

Sample Question Paper – D

1. Three (n , l and m) 1
2. Octahedral. 1
3. Compressibility factor, $Z = \frac{pV}{nRT}$ 1
4. Oxidation number of sulphur in $\text{Na}_2\text{S}_2\text{O}_3$ is +2 and in $\text{Na}_2\text{S}_4\text{O}_6$ is $+\frac{5}{2}$ Pt.. 1
5. "15 Volume" of hydrogen peroxide means that 1 litre of this solution will give 15 litre of oxygen at NTP. 1

6. Element	% by mass	Atomic mass	Moles of the element (relative no. of moles)	Simplest molar ratio	Simplest whole number molar ratio
C	92.32	12	$\frac{92.32}{12} = 7.69$	1	1
H	7.68	1	$\frac{7.68}{1} = 7.68$	1	1

Empirical formula = CH 1

7. Molar mass of methanol (CH_3OH) = $32 \text{ g mol}^{-1} = 0.032 \text{ kg mol}^{-1}$

$$\text{Molarity of the given solution} = \frac{0.793 \text{ kg L}^{-1}}{0.032 \text{ kg mol}^{-1}} = 24.78 \text{ mol L}^{-1} \quad 1$$

Applying

$$M_1 \times V_1 = M_2 V_2$$

(Given solution) (Solution to be prepared)

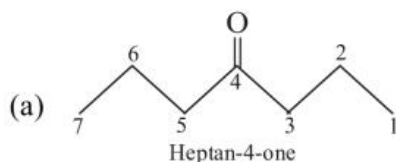
or

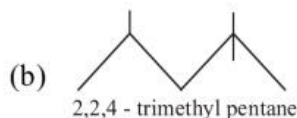
$$24.78 \times V_1 = 0.25 \times 2.5 \text{ L}$$

$$V_1 = 0.02522 \text{ L} = 25.22 \text{ ml.} \quad 1$$

8. Reactions affected will be those in which ($n_p = n_r$)_{gaseous}. By applying Le Chatelier's principle, we can predict the direction. Increase of pressure will shift the equilibrium to the side in which the number of moles is less.
- (a) $n_p = 2$, $n_r = 1$, i.e., $n_p > n_r$ reaction will go in the **backward direction**. 1
 - (b) $n_p = 3$, $n_r = 3$, i.e., $n_p = n_r$ reaction **will not be affected by pressure**. 1
9. Tetrachloroethene ($\text{Cl}_2\text{C} = \text{CCl}_2$) has earlier used as solvent for dry cleaning. This compound is suspected to be carcinogenic and contaminates the ground water. The process of using this compound has now been replaced by a new process in which liquefied carbon dioxide along with suitable detergent is used. This causes less harm to ground water. 2
10. (i) But - 1, 3 diene 1
- (ii) 4- phenyl but -1- ene 1

OR





1

11. (i) $^{35}_{17}\text{Cl}$ (ii) $^{233}_{92}\text{U}$ (iii) ^9_4Be

1 + 1 + 1

12. Energy of the incident radiation = Work function + Kinetic energy of photoelectron

$$\begin{aligned}\text{Energy of incident radiation (E)} &= h\nu = h \frac{c}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ Js})(3.0 \times 10^8 \text{ ms}^{-1})}{(256.7 \times 10^{-9} \text{ m})} \\ &= 7.74 \times 10^{-19} \text{ J} = 4.83 \text{ eV} \quad (1 \text{ eV} = 1.602 \times 10^{-19} \text{ J})\end{aligned}$$

2

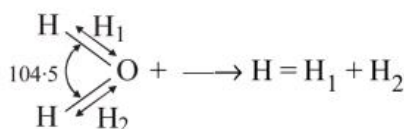
The potential applied gives the kinetic energy to the electron.

