Formulas:

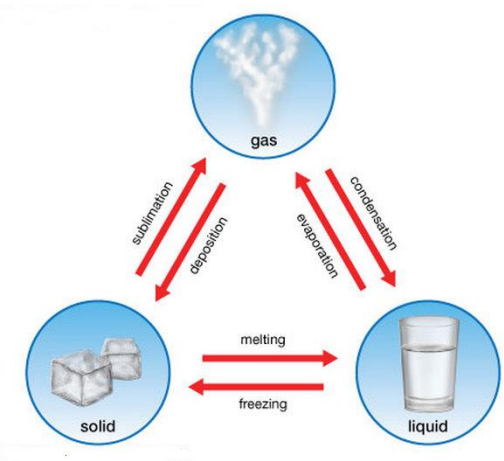
Rf values (Chromatography)	$\frac{Distance\ traveled\ by\ Compound\ (Solute)}{Distance\ traveled\ by\ Liquid\ (Solvent)}$
Relative Atomic Mass	$\frac{\sum(Isotope\ abundance\ \times\ Isotope\ mass\ number)}{\sum Isotope\ Abundance}$
Moles	$\frac{Mass}{Molar\ Mass}$ $Concentration\ \left(\frac{mol}{dm^3}\right) \times\ Volume\ (dm^3)$
Percentage Mass	$\frac{(Mr\ of\ Element)}{(Total\ Mr)} \times\ 100(\%)$
Percentage Yield	$\%\ Yield = \frac{Actual\ Yield}{Theoretical\ Yield} \times\ 100(\%)$
Concentration	$Cocentration\ \left(\frac{mol}{dm^3}\right) = \frac{\#\ of\ mol\ (mol)}{volume\ (dm^3)}$
Volume (cm^3)	$Volume\ (dm^3)\ \times\ 1000$

Units:

Moles	mol
Mass	g
Molar Mass	g/mol
Concentration	mol/dm^3
Volume	dm^3 cm^3

UNIT 0

States of Matter:



- Temp. rise → particles move faster (more energy)
- Temp. decrease → particles slower (less energy)
- Gas (expand): Spread out, move faster.
- Gas (contract): Condense, move slower.
- Solids (expand): Vibration, particle layers spread.
- Solids (contract): Compress, particles move closer.

Terms:

- Solvent: Part of the solution that dissolved a solute.
- Solute: Substance that dissolved in a solvent to make a solution.
- Solution: Mixture of Solute and Solvent.
- Saturated Solution: Maximum solute that can dissolve in 100ml of solution.
- Diffusion: Movement of solute particles (gas and liquid)
- Solubility: Ability of a solid, liquid, or gas (in grams) to dissolve in 100ml of solvent.

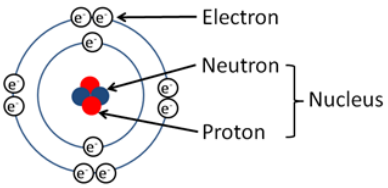
Ions – Electrically charged particles. Gain or lose electrons to get a full valence shell.
Compound – Two or more elements chemically combined (table salt, water, nitrogen gas).
Mixtures – Two or more elements non chemically combined; melt at a range of temperatures.
Pure Substances – made of only one type of substance and have fixed melting points.

Separation Techniques (mixtures):

- Filtration : filter insoluble liquids (Coffee, home filter, etc)
- Simple Distillation: Separating solids from liquid → pure liquid, salt from saltwater.
- Fractional Distillation: Separating 2 liquids with different boiling points.
- Crystallization: Crystalize solids (sugar from sugary water, etc)
- Chromatography: 2 similar substances (ink, drugs), as they have different weights.

Elements:

- Elements are the simplest substances.
- Elements made up of tiny atoms. Each element is made up of one particular type of atom.
- John Dalton → first person to think/ideas about atoms



Atoms:

Particle	Mass	Charge
Proton	1	+ 1
Neutron	1	0
Electron	1/2000	- 1

- Atoms of a particular element always has the same number of Protons.
- Atomic Number = # of Protons and # of Electrons (if no charge)
- Mass Number = # of Protons + # of Neutrons
- Electronic Configuration: arrangement of electrons in shells.
  - Shell 1 – 2 electrons
  - Shell 2 – 8 electrons
  - Shell 3 – 8 electrons
  - Shell 4 – 2 electrons
-

Isotopes:

- Atoms of the same elements (same # of protons) but with different # of Neutrons
- Isotopes of Hydrogen: protium (0 neut.), deuterium (1 neut.), tritium (2 neut.)

