



### III. Long Answer Type Questions

Question 1. Calculate no. of carbon and oxygen atoms present in 11.2 litres of  $\text{CO}_2$  at N.T.P.

Answer: Step I. Number of  $\text{CO}_2$  molecules in 11.2 litres

22.4 litres of  $\text{CO}_2$  at N.T.P. = 1 gram mol

11.2 litres of  $\text{CO}_2$  at N.T.P. =  $\frac{(1 \text{ gram mol})}{(22.4 \text{ litres})} \times (11.2 \text{ litres}) = 0.5 \text{ gram mol}$

Now 1 gram mole of  $\text{CO}_2$  contain molecules =  $6.022 \times 10^{23}$

$\therefore$  0.5 gram mole of  $\text{CO}_2$  contain molecules =  $6.022 \times 10^{23} \times 0.5 = 3.011 \times 10^{23}$

**Step II.** Number of carbon and oxygen atoms in  $3.011 \times 10^{23}$  molecules of  $\text{CO}_2$

1 molecule of  $\text{CO}_2$  contains carbon atoms = 1

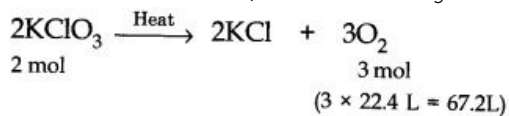
$\therefore$   $3.011 \times 10^{23}$  molecules of  $\text{CO}_2$  will contain carbon atoms =  $3.011 \times 10^{23}$

Similarly, 1 molecule of  $\text{CO}_2$  contains oxygen atoms = 2

$\therefore$   $3.011 \times 10^{23}$  molecules of  $\text{CO}_2$  will contain oxygen atoms =  $2 \times 3.011 \times 10^{23}$   
=  $6.022 \times 10^{23}$  atoms.

Question 2.  $\text{KClO}_3$  on heating decomposes to give  $\text{KCl}$  and  $\text{O}_2$ . What is the volume of  $\text{O}_2$  at N.T.P liberated by 0.1 mole of  $\text{KClO}_3$ ?

Answer: The chemical equation for the decomposition of  $\text{KClO}_3$  is



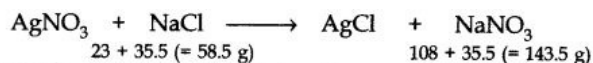
2 moles of  $\text{KClO}_3$  evolve  $\text{O}_2$  at N.T.P. = 67.2 L

1 mole of  $\text{KClO}_3$  evolve  $\text{O}_2$  at N.T.P. =  $\frac{67.2}{2}$  L

0.1 mole of  $\text{KClO}_3$  evolve  $\text{O}_2$  at N.T.P. =  $\frac{67.2}{2} \times 0.1 \text{ L} = 3.36 \text{ L}$

Question 3. 10 ml of a solution of  $\text{NaCl}$  containing  $\text{KCl}$  gave on evaporation 0.93 g of the mixed salt which gave 1.865 g of  $\text{AgCl}$  by reacting with  $\text{AgNO}_3$  solution. Calculate the quantity of  $\text{NaCl}$  in 10 mL of the solution.

Answer: The chemical equation for the reaction is:



Let the mass of NaCl and KCl in the mixture be respectively  $a$  g and  $b$  g.

$$\therefore a + b = 0.93 \text{ (given)}$$

Let us find AgCl formed on reacting NaCl and KCl with  $\text{AgNO}_3$  solution.

58.5 g of NaCl give AgCl = 143.5 g

$$\therefore a \text{ g of NaCl will give AgCl} = \frac{(143.5 \text{ g})}{(58.5 \text{ g})} \times (a \text{ g})$$

Similarly, 74.5 g of KCl give AgCl = 143.5 g

$$b \text{ g of KCl will give AgCl} = \frac{(143.5 \text{ g})}{(74.5 \text{ g})} \times (b \text{ g})$$

But mass of AgCl actually formed = 1.865 g (given)

$$\therefore \frac{143.5 \times a}{58.5} + \frac{143.5 \times b}{74.5} = 1.865; \quad \frac{143.5 \times a}{58.5} + \frac{143.5(0.93 - a)}{74.5} = 1.865$$

$$2.453 a + 1.93(0.93 - a) = 1.865; \quad 2.453 a + 1.795 - 1.93 a = 1.865$$

$$0.523 a = 0.07 \quad \text{or} \quad a = \frac{0.07}{0.523} = 0.14$$

Mass of NaCl in the mixture = **0.14 g**

Mass of KCl in the mixture =  $(0.93 - 0.14) = \mathbf{0.79 \text{ g}}$ .

Question 4. The cost of table salt ( $\text{NaCl}$ ) and table sugar ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ ) are Rs 1 per kg and Rs 6 per kg respectively. Calculate their cost per mole.

