3.5. Percent Composition of Compounds

Edison: Genius: 99% Perspiration
1% Inspiration.

Salt: 39.3% sodium
60.7% chlorine

Water: 11.2% Hydrogen
88.8% Oxygen

"Peroxide" 5.93% H
94.07% O

– Can ID + tell purity from % composition data!

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ex: $CuSO_4$ copper(II) sulfate
– can find % Cu, S, O by mass.

$1 \times Cu = 1 \times 63.55 = 63.55$
$1 \times S = 1 \times 32.07 = 32.07$
$4 \times O = 4 \times 16.00 = \underline{64.00}$
$$159.62$$

$1 \text{ mol } CuSO_4 = 159.62g \ CuSO_4$

$\% \ Cu = \dfrac{63.55g}{159.62g} \times 100 = 39.81\%$

$\% \ S = \dfrac{32.07g}{159.62g} \times 100 = 20.09\%$

$\% \ O = \dfrac{64.00g}{159.62g} \times 100 = 40.10\%$

Can find an empirical formula from % composition data!

simplest ratios!

ex: C_6H_6 molecule

↓

CH empirical

ex: Purple crystals...

24.75% K
34.77% Mn   } → formula!
40.51% O

How? Assume 100g sample.
- find #g of each element
- convert g → mol
- find ratio.

24.75g K , 34.77g Mn, 40.51g O

$\dfrac{24.75 g K \quad | \quad 1 \, mol \, K}{| \quad 39.10 g \, K} = 0.6330 \, mol \, K$

$\dfrac{34.77 g \, Mn \quad | \quad 1 \, mol \, Mn}{| \quad 54.94 \, g \, Mn} = 0.6329 \, mol \, Mn$

$\dfrac{40.51 g \, O \quad | \quad 1 \, mol \, O}{| \quad 16.00 g \, O} = 2.532 \, mol \, O$

$\dfrac{0.6330 \, mol \, K}{0.6329 \, mol} : \dfrac{0.6329 \, mol \, Mn}{0.6329} : \dfrac{2532 \, mol \, O}{0.6329}$