Group	Valence Shell	Gain or Lose	Charge	Form
Group 1	1 e^-	lose 1 e	+ 1	Metal
Group 2	2 e^-	lose 2 e	+ 2	Metal
Group 3	3 e^-	lose 3 e	+ 3	Metal
Group 5	5 e^-	gain 3 e	- 3	Non-metal
Group 6	6 e^-	gain 2 e	- 2	Non-metal
Group 7	7 e^-	gain 1 e	- 1	Non-metal

Hydroxide	OH^-
Ammonium	NH_4^+
Carbonate	CO_3^{2-}
Nitrate	NO_3^-
Sulfate	SO_4^{2-}

"ide" – one atom

"ate" – oxygen

How to Find Formulas:

Ex. Magnesium Chloride:

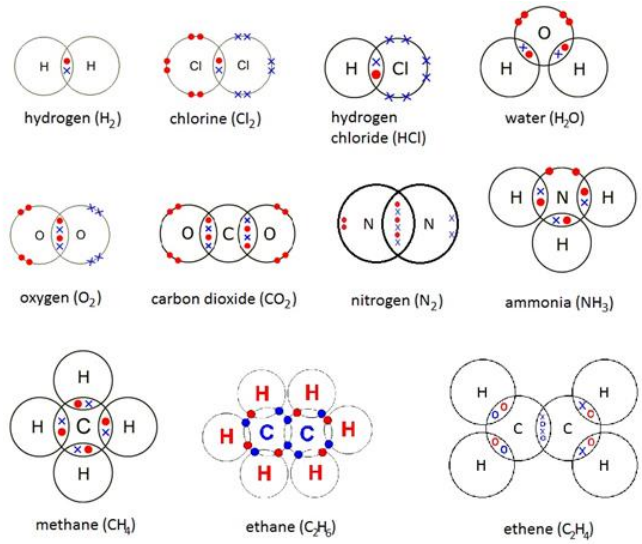
Steps:	Magnesium	Chlorine
Write Ions	Mg^{2+}	Cl^{-1}
Balance Charge	(2+) +	2(1-) = 0
Ratio	1	2
Overall	$MgCl_2$	

Ionic Bonds (one metal one non-metal)

- Ionic bonds are based on electrostatic forces between two ions of opposite charge.
- Giant ionic lattices
    - Lattices are oppositely charged ions attracted very closely to each other. Because of the strong electrostatic forces between them, it takes a lot of energy to separate the positive and negative ions (especially in a crystal lattice). Therefore, ionic compounds have high melting and boiling points.
- Ionic compounds do not conduct electricity when solid but do conduct electricity when molten and in aqueous solution. This is because the charged particles are free to move to conduct electricity. In solid state, they are held in fixed positions and can't move.

Covalent Bonds (two non-metals)

- Formed between atoms by sharing of a pair of electrons.
- Dot and cross diagrams:
    - The 8 diatomic molecules: H(1), N(3), O(2), F(1), Cl(1), Br(1), I(1)
    - Hydrogen Halides (combination of diatomic molecule and hydrogen)



Simple Molecular:

- Simple molecules have intermolecular forces, which are much weaker than the strong covalent bonds in molecules. Very little energy is required to break the intermolecular forces and therefore have a low melting point. (not directly connected vs covalent)
- Larger molecules (molecules with more mass) have more forces of attraction between them, this means that although the forces are weak, larger molecules have more attraction that need to be broken.

Giant covalent structures:

- They are solids at room temperature. In giant covalent structure, each molecule is connected to multiple molecules, meaning they are very strong. Because there are very many covalent bonds to break and need a lot of energy to break them. Therefore, they have high melting and boiling points.

Carbon Allotropes:

- Allotropes: different forms of the same elements. (atom arrangement)
- Diamond – 4 connections (no extra electrons)
    - Physical properties: high melting point, hard, no conduction, insoluble.
    -
- Graphite – 3 connections
    - Physical Properties: high melting points, soft and slippery (layers of carbon structures), insoluble in water.
    -
- C60 fullerene (buckyball) 3 connections
    - Physical Properties: strong in tension, conductor, ductile, high melting point

Metallic Lattice:

- Delocalized electrons are unfixed electrons, free to move within the structure.
- Delocalized electrons can carry charge around and conduct electricity.
- Lattices have layers of atoms that can slide over each other.
- Due to the structure (layers) the atoms can move over each other.

High Melting/Boiling Points:

- Strong attraction between positively charged ions and the sea of electrons.
- Electrostatic forces between ions.

Low Melting/Boiling Points:

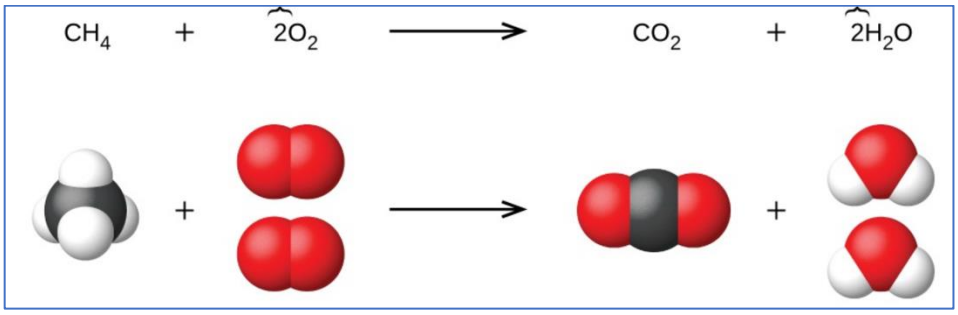
- Very little energy required to break the bonds.
- Weak intermolecular forces

Metal properties:

- Solid at room temperature
- High melting points
- Conducts electricity/heat
- Malleable, ductile
- Brittle
- Sonorous

Balancing Equations:

- Number of atoms (per element) on both sides should be the same.