Hence, kinetic energy of the electron = 0.35 eV

$$\therefore \text{Work function} = 4.83 \text{ eV} - 0.35 \text{ eV} = 4.48 \text{ eV}.$$

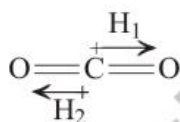
1

13. H_2O molecule has a dipole moment 1.84 D which shows that its molecule should be non-linear.



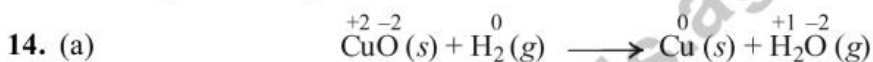
1½

Whereas dipole moment of CO_2 is zero, which shows that its molecule should be linear.



1½

where H_1 cancels H_2 .



In this case O. N. of Cu decreases from +2 (in CuO) to 0 (in Cu) and that of H increases from 0 (in H_2) to +1 (in H_2O). Therefore, CuO is reduced to Cu while H_2 is oxidized to H_2O . Thus, this is a redox reaction.

1



O. N. of Fe decreases from +3 (in Fe_2O_3) to 0 (in Fe) and that of C increases from +2 (in CO) to +4 (in CO_2). Therefore, Fe_2O_3 is reduced while CO is oxidized. Thus, this is a redox reaction.

1



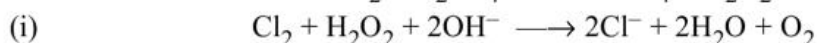
O. N. of B decreases from +3 (in BCl_3) to -3 in B_2H_6 and that of H increases from -1 (in LiAlH_4) to +1 (in B_2H_6). Therefore, BCl_3 is reduced and LiAlH_4 is oxidized. Hence, it is a redox reaction.

1

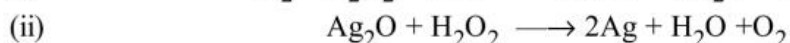
15. Anhydrous barium peroxide is not used because barium sulphate forms a protective layer around unreacted barium peroxide which prevents its further participation in the chemical reaction.



1

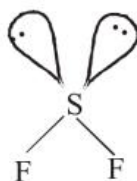


1



1

16. In BeF_2 , Be is surrounded by 2 electron bond pairs and therefore, the molecule is **linear**. on the other hand, in SF_2 , the central atom, S, is surrounded by 2 bond pairs and 2 lone pairs. Due to larger repulsions between lone pair—bond—pair, the bond angle is less than 109.5° and the SF_2 molecule is angular.



3

17.
$$Q_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} = \frac{(0.5)^2}{(3.0)(2.0)^3} = 0.0104$$
 1

As $Q_c \neq K_c$, reaction is not in equilibrium.

As $Q_c < K_c$ reaction will proceed in the forward direction. 1

18. (i) $d = \frac{MP}{RT}$. For the same gas at different temperatures and pressures, $\frac{d_1}{d_2} = \frac{P_1}{T_1} \times \frac{T_2}{P_2}$ 1

Here, $d_1 = 5.46 \text{ g dm}^{-3}$, $T_1 = 27^\circ\text{C} = 300 \text{ K}$, $P_1 = 2 \text{ bar}$

