ASSIGNMENT-3

AMOGH GARG - 2020UCD2123

(1) Molecules of water in 54 g of H_2O?

Moles of H_2O = $\frac{54}{18}$ = 3 moles

1 mole contains 6.022×10^{23} molecules.

∴ 3 moles would contain 18.066×10^{23} molecules of water.

(2) Mass of 6.022×10^{23} molecule of NH_4Cl?

6.022×10^{23} molecules ≡ 1 mole of NH_4Cl

∴ Molar mass is 53.5 g.

↳ Mass of 1 mole.

(3) Mass of 12.044×10^{23} oxygen atoms.

No. of moles = $\frac{12.044 \times 10^{23}}{6.022 \times 10^{23}}$ = 2

∴ Mass = 2 × 16 = 32 g.

(4) Atoms of Hydrogen in 36g of NH_4.

1 mol. contains $4N_A$ H-atoms.

No of mol. of NH_4 = $\frac{36}{18}$ = 2

∴ Atoms of H = $2 \times 4N_A$

= $8N_A$ (where N_A is avagadro number)

(5) Hydrogen atoms in 1 mol. of H_2?

1 mol. contains 6.022×10^{23} molecules of H_2.

$= 2 \times 6.022 \times 10^{23}$ atoms of Hydrogen

$= 12.044 \times 10^{23}$ atoms of Hydrogen.

(6) Cu atoms in 0.3175 g of Cu ?

No. of moles $= \frac{0.3175}{63.5} = 0.005$

No. of atoms $= 0.005 \times 6.022 \times 10^{23}$

$= 0.03 \times 10^{23}$ atoms

$= 3 \times 10^{21}$ atoms

(7) Number of molecules in 22.4 L of CH_4 gas at NTP.

Molar volume at NTP is 22.4 L

∴ Moles of $CH_4 = \frac{22.4}{22.4}$

⇒ No. of molecules $= \frac{22.4}{22.4} \times 6.022 \times 10^{23}$

$= 6.022 \times 10^{23}$ molecules.

(8) (a) Volume of 1 g of H_2 gas at NTP ?

Moles of $H_2 = \frac{1}{2}$

⇒ Volume $= \frac{1}{2} \times 22.4 = 11.2$ L

(b) Volume of 20g H_2 at NTP ?

Moles of $H_2 = \frac{20}{2} = 10$

⇒ Volume $= 10 \times 22.4 = 224$ L

(c) Volume occupied by 6.022×10^{23} molecules of any gas at NTP ?

6.022×10^{23} molecules = 1 mole

⇒ Volume occupied is molar volume

$= 22.4$ L

(9) An atom of element Y weighs 6.644×10^{-23} g. Calculate the no. of g-atoms in 40 Kg of it?

No. of g-atoms $= \frac{40 \times 1000}{6.644 \times 10^{-23}}$

$= 6.02 \times 10^{26}$ atoms

(10) No. of moles and atoms of H and S in 10 mole of H_2S?

No. of moles of H $= 2 \times 10 = 20$ mol

" " " " S $= 10$ mol.

No. of atoms of H $= 20 \times 6.022 \times 10^{23}$

$= 12.044 \times 10^{24}$ atoms

" " " " S $= 6.022 \times 10^{23} \times 10$

$= 6.022 \times 10^{24}$ atoms

(11) Number of atoms of each element in 245 g of $KClO_3$.

Moles of $KClO_3 = \frac{245}{122.5} = 2$ mol.

Atoms of K $= 2 \times N_A = 12.044 \times 10^{23}$ atom

" " Cl $= 2 \times N_A =$ " "

" " O $= 3 \times 2 \times N_A = 36.132 \times 10^{23}$ atom

(12) If 4g of NaOH dissolves in 36g of H_2O, calculate the mole fraction of each component in the solution. Also determine the Molarity.

