WORKSHEET 1

CHAPTER 5 – MOLE CONCEPT AND STOICHIOMETRY

A. Give suitable word/words for the following statements

1. It is a number that represents how many times an atom of an element is heavier than 1/12th mass of carbon atom.
2. The molecular weight of an element expressed in grams.
3. The number of atoms present in 12 g of carbon-12.
4. Equal volumes of gases under similar conditions of temperature and pressure contain equal number of molecules.
5. A formula of a chemical substance which tells the actual number of atoms in one molecule of a substance.

B. Fill in the blanks from the choices given within the brackets.

1. The relative molecular mass is a number that represents how many times one _____ (atom/molecule) of a substance is heavier than 1/12th mass of carbon-12.
2. Whenever the gases react chemically, they do so in _____ (weights/volumes) which bear a simple ratio to each other and to the products, if gaseous, provided the temperature and pressure of reacting gases and products remains the same.
3. A/An _____ (atom/molecule) is the smallest unit of matter, which may or may not have an independent existence, but always takes part in a chemical reaction.
4. Equal volumes of all _____ (liquids/gases), under similar conditions of temperature and pressure, contain equal number of molecules.
5. The mass of substance containing particles equal to Avogadro's number is called _____ (molecule/mole).

C. Answer the following.

1. A gaseous compound of nitrogen and hydrogen contains 12.5% hydrogen by mass. Find the molecular formula of the compound if its relative molecular mass is 37. [N = 14, H = 1].
2. Define mole.
3. A gas cylinder contains 24×10^{24} molecules of nitrogen gas. If Avogadro's number is 6×10^{23} and the relative atomic mass of nitrogen is 14, calculate
   a. mass of nitrogen gas in the cylinder.
   b. volume of nitrogen at S.T.P. in dm^3.
4. Commercial sodium hydroxide weighing 30 g has some sodium chloride in it. The mixture on dissolving in water and subsequent treatment with excess silver nitrate solution formed a precipitate weighing 14.3 g.

   What is the percentage of sodium chloride in the commercial sample of sodium hydroxide? The equation for the reaction is

   $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

   [Relative molecular mass of NaCl = 58; AgCl = 143]
5. A certain gas 'X' occupies a volume of 100 cm^3 at S.T.P. and weighs 0.5 g. Find its relative molecular mass.

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D. The volumes of gases A, B, C and D are in the ratio 1 : 2 : 2 : 4 under the same conditions of temperature and pressure.

1. Which sample of gas contains the maximum number of molecules?
2. If the temperature and the pressure of gas A are kept constant, then what will happen to the volume of A when the number of molecules is doubled?
3. If this ratio of gas volumes refers to the reactants and products of a reaction, which gas law is being observed?
4. If the volume of A is actually 5.6 dm^3 at S.T.P., calculate the number of molecules in the actual volume of D at S.T.P. (Avogadro's Number = 6×10^{23})

E. From the equation, $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

1. Calculate the weight of calcium chloride obtained from 10 g of calcium carbonate.
2. Calculate the volume at S.T.P. of carbon dioxide obtained from 10 g of calcium carbonate.
(Ca = 40; C = 12; O = 16; H = 1; Cl = 35.5 and 1 mole of a gas at S.T.P. occupies 22.4 litres)

ANSWERS

WORKSHEET 1

A. Give suitable word/words for the following statements.

1. Atomic weight
2. Gram-molecular weight
3. Avogadro's number
4. Avogadro's law
5. Molecular formula

B. Fill in the blanks from the choices given within the brackets.

1. molecule
2. volumes
3. atom
4. gases
5. mole

C. Answer the following.

1. Calculation of Empirical Formula.

Element	Percentage by mass	Atomic weight	No. of moles	Simple Ratio
H	12.5	1	12.5	$\frac{12.5}{6.25} = 2$
N	87.5	14	6.25	$\frac{6.25}{6.25} = 1$

So, the empirical formula = NH_2

Molecular weight = 37

Empirical weight. = $14 + 2 \times 1 = 16$

$$n = \frac{\text{M.W.}}{\text{E.W.}} = \frac{37}{16} = 2.3 \cong 2$$

Molecular formula = $(\text{Empirical formula})_n$

$= (NH_2)_2$

$= N_2H_4$

2. One mole is the amount of a substance which contains as many entities (atoms, molecules, ions) as there are atoms in exactly 0.012 kg of C-12.

3. **a.** Molecular weight of $N_2 = 2 \times 14 = 28$

$\because$ 6×10^{23} molecules of N_2 weigh = 28 g

$\therefore$ 24×10^{24} molecules of N_2 will weigh

$$= \frac{28}{6 \times 10^{23}} \times 24 \times 10^{24} \text{ g}$$

$= 28 \times 40 = 1120$ g

b. $\because$ 6×10^{23} molecules of N_2 occupy 22.4 L at S.T.P.

$\therefore$ 24×10^{24} molecules of N_2 will occupy

$$= \frac{22.4 \times 24 \times 10^{24}}{6 \times 10^{23}} \text{ L}$$

$= 22.4 \times 40 = 896$ L

since 1 L = 1 dm^3, so 24×10^{24} molecules of N_2 will occupy 896 dm^3 of volume.

4. $\underset{58}{NaCl} + AgNO_3 \rightarrow \underset{143}{AgCl} + NaNO_3$

$\because$ 143 g of AgCl is obtained from 58 g of NaCl

$\therefore$ 14.3 g of AgCl is obtained from $\frac{58 \times 14.3 \text{ g}}{143}$

= 5.8 g of NaCl

Weight of commercial NaOH = 30 g

% of NaCl in NaOH = $\frac{5.8 \times 100}{30}$

= 19.33 %

5. $\because$ 100 cm^3 of gas weighs 0.5 g at STP

$\therefore$ 22400 cm^3 of gas X will weigh = $\frac{0.5}{100} \times 22400 = 112$ g

$\therefore$ Relative molecular mass of gas = 112

D. The volumes of gases A, B, C and D are in the ratio 1 : 2 : 2 : 4 under the same conditions of temperature and pressure.

1. D
2. Volume doubles
3. Gay Lussac's Law
4. 22.4 dm^3 has Na molecules (6×10^{23})

5.6 dm^3 has x molecules

$x = \frac{5.6 \times 6 \times 10^{23}}{22.4}$

= 1.5×10^{23} molecules

Number of molecules of D = $1.5 \times 10^{23} \times 4 = 6.0 \times 10^{23}$

E. From the equation, $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

1. $\underset{(40 + 12 + 48)}{CaCO_3} + 2HCl \rightarrow \underset{(40 + 71)}{CaCl_2} + H_2O + CO_2$

100 g of calcium carbonate produces calcium chloride = 111 g

$\therefore$ 10 g of calcium carbonate produces calcium chloride

= $\frac{111 \times 10}{100}$ = 11.1 g.

2. 100 g of calcium carbonate produces carbon dioxide = 22.4 L at S.T.P.

$\therefore$ 10 g of calcium carbonate produces calcium chloride = $\frac{22.4 \text{ L} \times 10 \text{ g}}{100 \text{ g}}$ = 2.24 L

$\because$ 1 L = 1 dm^3

so volume occupied = 2.24 dm^3 at S.T.P.