Moles and Equations

→ Important Definitions

→ **Isotopes** - Atoms of the same element with different number of neutrons. Ex. C-12 (6p 6n), C-13 (6p 7n), C-14 → Radioactive (6p 8n)

→ **Relative Atomic mass (A_r)** - The average mass of the atoms of the naturally occuring isotopes of an element relative to $\frac{1}{12}$th the mass of a Carbon-12 atom.

→ **Relative Isotopic mass** - The mass of an atom of an isotope of an element relative to $\frac{1}{12}$th the mass of a Carbon-12 atom.

→ **Relative Molecular mass (M_r)** - The mass of a molecule of a compound relative to $\frac{1}{12}$th the mass of a Carbon-12 atom.

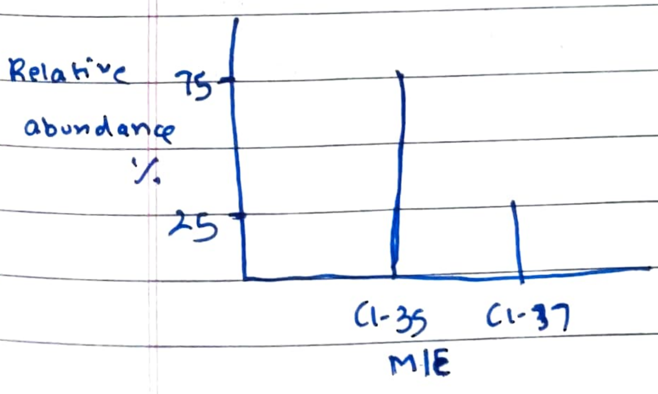
→ **Mole** - unit for amount of substance. One mole of a substance is the amount that contains the same number of specific particles as the number atoms in 12g of C-12 $n = M/M_r$

→ **Avogadro Constant** = 6.023×10^{23}, it is the number of atoms in one mole of a substance

→ **Calculating A_r using mass spectra**

Cl-35 — % abundance = 75%

Cl-37 — % abundance = 25%



$A_r = (0.75 \times 35) + (0.25 \times 37)$

$A_r = 35.5$

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→ Q on Ar

~~Isotope relative~~	Isotope	^{136}Ce	^{138}Ce	^{140}Ce	^{142}Ce
	mass	135.907	137.906	139.905	x
	%	0.185	0.251	88.450	y

$0.185 + 0.251 + 88.450 + y = 100$

$88.886 + y = 100$

$y = 100 - 88.886$

$y = 11.114\%$

$(135.907 \times 0.00185) + (137.906 \times 0.00251) + (139.905 \times 0.88450)$

$+ (x \times 0.11114) = 140.116$

$= 124.3435445 + 0.11114x = 140.116$

$0.11114x = 140.116 - 124.3435445$

$0.11114x = 15.7724555$

$x = \boxed{141.915}$

→ Q on Ar

isotope	^{32}S	^{34}S
mass	32	34
%	x	$100 - x$

$A_r = 32.09$

$$\frac{(32 \times x) + (34 \times (100 - x))}{100} = 32.09$$

$32x + 3400 - 34x$

$34 - 2x$

$34 - 2x = 32.09$

$-2x = 32.09 - 34$

$-2x = -1.91$

$x = \frac{-1.91}{-2}$

$x = 95.5\%$

$100 - x = 4.5\%$

% ^{32}S = 95.5%

% ^{34}S = 4.5%

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→ Q on Ar

(74 × 0.0089) + (76 × 0.0937) + (77 × 0.0763) + (78 × 0.237) + (80 × 0.4961) + (82 × 0.0873)

= 79.0421, identity - Selenium (as mass of Se = 78.960)

⇒ Mole calculations involving "mass" and "volume & concentration"

$$\text{Mole } (n) = \frac{\text{Mass } (M)}{M_r}$$

$$n = \frac{M}{M_r}$$

Mole (n) = concentration (c) × volume (v)

$n = cv$

Note: $1\,dm^3 = 1000\,cm^3$

Note: if concentration is given in $g\,dm^{-3}$ divide it by M_r to convert it to $mol\,dm^{-3}$

→ At room temperature and pressure (298K, 1Atm) 1 mole of all gases occupy $24\,dm^3$ volume.

so $1\,mol = 24\,dm^3$

$2\,mol = 48\,dm^3$

$$n = \frac{V}{24} \quad \text{or} \quad n \times 24 = V$$

⇒ Percentage Composition by mass

$MgCO_3$, find the % of Mg

Total mass = (24.3) + (12) + (16 × 3)

= 84.3

Mg mass = 24.3

$$\%\text{ mass} = \frac{24.3}{84.3} \times 100$$

= 28.8%

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⇒ Balancing Equations

$N_2 + H_2 \longrightarrow NH_3$

$N_2 + H_2 \longrightarrow 2NH_3$

$N_2 + 3H_2 \longrightarrow 2NH_3$

1 mol   3 mol   2 mol

1 : 3 : 2 (mole ratio)

⇒ Limiting Reagent or Reactant

$N_2 + 3H_2 \longrightarrow 2NH_3$

ex. we have 0.5 mol of N_2
5 mol of H_2

but we know 0.5 mol of N_2 will only react with 1.5 mol of H_2 which means N_2 is limiting and H_2 is excess

→ Questions

1. a] $n = \frac{M}{M_r} = \frac{0.83}{6.9} = 0.120$

b] $n \times 24 = v$

$0.06 \times 24 = v$

$1.44 dm^3 = v$

c] $n = c \times v$

$\frac{0.120}{0.50} = c$

$0.24 \ mol \ dm^{-3} = c$

2] a] $7.5 \times 10^{-3} \ cm^3$

b] $3.75 \times 10^{-3} \ cm^3$

$3.75 \times 10^{-3} \times x = 1000$

$x = 266667$

$x = 2.7 \times 10^4$

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⇒ Emperical Formula

→ it shows the simplest whole number ratios of the number of atoms of each element in the compound.

⇒ Molecular Formula

→ it shows the actual number and type of each atom in the ~~____~~ compound.

→ Question

Compound A has following composition by mass

C: 66.7%, H: 11.1%, O: 22.2%

$M_r = 72$

$C = n = \frac{66.7}{12} = \frac{5.56}{1.3875} = 4$

$H = n = \frac{11.1}{1} = \frac{11.1}{1.3875} = 8$

$O = n = \frac{22.2}{16} \quad \frac{1.3875}{1.3875} = 1$

$C_4H_8O_1$ = Emperical

to find Molecular formula

1. divide ~~Emperical formula~~ mass by emperical formula

ex. $\frac{M_r}{Em} = \frac{72}{72} = 1$ → this value is to be multiplied by the emperical formula which will give the molecular formula.

→ Question

Compound W has composition

C: 40%, H: 6.7%, O: 53.3%

$C = n = 40/12 = 10/3 = 1$

$H = n = 6.7/1 = 6.7 = 2$

$O = n = 53.3/16 = 3.33125 = 1$

CH_2O