Moles of NaOH $= \frac{4}{40} = 0.1$

" " $H_2O = 2$

$\chi_{NaOH} = \frac{0.1}{2.1} = 0.047$

$\chi_{H_2O} = \frac{2}{2.1} = 0.953$

Molarity = $\frac{\text{Moles of solute}}{\text{Volume of solution}}$

$= \frac{0.1}{10} = 0.1$ mol/L

(13) No. of atoms in 12.2 L of the below gas at NTP

(i) Mono-atomic – 3.011×10^{23} atoms

(ii) Di-atomic – 6.022×10^{23} atoms

(14) If mole were to taken 1×10^{24} particles, what would be mass of :

(i) 1 mole of oxygen gas

$= \frac{32}{6.02 \times 10^{23}} \times 1 \times 2^{24} = 53.2$ g

(ii) a single oxygen molecule

Mass of 10^{24} particles is 53.2 g.

∴ Mass of 1 molecule $= \frac{53.2}{10^{24}}$

$= 53.2 \times 10^{-24}$ g

(15) Calculate standard molar volume of O_2 gas. (density at NTP is 1.429 g/L)

$PV = nRT$

$\Rightarrow V = \frac{nRT}{P}$ ($n = 1$, $P = 1$ atm, $T = 273$ K

Also, $d = \frac{\text{mass}}{\text{volume}} \Rightarrow \text{Volume} = \frac{32}{1.429}$

$= 22.39$ L

(16) If 2 mol of $CaCO_3$ occupies a volume of 67 ml, Find density ?

$$\text{Density} = \frac{\text{Mass}}{\text{volume}} = \frac{200}{67}$$

$$= 2.985 \text{ g/ml}$$

(17) No. of methane molecules and how many carbon and hydrogen atoms are there in 25 g of methane.

Moles of methane $= \frac{25}{16}$ mol.

Molecules of methane $= \frac{25}{16} \times 6.022 \times 10^{23}$

$= 9.41 \times 10^{23}$ molecules

No. of C-atoms $= \frac{25}{16} \times N_A = 9.41 \times 10^{23}$ atoms

No. of H-atoms $= \frac{25}{16} \times 4 \times N_A = 37.63 \times 10^{23}$ atoms

(18) A metal M of atomic mass 54.94 has a density of 7.42 g/cc. Calculate apparent volume occupied by one atom of the metal.

Molar volume $= \frac{54.94}{7.42}$

Volume of N_A atoms.

$\therefore$ Volume of one atom $= \frac{54.94}{7.42} \times \frac{1}{6.022 \times 10^{23}}$

$= 1.23 \times 10^{-23}$ cc

(19) Number of moles of Ca, C and oxygen atoms and its mass in 200 g of $CaCO_3$.

Moles of $CaCO_3 = 2$

Moles of Ca $= 2$

" " C $= 2$

" " O $= 6$

Mass of Ca $= 2 \times 40 = 80$ g

" " C $= 2 \times 12 = 24$ g

" " O $= 6 \times 16 = 96$ g

(20) Total number of electrons present in 3.2 g of CH_4?

1 molecule of CH_4 contains 16 $e^{\ominus}$.

No. of moles of CH_4 $= \frac{3.2}{16} = 0.2$

No. of molecules $= \frac{2}{10} \times 6.022 \times 10^{23}$

$= 12.044 \times 10^{22}$ molecules.

$\therefore$ No. of $e^{\ominus}$ $= 16 \times 12.044 \times 10^{22}$

$= 192.704 \times 10^{22}$

$= 1.927 \times 10^{24}$ electrons.

(21) Amount of Ca in $Ca(NO_3)_2$ that contains 20 g of Nitrogen?

1 mol. $Ca(NO_3)_2$ contains 28 g Nitrogen. and 40 g calcium.

$\therefore$ Mass of calcium $= \frac{20 \times 40}{28}$

$= 28.571$ g

(22) Number of atoms in 1 g atom of AL.

