ionic in nature. **3**

**16. (a)** Water can act as an acid towards $NH_3$ and as a base towards $H_2S$ :

$$\underset{}{H_2O\ (l)} + \underset{}{NH_3\ (aq)} \longrightarrow \underset{}{NH_4^+\ (aq)} + \underset{}{OH^-\ (aq)}$$
$$\text{Acid}_1 \quad \text{Base}_2 \quad \text{Acid}_2 \quad \text{Base}_1$$

$$\underset{}{H_2O\ (l)} + \underset{}{H_2S\ (aq)} \longrightarrow \underset{}{H_3O^+\ (aq)} + \underset{}{HS^-\ (aq)}$$ **1**
$$\text{Base}_1 \quad \text{Acid}_2 \quad \text{Acid}_1 \quad \text{Base}_2$$

**(b)** The bleaching action of hydrogen peroxide is due to the nascent oxygen which it liberates on decomposition,

$$H_2O_2 \longrightarrow H_2O + [O]$$

The nascent oxygen combines with colouring matter which, in turn, gets oxidized. Thus, the bleaching action of $H_2O_2$ is due the oxidation of colouring matter by nascent oxygen. It is used for the bleaching of delicate materials like ivory, feathers, silk, wool, etc.

$$\text{Colouring matter} + [O] \longrightarrow \text{Colourless matter}$$ **2**

**17. (i)**

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

At equilibrium $0{\cdot}5 \times 10^{-1}$ mol $L^{-1}$ $x$ mol $L^{-1}$ $x$ ml $L^{-1}$

$$K_c = \frac{x^2}{0{\cdot}5 \times 10^{-1}} = 8{\cdot}3 \times 10^{-3} \text{ (Given)}$$

or $$x^2 = (8{\cdot}3 \times 10^{-3})\ (0{\cdot}5 \times 10^{-1}) = 4{\cdot}15 \times 10^{-4}$$

or $$x = \sqrt{4{\cdot}15 \times 10^{-4}} = 2{\cdot}04 \times 10^{-2} \text{ M} = 0{\cdot}02 \text{ M}$$

Hence, $[PCl_3]_{eq} = [Cl_2]_{eq} = 0{\cdot}02$ M **2**

(ii) $$K_p = K_c\ (RT)\ \Delta^{ng}$$
$$= 8{\cdot}3 \times 10^{-3} \times 0{\cdot}082 \times 473$$
$$= 0{\cdot}3216 \text{ atm.}$$ **1**

**18.** Calculation of partial pressure of $H_2$ in I L vessel

$P_1 = 0{\cdot}8$ bar, $V_1 = 0{\cdot}5$ L

$P_2 = ?$ $V_2 = 1{\cdot}0$ L

As temperature remains constant, $P_1V_1 = P_2V_2$

$(0{\cdot}8 \text{ bar})\ (0{\cdot}5\text{L}) = P_2\ (1{\cdot}0\text{L}))$ or $P_2 = 0{\cdot}40$ bar, *i.e.* $pH_2 = 0{\cdot}40$ bar **1**

Calculation of partial pressure of $O_2$ in I L vessel

$$P_1V_1 = P_2V_2$$

$(0{\cdot}7 \text{ bar}\ (2{\cdot}0 \text{ L})$ or $P_2 = 1{\cdot}4$ bar, *i.e.*, $pO_2 = 1{\cdot}4$ bar **1**

Total pressure $= pH_2 + pO_2 = 1{\cdot}4$ bar $+ 1{\cdot}4$ bar $= 2{\cdot}8$ bar **1**

**19.** The tropospheric pollution occurs because of the presence of undersirable gaseous and solid particles in the air. The main pollutants in the troposphere are as follows :

(i) **Gaseous air pollutants :** The gaseous air pollutants include oxides of sulphur ($SO_2$, $SO_3$), nitrogen (NO, $NO_2$), carbon (CO, $CO_2$), hydrogen sulphide ($H_2S$) hydrocarbons, ozone and other oxidants. **2**

(ii) **Particulate pollutants :** These pollutants are dust, fumes, mist, spray, smoke, etc. **1**