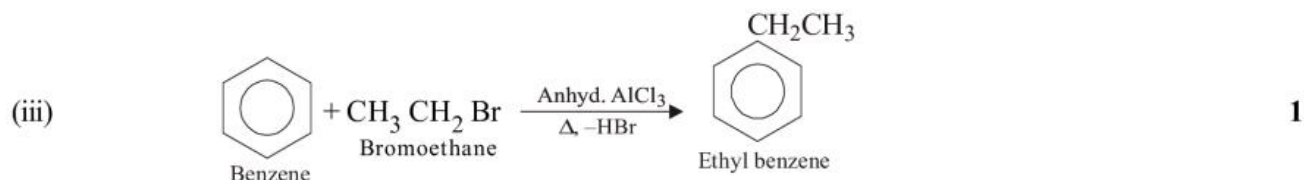
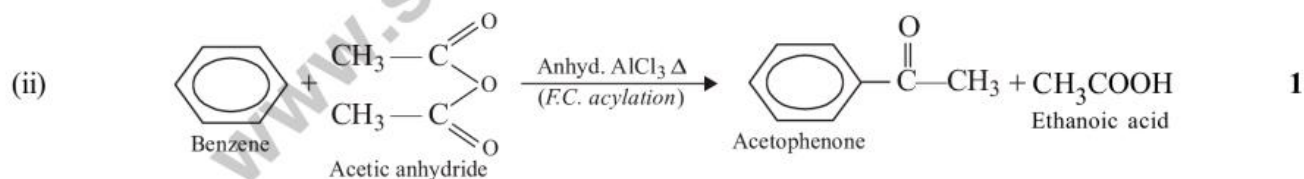
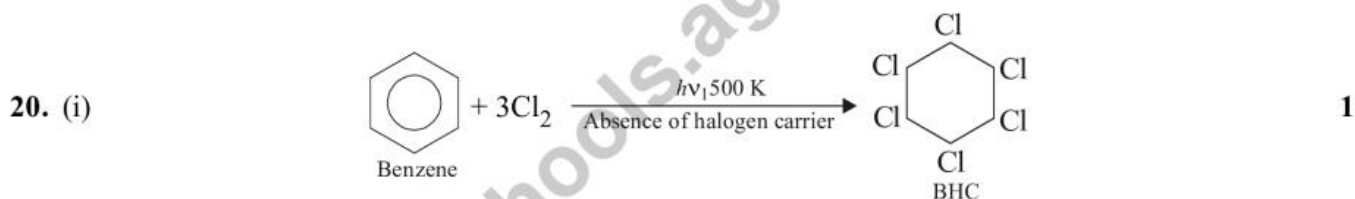
At STP, $D_2 = ?$ $T_2 = 0^\circ\text{C} = 273 \text{ K}$, $P_2 = 1 \text{ bar}$

$$\frac{5.46 \text{ g dm}^{-3}}{d_2} = \frac{2 \text{ bar}}{300 \text{ K}} \times \frac{273 \text{ K}}{1 \text{ bar}}$$
 2

or $d_2 = 3 \text{ g dm}^{-3}$

(ii) Higher the critical temperature, more easily the gas can be liquefied, *i.e.*, greater are the intermolecular forces of attraction. Hence, CO_2 has stronger intermolecular forces than CH_4 . 1

19. The solar energy radiated back from the earth surface is absorbed by green house gases such as CO_2 , CH_4 , O_3 , CFC's, water vapour, etc. present near the earth's surface. Therefore, they heat up the atmosphere near the earth's surface and keep it warm. Therefore, they keep the temperature of each constant and help in growth of plants and existence of life on earth. If there are no green house gases, there would have no vegetation on earth and hence no life on earth. 3



21. In Dumas method, a known mass of an organic compound is heated with excess of CuO in an atmosphere of CO_2 when nitrogen of the organic compound is converted into N_2 gas. The volume of N_2 thus obtained is converted into N. T. P. and percentage of nitrogen is calculated by using the relation.

$$\%N = \frac{28}{22400} \times \frac{\text{Vol. of } \text{N}_2 \text{ at N.T.P.}}{\text{Mass of substance}} \times 100$$
 1½

In kjeldahl's method, a known mass of an organic compound is heated with conc. H_2SO_4 in the presence of K_2SO_4 (raises the boiling point of H_2SO_4) and little CuSO_4 or Hg (catalyst) in a Kjeldahl's flask when nitrogen present in the compound is quantitatively converted into $(\text{NH}_4)_2\text{SO}_4$. The $(\text{NH}_4)_2\text{SO}_4$ thus obtained is boiled with excess of NaOH solution to liberate NH_3 gas which is absorbed in a known excess of standard solution of H_2SO_4 or HCl . The volume of acid unused is determined by titration against a standard alkali solution. From the volume of acid used the percentage of N is calculated from the relation :

$$\% \text{ N} = \frac{1.4 \times \text{Molarity of acid} \times \text{Basicity of acid} \times \text{Vol. of acid used}}{\text{Mass of substance taken}} \quad 1\frac{1}{2}$$