Number of atoms $= 6.022 \times 10^{23}$ atoms

$\because$ 1 g-atom $\equiv$ 1 mole

(23) If components of air are N_2 (78 %), O_2 (21 %) Ar (0.9 %) and CO_2 (0.1 %) by volume, what would be molecular mass of air?

Molecular mass of air:

$$\frac{78 \times 28 + 21 \times 32 + 0.9 \times 40 + 0.1 \times 44}{100}$$

$= 28.964$ g

(24) No. of molecules in 1.624 g of Ferric chloride ($FeCl_3$)?

No. of molecules = $\frac{1.624}{162.5} \times N_A$

$= 0.01 \times 6.022 \times 10^{23}$

$= 6.022 \times 10^{21}$ molecules

(25) Mass of 1 NH_3 molecule?

Mass of 6.022×10^{23} molecules of $NH_3 = 17g$

∴ Mass of 1 molecule = $\frac{17}{6.022 \times 1023}$

$= 2.823 \times 10^{-23} g$

(26) Atomic masses of two elements P and Q are 20 and 40 respectively. x g of P contains y atoms, how many atoms are present in 2x of Q?

x g of P ⟶ y atoms

Moles of P = $\frac{x}{20}$

⇒ $y = \frac{x}{20} \times N_A$

Atoms in 2x g of Q = $\frac{2x}{40} \times N_A$

$= \frac{x}{20} \times N_A = y$

∴ y atoms are present in 2x g of Q.

(27) Oxygen is present in 1L flask at pressure of 7.6×10^{-10} mm of Hg at 0°c. Calculate the number of oxygen molecules in flask.

$PV = nRT \Rightarrow n = \frac{7.6 \times 10^{-10} \times 1}{760 \times 0.0821 \times 273}$

$\Rightarrow n = \frac{PV}{RT}$

$= 4 \times 10^{-4}$ moles.

$\therefore$ No. of molecules $= 4 \times 10^{-4} \times 6.022 \times 10^{23}$

$= 24.088 \times 10^{19}$ molecules

(28) Ratio of volume occupied by 1 mole of O_2 and 1 mole of O_3 in identical conditions?

Volume occupied by 1 mole of any gas at identical condition is same.

$\therefore$ Ratio is 1:1.

(29) Calculate the mass of 0.5 moles of $CaCO_3$.

Mass $= \frac{1}{2} \times 100 = 50$ grams.

(30) The cost of the Table salt (NaCl) and Table Sugar ($C_{12}H_{22}O_{11}$) is Rs.10 and Rs.40 per Kg. Find the cost of the salt and sugar per mole?

Moles of NaCl in 1000g $= \frac{1000}{58.5}$

$\therefore$ Cost of 1 mole $= \frac{1000}{58.5} \times \frac{10}{1000} \times 58.5$

$= ₹\ 0.585$

Moles of $C_{12}H_{22}O_{11}$ in 1000g $= \frac{1000}{342}$

$\therefore$ Cost of 1 mole $= \frac{40 \times 342}{1000}$

$= ₹\ 13.68$

(31) The number of Oxygen atoms in 0.2 mole of $Na_2CO_3 \cdot 10H_2O$?

Atoms of O in 1 molecule of $Na_2CO_3 \cdot 10H_2O = 13$

No. of molecules of $Na_2CO_3 \cdot 10H_2O = \frac{2}{10} \times 6.022 \times 10^{23}$

$= 12.044 \times 10^{22}$

No of O atoms $= 12.044 \times 10^{22} \times 13$

$= 156.572 \times 10^{22}$

$= 1.56572 \times 10^{24}$ atoms

(32) $Br_3C_6H_3(C_3H_8)_n$, was prepared by heating styrene with tribromobenzoyl peroxide in absence of air. If it was found to contain 10.46 % bromine by weight. Find n.

$$\% \text{ of Bromine} = \frac{\text{Mass of Bromine}}{\text{Mass of compound}} \times 100$$

$$10.46 = \frac{3 \times 80}{314 + 104n} \times 100$$

$$\Rightarrow 10.87n = 240 - 32.84$$

$$[n \approx 19]$$

(33) It has been estimated that 93 % of all atoms in entire universe are hydrogen and that the vast majority of those remaining are helium. Estimate mass % composition of universe.