1.000 K : 1.000 Mn : 4.001 O

≈   1   :   1   :   4

⇒ $KMnO_4$

```
┌─────────────────┐
│   Mass          │
│   percent       │
└─────────────────┘
        │
        ▼   Convert to grams and
            divide by molar mass

┌─────────────────┐
│   Moles of      │
│   each element  │
└─────────────────┘
        │
        ▼   Divide by the smallest
            number of moles

┌─────────────────┐
│   Mole ratios   │
│   of elements   │
└─────────────────┘
        │
        ▼   Change to
            integer subscripts

┌─────────────────┐
│   Empirical     │
│   formula       │
└─────────────────┘
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Mass - Spectrometer

— "Weighing" molecules / atoms.

Electron beam · Sample gas · e^- · M · M^+ · Filament · Accelerating plates · + · Ion beam · N · S · Magnet · light · Detecting screen · heavy
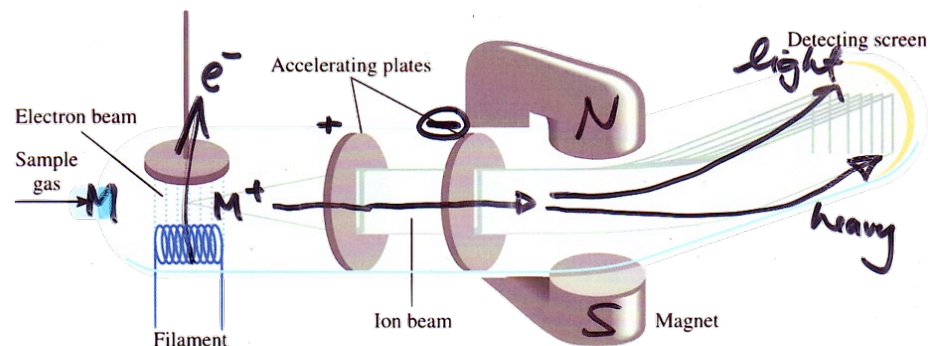
— several to Mars
— Titan (Saturn)
— Sun

$^{20}_{10}$Ne(90.92%)

$^{21}_{10}$Ne(0.26%) $^{22}_{10}$Ne(8.82%)
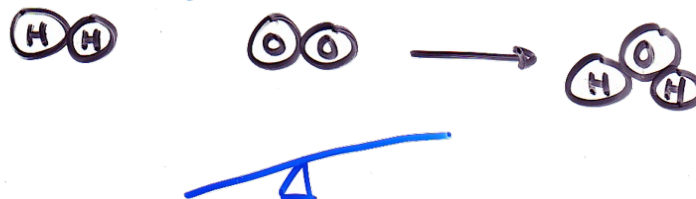
Intensity of peaks

19   20   21   22   23

Atomic mass (amu)
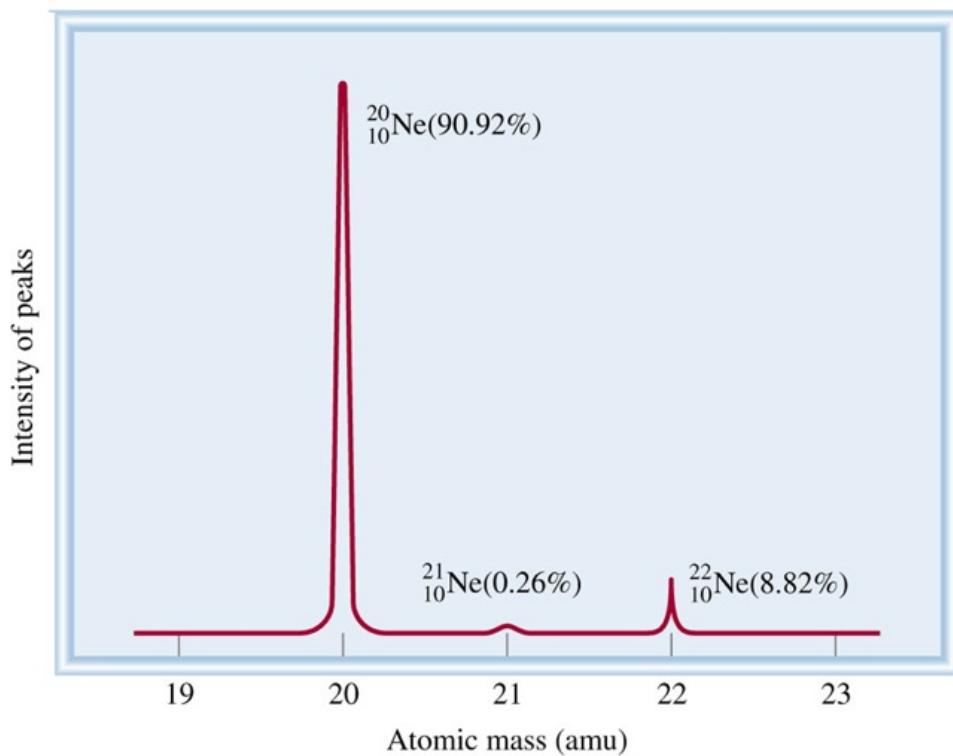
3.7 Chemical Reactions + Chemical Equations

word eq.

ex: Hydrogen + Oxygen ⟶ Water

ex: H_2 + O_2 ⟶ H_2O
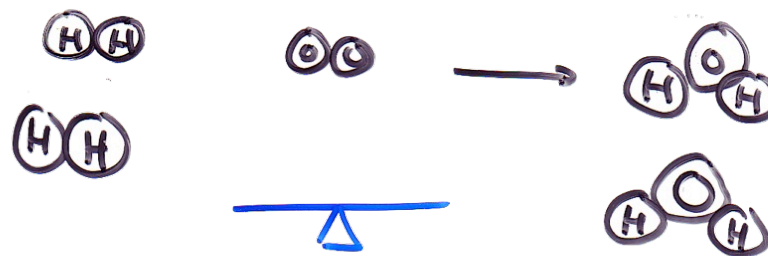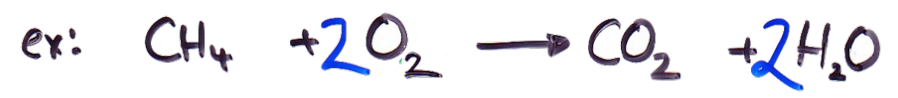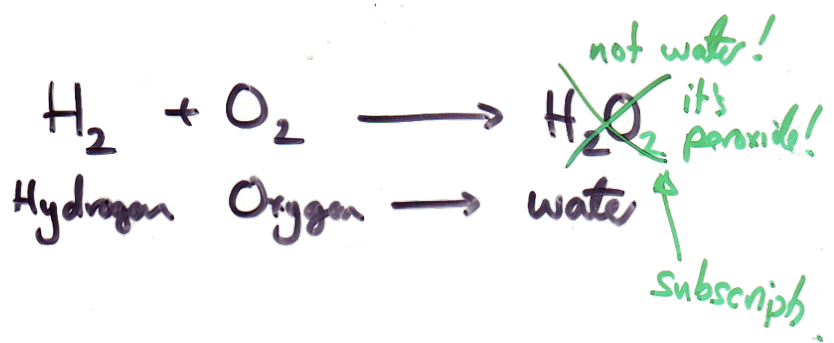
Unbalanced!

Balanced.

$$2H_2 + 1O_2 \longrightarrow 2H_2O$$

BALANCED

↑ ↑ ↑
coefficients
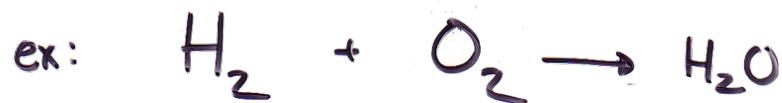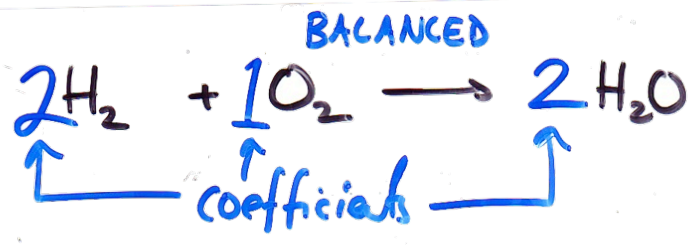
- Balance chem eq's, by altering the coefficients!

$$H_2 + O_2 \longrightarrow H_2O_2$$

not water!
it's peroxide!

Hydrogen Oxygen → water

↑ subscript

$$ex: \quad CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

C : 1
H : 4
O : ~~2~~ 4

C : 1
H : ~~2~~ 4
O : ~~2~~ 4

$$C_2H_6 + \frac{7}{2}O_2 \longrightarrow 2CO_2 + 3H_2O$$

C: 2   C: $\cancel{\times}$2

H: 6   H: $\cancel{\times}$6

O: $\cancel{\times}$7   O: $\cancel{\times}\cancel{\times}$7

Lowest whole # coeffitients.

x2

$$2C_2H_6 + 7O_2 \longrightarrow 4CO_2 + 6H_2O$$