22. (i) **Important use of caustic soda**—(a) It is used in refining of petroleum. 1
 (ii) **Important use of sodium carbonate**—(a) It is used in the manufacture of glass, borax and caustic soda. 1
 (iii) **Important use of quick lime**—It is used in the purification of sugar and in the manufacture of dye stuffs. 1

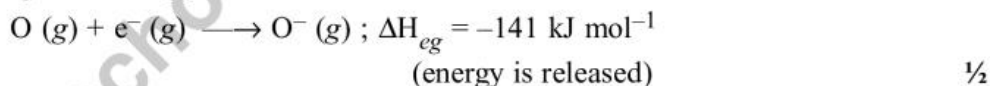
OR

Sodium and potassium cations play a very important role in biological fluids. They are present in biological fluids and the ratio of K to Na is 7 : 1 in mammals such as human beings, rats and horses. These cations accumulate in cells and create a concentration gradient and potential in the membrane. These cations regulate osmotic pressure balance of the cells. 1 + 1

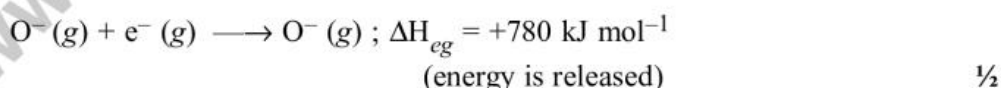
Calcium is present in the form of calcium phosphate $\text{Ca}_3(\text{PO}_4)_2$ in bone. Ca plays a key role in formation of phosphorus oxygen linkages in biological systems for storage of energy. 1

23. (i) (a) F (-328 kJ mol^{-1}) has more negative electron gain enthalpy than O (-141 kJ mol^{-1}). 1
 (b) Cl (-349 kJ mol^{-1}) has more negative electron gain enthalpy than F (-328 kJ mol^{-1}). 1
 (ii) When an electron is added to oxygen atom to form O^- ion energy is released. But when another electron is added to O^- to form O^{2-} energy is absorbed to overcome the strong electrostatic repulsion between the negatively charged O^- and the new electron being added. The second electron gain enthalpy of O is positive. 1

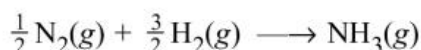
Thus, **first electron gain enthalpy** :



Second electron gain enthalpy :



24. (i) Reaction for the enthalpy of formation of $\text{NH}_3 (\text{g})$ is :

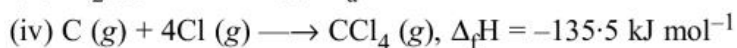
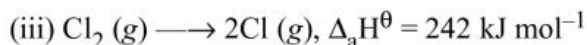


$$\therefore \Delta_f H^\circ = -92.4/2 = -46.2 \text{ kJ mol}^{-1} \quad 2$$

- (ii)
- | | | |
|--|--|---|
| $\text{C (graphite)} + \text{O}_2 (\text{g}) \longrightarrow \text{CO}_2 (\text{g})$ | $\Delta H^\circ = -393.5 \text{ kJ/mol}$ | |
| $2\text{H}_2 (\text{g}) + \text{O}_2 (\text{g}) \longrightarrow 2\text{H}_2\text{O} (\text{l})$ | $\Delta H^\circ = -571.6 \text{ kJ/mol}$ | |
| $\text{CO}_2 (\text{g}) + 2\text{H}_2\text{O} (\text{l}) \longrightarrow \text{CH}_3\text{OH} (\text{l}) + (3/2)\text{O}_2$ | $\Delta H^\circ = 726.4 \text{ kJ/mol}$ | |
| $\text{C (graphite)} + (1/2) \text{O}_2 (\text{g}) + 2\text{H}_2 (\text{g}) \longrightarrow \text{CH}_3\text{OH} (\text{l})$ | $\Delta H^\circ = -238.7 \text{ kJ/mol}$ | 3 |