Out of 100 atoms, 93 are H at 7 are He.

Mass of Hydrogen $= 93 \times 1 = 93$

Mass of Helium $= 7 \times 4 = 28$

Mass % of Hydrogen $= \frac{93}{93+28} \times 100 = 76.86\%$

Mass % of Helium $= 23.14\%$

(34) Molecular wt. of haemoglobin is about 65,000 g/mol. Haemoglobin contains 0.35% Fe by mass. How many iron atoms are there in haemoglobin molecule?

Mass of Fe = $\frac{0.35}{100} \times 65000$

= 227.5 g

Atoms of Fe = $\frac{227.5}{56} \times 6.022 \times 10^{23}$

= 24.464×10^{23} atoms in 1 mole of haemoglobin.

(35) Number of atoms of oxygen present in 88 g of $(CO_2)_2$. What would be the wt. of CO having the same number of Oxygen atoms?

Atoms of Oxygen = $\frac{88}{88} \times N_A \times 4$

= 24.088×10^{23} atoms of Oxygen

⇒ For CO to have same number of O atoms 4 moles of CO should be present.

∴ Mass of CO = 112 g.

(36) d_{water} = 1 g/ml ; $d_{ethanol}$ = 0.789 g/ml.
What volume of ethanol contains the same number of molecules as are present in 175 mL of water?

Mass of 175 ml of water = 175 g

Molecules of H_2O = $\frac{175}{18} \times 6.022 \times 10^{23}$

= 58.547×10^{23}

⇒ $58.547 \times 10^{23} = \frac{g}{46} \times 6.022 \times 10^{23}$ C_2H_5OH

⇒ $g_{ethanol}$ = 447.22 g

$\therefore$ Volume $= \frac{447.22}{0.789}$

$= 566.82$ ml

(37) Chlorophyll contains 2.68 % of Mg by wt. Calculate Mg atoms in 1g of chlorophyll.

$\Rightarrow$ Mass of Mg $= \frac{2.68}{100} \times 1$

$= 0.1072$

No. of magnesium atom $= \frac{0.1072}{24} \times 6.022 \times 10^{23}$

$= 0.0268 \times 1023$

$= 2.68 \times 10^{21}$ atoms

(38) Calculate the diameter of atom of mercury, assuming that each atom is occupying a cube of edge length equal to the diameter of mercury atom. ($\text{Density}_{\text{mercury}} = 13.6$ g/cc)

In 1 gm of Hg, no. of atoms present $= \frac{6.023 \times 10^{23}}{2 \times 10^{2}} = 3.012 \times 10^{21}$ atoms

$\because$ Density $= 13.6$ g/cc

Mass of 1 atom $= \frac{1}{3.012 \times 10^{21}}$

Volume of 1 atom $= \frac{1}{3.012 \times 10^{21} \times 13.6}$ g/cc

$= 2.44 \times 10^{23}$ cc

Since each Hg atom occupies a cube of edge length equal to its diameter.

Diameter of one Hg atom $= (2.44 \times 10^{-23})^{1/3}$

$= 2.905 \times 10^{-8}$ cm

(39) How many years it would take to spend N_A number of Rs. at the rate of Rs. 10 Lakhs per sec ?

$$10,00,000 = \frac{6.022 \times 10^{23}}{\text{Time}}$$

$$\Rightarrow \text{Time} = 6.022 \times 10^{17} \text{ s.}$$

(40) Total number of neutrons present in 7 mg of ^{14}C atoms.

1 atom of ^{14}C contains 8 neutrons.

$$\text{Total neutrons} = \frac{7 \times 10^{-3}}{14} \times 6.022 \times 10^{23} \times 8$$

$$= 24.088 \times 10^{20} \text{ neutrons.}$$