Answer:

(a) Cost of table salt ( $\text{NaCl}$ ) per mole

Gram molecular mass of  $\text{NaCl} = 23 + 35.5 = 58.5 \text{ g}$  Now, 1000 g of  $\text{NaCl}$  cost = Rs 2

$$\therefore 58.5 \text{ g of NaCl will cost} = \frac{2}{(1000 \text{ g})} \times (58.5 \text{ g}) = 0.117 \text{ Rupee}$$

$$= 0.117 \times 100 = \mathbf{12 \text{ paise (approx.)}}$$

(b) Cost of table sugar ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ ) per mole

Gram molecular mass of ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ ) =  $12 \times 12 + 22 \times 1 + 16 \times 11 = 144 + 22 + 176 = 342 \text{ g}$

Now, 1000 g of sugar cost = Rs 6

$$\therefore 342 \text{ g of sugar will cost} = \frac{6}{(1000 \text{ g})} \times (342 \text{ g}) = 2.052$$

$$= \mathbf{2.0 \text{ Rupees (approx.)}}$$

Question 5. A flask P contains 0.5 mole of oxygen gas. Another flask Q contains 0.4 mole of ozone gas. Which of the two flasks contains greater number of oxygen atoms?

Answer:

1 molecule of oxygen ( $\text{O}_2$ ) = 2 atoms of oxygen

1 molecule of ozone ( $\text{O}_3$ ) = 3 atoms of oxygen

**In flask P:** 1 mole of oxygen gas =  $6.022 \times 10^{23}$  molecules

0.5 mole of oxygen gas =  $6.022 \times 10^{23} \times 0.5$  molecules

$$= 6.022 \times 10^{23} \times 0.5 \times 2 \text{ atoms} = \mathbf{6.022 \times 10^{23} \text{ atoms}}$$

**In flask Q:** 1 mole of ozone gas =  $6.022 \times 10^{23}$  molecules

0.4 mole of ozone gas =  $6.022 \times 10^{23} \times 0.4$  molecules

$$= 6.022 \times 10^{23} \times 0.4 \times 3 \text{ atoms} = \mathbf{7.23 \times 10^{22} \text{ atoms}}$$

$\therefore$  Flask Q has a greater number of oxygen atoms as compared to the flask P.

Question 6. Calculate the total number of electrons present in 1.6 g of methane.

Answer:

(i) Molar mass of methane ( $\text{CH}_4$ ) =  $12 + 4 \times 1 = 16 \text{ g}$

16 g of methane contain molecules =  $6.022 \times 10^{23}$

$$1.6 \text{ g of methane contain molecule} = \frac{6.022 \times 10^{23}}{(16 \text{ g})} \times (1.6 \text{ g}) = 6.022 \times 10^{22}$$

(ii) Number of electrons in  $6.022 \times 10^{22}$  molecules of methane

1 molecule of methane contains electrons =  $6 + 4 = 10$

$$6.022 \times 10^{22} \text{ molecules of methane contain electrons} \\ = 6.022 \times 10^{22} \times 10 = 6.022 \times 10^{23}.$$

Question 7. The vapour density of a mixture of  $\text{NO}_2$  and  $\text{N}_2\text{O}_4$  is 38.3 at  $27^\circ\text{C}$ . Calculate the number of moles of  $\text{NO}_2$  in 100 g of the mixture.

Answer:

Vapour density of the mixture of  $\text{NO}_2$  and  $\text{N}_2\text{O}_4$  = 38.3

Molecular mass of the mixture =  $2 \times \text{Vapour density} = 2 \times 38.3 = 76.6 \text{ u} = 76.6 \text{ g}$

Mass of the mixture = 100 g

$$\text{No. of moles of the mixture} = \frac{100}{76.6}$$

Let the mass of  $\text{NO}_2$  in the mixture =  $x \text{ g}$

$\therefore$  Mass of  $\text{N}_2\text{O}_4$  in the mixture =  $(100 - x) \text{ g}$

Molar mass of  $\text{NO}_2$  =  $14 + 32 = 46 \text{ u} = 46 \text{ g}$

Molar mass of  $\text{N}_2\text{O}_4$  =  $28 + 64 = 92 \text{ u} = 92 \text{ g}$

$$\text{No. of moles of } \text{NO}_2 = \frac{x}{46}$$

$$\text{No. of moles of } \text{N}_2\text{O}_4 = \frac{(100 - x)}{92}$$

$$\text{Total no. of moles in the mixture} = \frac{x}{46} + \frac{(100 - x)}{92}$$

$$\text{Equating (i) and (ii), } \frac{x}{46} + \frac{(100 - x)}{92} = \frac{100}{76.6}$$

$$92x + 46(100 - x) = \frac{100}{76.6} \times 46 \times 92 = 5524.8$$

$$92x - 46x = 5524.8 - 4600 = 924.8.$$

Question 8. The Vapour Density of a gaseous element is 5 times that of oxygen under similar conditions. If the molecule is triatomic, what will be its atomic mass?

Answer: Molecular mass of oxygen = 32 u

$$\text{Density of oxygen} = \frac{32}{2} = 16 \text{ u}$$

Density of gaseous element =  $16 \times 5 = 80 \text{ u}$

Molecular mass of gaseous element =  $80 \times 2 = 160 \text{ u}$

Atomicity of the element = 3

$$\text{Atomic mass of the element} = \frac{\text{Molecular Mass}}{\text{Atomicity}} = \frac{160}{3} = 53.33 \text{ u.}$$

1/6th of its volume. Since equal volumes of gases have equal number of moles according to Avogadro's Law,

$$\therefore \frac{\text{Moles of } \text{CO}_2}{\text{Moles of both gases}} = \frac{x}{(2x + y)} = \frac{1}{6}$$

$$\text{or } 6x = 2x + y \quad \text{or } 4x = y \quad \text{or } \frac{y}{x} = 4$$

$\therefore$  Molar ratio of formic acid : oxalic acid = 4 : 1.

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