OR

- (i) For an isolated system with $\Delta U = 0$, the spontaneous change will occur if $\Delta S > 0$. 2
 (ii) The chemical equations implying to the given values of enthalpies are :
 (i) $\text{CCl}_4 (\text{l}) \longrightarrow \text{CCl}_4 (\text{g}), \Delta V_{ap} \text{HO} = 30.5 \text{ kJ mol}^{-1}$
 (ii) $\text{C (g)} \longrightarrow \text{C (g)}, \Delta_a H^\circ = 715.0 \text{ kJ mol}^{-1}$



Enthalpy change for the given process $\text{CCl}_4(g) \longrightarrow \text{C}(g) + 4\text{Cl}(g)$ can be calculated using the following algebraic calculations as :

Equation (ii) + 2 × Equation (iii) – (Equation (i) – Equation (iv))

$$\Delta H = \Delta_a H^\theta(\text{C}) + 2\Delta_a H^\theta(\text{Cl}_2) - \Delta_{\text{vap}} H^\theta - \Delta_f H$$

$$= (715.0 \text{ kJ mol}^{-1}) + 2(242 \text{ kJ mol}^{-1}) - (30.5 \text{ kJ mol}^{-1}) - (-135.5 \text{ kJ mol}^{-1})$$

$$\therefore \Delta H = 1304 \text{ kJ mol}^{-1}$$

bond enthalpy of C – Cl in $\text{CCl}_4(g)$

$$= \frac{1304}{4} \text{ kJ mol}^{-1}$$

$$= 326 \text{ kJ mol}^{-1}$$

3

25. Amount of carbon in 3.38 g $\text{CO}_2 = \frac{12}{44} \times 3.38 \text{ g} = 0.9218 \text{ g}$

Amount of hydrogen in 0.690 g $\text{H}_2\text{O} = \frac{2}{18} \times 0.690 \text{ g} = 0.0767 \text{ g}$

As compound contains only C and H, therefore, total mass of the compound

$$= 0.9218 + 0.0767 \text{ g} = 0.9985 \text{ g}$$

$$\% \text{ of C in the compound} = \frac{0.9218}{0.9985} \times 100 = 92.32$$

1

$$\% \text{ of H in the compound} = \frac{0.0767}{0.9985} \times 100 = 7.68$$

1

Calculation of Empirical Formula

Element	% by mass	Atomic mass	Moles of the element	Simplest molar ratio	Simplest whole no. molar ratio
C	92.32	12	$\frac{92.32}{12} = 7.69$	1	1
H	7.68	1	$\frac{7.68}{1} = 7.68$	1	1

$\therefore$ Empirical formula = CH

1

10.0 L of the gas at STP weigh = 11.6 g

$$\therefore 22.4 \text{ L of the gas at S. T. P will weigh} = \frac{11.6}{10.0} \times 22.4 = 25.984 \text{ g} = 26 \text{ g}$$

$$\therefore \text{Molar mass} = 26 \text{ g mol}^{-1}$$

1

Empirical formula mass of CH = 13 gm

$$\therefore n = \frac{\text{Molecular mass}}{\text{E. F. mass}} = \frac{26}{13} = 2$$

Molecular formula of the compound is = $(\text{CH})_2$ or C_2H_2

OR

- (a) **Chromatography** : The technique of separating the components of a mixture by their separation is achieved by the differential movement of individual components through a stationary phase under the influence of a mobile phase. 1

The retention factor is

$$R_f = \frac{\text{Distance travelled by the component (x)}}{\text{Distance travelled by the solvent (y)}} \quad 1$$

- (b) **Step I.** To determine the volume of H_2SO_4 used,

$$\begin{aligned} \text{Volume of acid taken} &= 50 \text{ ml of } 0.5 \text{ M } \text{H}_2\text{SO}_4 \\ &= 25 \text{ ml of } 1.0 \text{ M } \text{H}_2\text{SO}_4 \end{aligned}$$

Volume of alkali used for neutralisation of excess of acid

$$\begin{aligned} &= 60 \text{ ml of } 0.5 \text{ M } \text{NaOH} \\ &= 30 \text{ ml of } 1.0 \text{ M } \text{NaOH} \end{aligned} \quad \frac{1}{2}$$

