Definitions

- Chemistry: Study of matter
- Organic Chemistry: Study of compounds containing carbon
- Atom: Is the smallest possible particle that defines a complete chemical element
- Molecules: Atoms connected in a particular arrangement
    - Changing the arrangement or connections changes the molecule and its physical properties.
- Compound: Collection of molecules of the same type
    - Water (H_2O), Cholesterol (27 carbons, white crystalline powder, average male contains 80g)
- Atomic Number: number of protons in nucleus of atoms
- Atomic Weight: mass of protons and neutrons
- Molecular Weight (MW): mass of atoms in molecule
    - Hydrogen = H, Atomic number = 1, 1 proton = $p^+ = (1H^+)$
    - Deuterium = D or d, Atomic number = 1, 1 proton and 1 neutron, Atomic Weight = 2 is an Isotope of Hydrogen

Mole Concept

- 1 mole = 6.02×10^{23} (Avogadro's number) (can be atoms, molecules etc)
- 1 mole H = 1 g
- H_2O: MW = [(2 x 1 g/mol)H + (1 x 16 g/mol)O] = 18 g/mol
- 18g of H_2O is 6.02×10^{23} molecules = 1 mole of H_2O or 6.02×10^{23} molecules of water

Typical Molecule

- A few Angstroms (Å) in length
- 1 Å = 10^{-8} cm

Example: cholesterol is 18 Å across. If you lined all of the cholesterol molecules in a 80g bottle end to end it would wrap around the earth roughly 5,000,000 times.

Purity of Compounds

- 1 mole of H_2O (6.02×10^{23} molecules) = 18g then add 1×10^6 other molecules (eg. sugar) the purity of the water would be 99.999 999 999 999 999% pure.
- Purity: A pure compound shows no change in physical properties upon attempts to further purify. (purity is a relative term)

Physical Properties

- Defined by chemical structure.
- Melting point (mp) and Boiling point (bp): Each compounds has a characteristic mp and bp.
- Taste, appearance, odour, and biological properties (how it interacts with other molecules).
- Density (g/cm^3).
- Absorption of radiation.
- Solubility

Chemical Analysis

- Qualitative Analysis
- Quantitative Analysis

Qualitative Test for Inorganic or Organic Compound

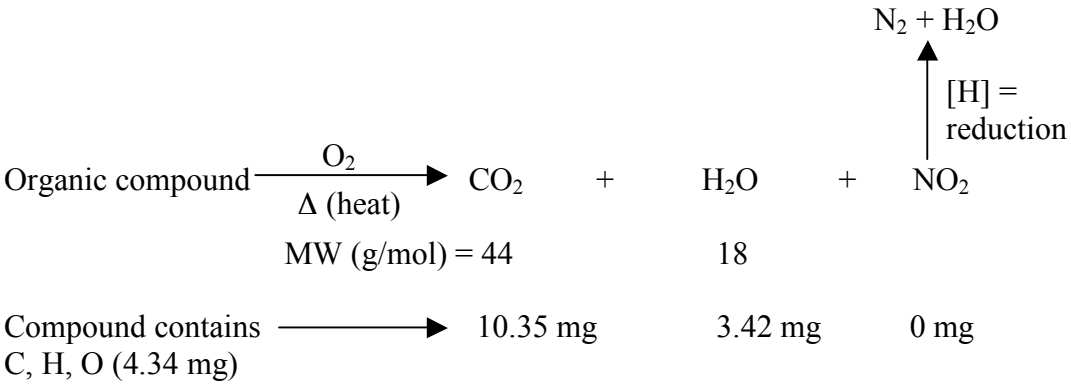
- Qualitative: Determine if you have the compound of interest.

Organic	Inorganic
- Contains carbon	- No carbon
- Low mp < 200 °C	- High mp
- Burn frequently	- "Does not burn"
- Soluble in non-polar solvents	- Soluble in H_2O

THERE ARE MANY EXCEPTIONS !!!

Quantitative Analysis

- Quantitative: How much of the compound of interest (quantity).



Note- Matter cannot be created or destroyed in a chemical reaction, therefore the amount of carbon in the CO_2 is equal to the amount of carbon in the starting sample.

Weight of carbon (in sample) = $\frac{12 \text{ g/mol of C}}{44 \text{ g/mol } CO_2}$ x 10.35 mg of CO_2 = 2.82 mg of C

Weight of hydrogen = $\frac{2(1 \text{ g/mol of H})}{18 \text{ g/mol of } H_2O}$ x 3.42 mg of H_2O = 0.383 mg of H

Weight of oxygen = 4.34mg – (2.82 mg of C + 0.383 mg of H) = 1.14 mg of O

Now one can calculate percentage composition

% Composition

$$\% C = \frac{\text{Mass of carbon}}{\text{Mass of sample}} = \frac{2.82\text{mg of C}}{4.34\text{mg}} = 65.1\%$$

$$\% H = \frac{0.383\text{ mg of H}}{4.34\text{mg}} = 8.83\%$$

% O = 100% - 65% - 8.83% = 26.1%

The empirical (and with additional date, molecular formula) can be determined from % composition