**20.** (i)

$$C_2H_5OH + PCl_5 \longrightarrow C_2H_5Cl + POCl_3 + HCl$$

$$C_2H_5Cl + H_2 \xrightarrow{Zn,\ H^+} C_2H_6 + HCl$$

Ethane **1**

(ii)

$$C_6H_5NHCOCH_3 + H_2O \longrightarrow C_6H_5NH_2 + CH_3COOH$$

$$C_6H_5NH_2 + HNO_2 \xrightarrow[273\text{ K}]{NaNO_2 / HCl} C_6H_5N_2Cl + 2H_2O$$

$$C_6H_5N_2Cl + H_3PO_2 + H_2O \longrightarrow C_6H_6 + N_2 + H_3PO_3 + HCl$$ **1**

(iii) $$C_6H_6 + HNO_3\ (\text{Conc.}) \xrightarrow{H_2SO_4\ (\text{conc.})} C_6H_5NO_2 + H_2O$$ **1**

**21.** (i) In steam distillation, water and the organic substance vapourise together and the total vapour pressure becomes equal to atmospheric pressure, *i.e.*,

Vapour pressure of organic substance + Vapour pressure of water

= Atmospheric pressure

This means that in steam distillation, the organic substance vapourises and gets distilled at lower temperature than its boiling point. The proportion of the organic substance that distils over with steam can be obtained. **1½**

(ii) The technique of chromatography is based on the difference in the rates at which the components of a mixture move through a porous medium (called stationary phase) under the influence of some solvent or gas (called moving phase).

Thus, the technique consist of two phases—one of these is a stationary phase of large surface area while the second is a moving phase which is allowed to move slowly over the stationary phase. The stationary phase is either a solid or a liquid while the moving phase may be a liquid or a gas. **1½**

**22.** (i) $\underset{\text{Gypsum}}{2(CaSO_4.2H_2O)} \xrightarrow{393\ K} \underset{\text{Plaster of Paris}}{(CaSO_4)_2.H_2O} + 3H_2O$ **1**

(ii) $CaCO_3 \rightleftharpoons \underset{\text{Quick lime}}{CaO} + CO_2,\ \Delta H = 179{\cdot}9\ kJ$ **1**

(iii) $CaO + H_2O \longrightarrow \underset{\text{Slaked lime}}{Ca(OH)_2}$ **1**

**OR**

(i) Ionisation enthalpies of alkaline earth metals are higher than those of alkali metals. This is because of smaller size of alkaline earth metal corresponding to alkali metal of the same period. **1**

(ii) The oxides of alkali and alkaline earth metal dissolve in water to form their respective hydroxides. These oxides are strong bases. However, the oxides of alkali metals are more basic than those of alkaline earth metals. This is because the ionization enthalpy of alkali metals is lower or the electropositive character of alkali metals is higher than that of corresponding alkaline earth metal so that M–OH bond in a alkali metals can more easily ionize. **1**

$$MOH \longrightarrow M^+ + OH^-$$

(iii) Because of small size and high charge, the lattice enthalpies of alkaline earth metals are much more than those of alkali metals and therefore, the solubility of alkaline earth metal hydroxides is less than that of alkali metals. **1**

**23.** (i) $\underset{(39\ pm)}{Be^{2+}} < \underset{(65\ pm)}{Mg^{2+}} < \underset{(95\ pm)}{Na^+} < \underset{(181\ pm)}{Cl^-}$ ½ + ½ + ½ + ½

(ii) (a) $Br^-$ (b) $O^{2-}$ (c) $Na^+$ (d) As ½ + ½ + ½ + ½

**24.** (i) For one mole of an ideal gas, $C_v = \left(\frac{\Delta U}{\Delta T}\right)$

Or $\Delta U = C_v \Delta T$

For an isothermal process, T is constant so that

$\Delta T = 0$

$\therefore \quad \Delta U = 0$ **2**

(ii) $\Delta H = \Delta U + \Delta(PV)$

For an ideal gas, $PV = RT$

$\therefore \quad \Delta H = \Delta U + \Delta(RT)$

Or $= \Delta U + R\Delta T$

Since T is constant

$\Delta T = 0$

$\Delta H = 0$ **3**

Standard free energy of formation ($\Delta_f G^o$) for the reaction $\frac{1}{2}N_2\ (g) + \frac{1}{2}O_2\ (g) \longrightarrow NO\ (g)$ is positive (+86·7 kJ $mol^{-1}$), hence, the reaction is non-spontaneous under the standard condition. **5**

**25. Distillation** means the conversion of a liquid into vapours, which on condensation by cooling gives a pure liquid. This method is used for purification of liquids which boil without decomposition and contain nonvolatile impurities. This method can also be used for separating liquids having sufficient differences in their boiling points. **1**