Now 1 mole of H_2SO_4 neutralises 2 moles of NaOH



$$\therefore 30 \text{ ml of } 1 \text{ M } \text{NaOH} = 15 \text{ ml of } 1 \text{ M } \text{H}_2\text{SO}_4$$

$\therefore$ Volume of acid used by ammonia

$$= 25 - 15 = 10 \text{ ml.} \quad 1$$

Step II. To determine percentage of nitrogen in the compound 1 mole of H_2SO_4 neutralises 2 moles of NH_3 .

$$\therefore 10 \text{ ml of } \text{MH}_2\text{SO}_4 = 20 \text{ ml of } 1 \text{ M } \text{NH}_3. \quad \frac{1}{2}$$

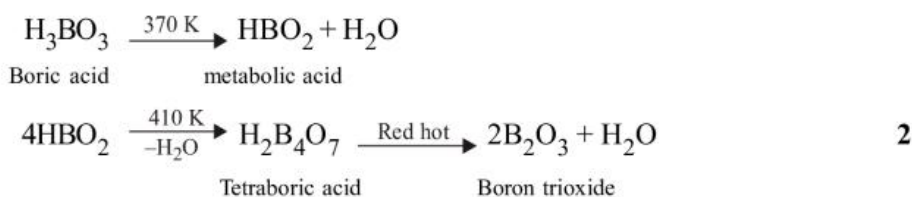
But 1000 ml of 1 M NH_3 contains 14 g of nitrogen

$$\therefore 20 \text{ ml of } 1 \text{ M } \text{NH}_3 \text{ will contain N} = \frac{14}{1000} \times 20$$

This is the amount of N present in 0.5 g of compound.

$$\% \text{N} = \frac{14}{1000} \times \frac{20}{0.5} \times 100 = 56.0 \quad 1$$

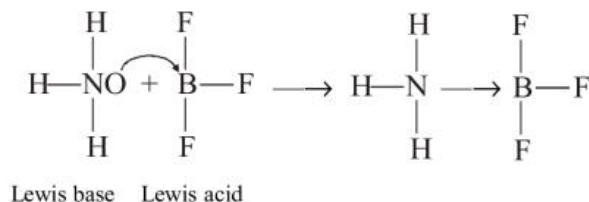
26. (a) Boric acid, on heating, loses water in three different stages at different temperatures ultimately giving boron trioxide.



- (b) BCl_3 is more stable than TlCl_3 because inert pair is missing in BCl_3 . Due to inert pair thallium will prefer to form TlCl rather than TlCl_3 . It prefers to show an oxidation state of +1. 1

- (c) The Lewis structure of BF_3 is $\begin{array}{c} \text{F} \\ \vdots \\ \text{B} : \text{F} \\ \vdots \\ \text{F} \end{array}$ or $\begin{array}{c} \text{F} \\ | \\ \text{B} - \text{F} \\ | \\ \text{F} \end{array}$. 1

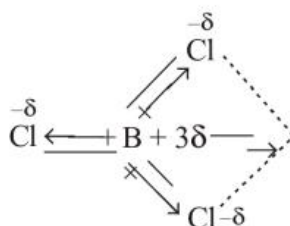
Clearly B has not been able to complete its octet [It has only 6 electrons around it]. Therefore, BF_3 is an electron deficient compound. All such electron-deficient compounds are electron pair acceptors and so it is Lewis acids.



1

OR

- (a) (1) BCl_3 molecule due to sp^2 hybridisation of boron is trigonal planar molecule and has a symmetrical shape. 1/2
- (2) Individual B—Cl bond has dipole, the molecule BCl_3 has a zero dipole moment. This is due to the fact that individual dipole moments cancel out on account of the symmetry of the molecule as shown below : 1/2



1

Dipole moment is zero for symmetrical BCl_3

- (b) AlF_3 is insoluble in anhydrous HF, but dissolves on addition of NaF due to the formation of Na_3AlF_6 . 1



1

Sodium hexafluoroaluminate (III)



1

Aluminium
trifluoride

• •