**Distillation under reduced pressure** also involves conversion of a liquid into vapours by heating followed by condensation of the vapours thus produced by cooling under reduced pressure. In this method, the pressure acting on the system is not atmospheric pressure but is reduced with help of a vacuum pump. This method is used to purify liquids which decompose below their normal boiling points. **2**

**Steam distillation** is similar to distillation under reduced pressure even though there is no reduction in the total pressure acting on the solution. It is used for the separtion and purification of a liquid which is appreciably volatile when the sum of the vapour pressure of the organic liquid ($p_1$) and that of water ($p_2$) becomes equal to atmospheric pressure *i.e.* ($p$) = $p_1 + p_2$. **2**

**OR**

The process of displacement of σ-electrons along the saturated carbon chain due to the presence of a polar covalent bond at one end of the chain is called **inductive effect** and is denoted as **I-effect**.

This is a permanent effect and is generally represented by an arrow with its head in the middle of the covalent bond pointing in the direction of displacement of electron as shown below :

$$\overset{\delta+'''}{C} \longrightarrow \overset{\delta+''}{C} \longrightarrow \overset{\delta+'}{C} \longrightarrow \overset{\delta+}{C} \longrightarrow \overset{\delta-}{Cl}$$

However, it may be noted that this effect decreases sharply as we move away from the atoms involved in the intial polar bond and becomes negligible from the fourth atom onwards. **1½**

The phenomenon of movement of electrons from one atom to another in a multiple bond at the demand of attacking reagent is called **electromeric effect** and is denoted as **E-effect.**

The electromeric shift of electrons occurs only at the moment of reaction.

Like the inductive effect, the electromeric effect is also classified as :

(i) Electron donating electromeric effect or + E effect

(ii) Electron withdrawing electromeric effect or – E effect. **1½**

(a) – I effect (b) + I effect **1 + 1**

**26.** (a) Aluminium reacts with acids as well as alkalies and therefore, shows amphoteric character.

$$2Al\ (s) + 6HCl\ (aq) \longrightarrow 2Al^{3+}\ (aq) + 6Cl\ (aq) + 3H_2(g)$$

$$2Al(s) + 2NaOH\ (aq) + 6H_2O\ (l) \longrightarrow 2Na^+\ [Al(OH)_4]^-\ (aq) + 3H_2(g)$$

Sodium tetrahydroxoaluminate (III) **2**

(b) (i) Electron deficient compounds are those in which the central atom either does not have eight electrons in the valence shell or it has eight electrons but can expand its valency beyond 4 due to the presence of vacant *d*-orbitals. **1**

(ii) $BCl_3$ is an electron deficient species because it has 6 electrons in the valence shell of B atom. It accepts a pair of electrons from $NH_3$ to complete its octet.

$$Cl_3B + NH_3 \longrightarrow Cl_3B \leftarrow NH_3$$ **1**

(iii) In $SiCl_4$, the central Si atom has 8 electrons but it can expand its valency beyond 4 due to the presence of vacant *d*-orbitals. Therefore, it may allso be regarded as electron deficient. **1**

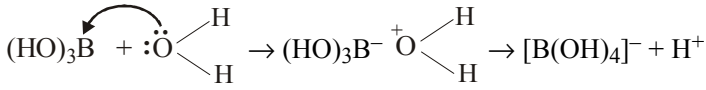
**OR**

(a) B atom in $BCl_3$ has only six electrons in the valence shell and therefore, is an electron deficient molecule. It can readily accept a pair of electrons donated by water and hence undergoes hydrolysis to form boric acid and HCl.

$$BCl_3 + 3H_2O \longrightarrow H_3BO_3 + 3HCl$$

In contrast, C atom in $CCl_4$ has 8 electrons in its valence shell. It does not have vacant *d*-orbitals to extend its octet. Therefore, it is an electron precise molecule and hence neither accepts nor donates a pair of electrons. Therefore, it does not accept a pair of electrons from $H_2O$ molecule and hence $CCl_4$ does not undergo hydrolysis in water. **2**

(b) Boric acid is not a protic acid because it does not ionize in water to give a proton. But it acts as a Lewis acid by accepting electrons from hydroxide ion :



Or $B(OH)_3\,(aq) + 2H_2O \rightarrow [B(OH)_4]^-\,(aq) + H_3O^+(aq)$

Thus, boric acid acts as Lewis acid because it reacts with $OH^-$ (Lewis base) ions rather than acting as a Bronsted acid. **3**