Terms:

Mole: relative atomic mass in grams.

Avogadro's Constant: 6.02×10^{23} (one mole of any substance).

Molar Mass: relative formula mass in grams per mole.

Relative Atomic Mass (Ar): Average mass of an element's atoms.

Relative Formula Mass (Mr): Sum of all individual atomic masses.

Reacting Masses:

- Ratio depends on the Coefficient (# before molecule → $2NH_3$)
- Mol is dependent on ratio of substances

Step 1: Write the chemical equation
Step 2: Write the mass of N_2
Step 3: Divide by the M_r to find the Amount, in moles of N_2
Step 4: Use the chemical equation to find the ratio of N_2 to NH_3

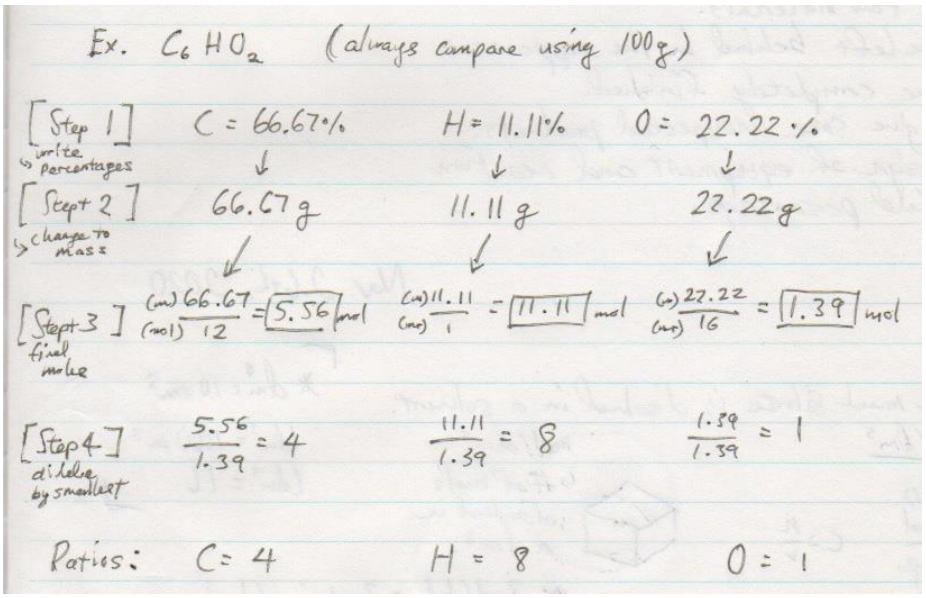
	N_2	+	$3H_2$	→	$2NH_3$	
Mass (g)	$\frac{7}{28}$				= 8.5 g	← **This is the answer**
M_r					x 17	← **Step 6** – Multiply the moles of NH_3 by the M_r
Moles	= 0.25		x 2		0.5	
Ratio	1				2	

Step 5 – Multiply the amount, in moles of N_2 by the ratio to find the number of moles of NH_3

Empirical and Molecular Formulae:
Molecular formulae: Actual whole number ratio.
Empirical formulae: Simplest whole number ratio of elements.

Molecular Formulae	Empirical Formulae
N_2O_4	NO_2
$C_{10}H_{22}$	C_5H_{11}
$C_6H_{12}O_6$	CH_2O

Finding Empirical Formulae from non-percentage composition (picture):



Percentage Mass by Composition (picture):

$$\frac{(Mr\ of\ Element)}{(Total\ Mr)} \times 100(\%)$$

Ex. Fe_2O_3 (% of Fe)

Step 1	Mr of Fe = 56 x 2 = 112
Step 2	Mr of O = 16 x 3 = 48
Step 3	Total Mr = 112 + 48 = 160
Step 4	$\frac{112}{160} \times 100 = 70\%$

Percentage Yield (picture):

- Amount of product you can actually make as a percentage of the amount you should theoretically make.

$$\%\ Yield = \frac{Actual\ Yield}{Theoretical\ Yield} \times 100(\%)$$

Concentration:

- Measurement of how much solute is dissolved in a solvent.
- # of mol dissolved in a dm^3

* dm^3 x 1000 = cm^3

$$Cocentration\left(\frac{mol}{dm^3}\right) = \frac{\#\ of\ mol\ (mol)}{volume\ (dm^3)}$$

$$Moles = Concentration\left(\frac{mol}{dm^3}\right) \times Volume\ (dm^3)$$

Indicators:

- Chemicals that change colour in the presence of alkali and acids.
- Universal Indicators: Mixture of indicators, range from ph1 to 14 (too many colors).
- Simple Indicators: Only two colours, very obvious.

Indicators	Acid Colour	pH at colour change	Basic Colour
Methyl Orange	Red	3 – 5	Yellow
Litmus	Red	5 – 8	Blue
Phenolphthalein	Colorless (null)	8 – 10	Pink

Acids:

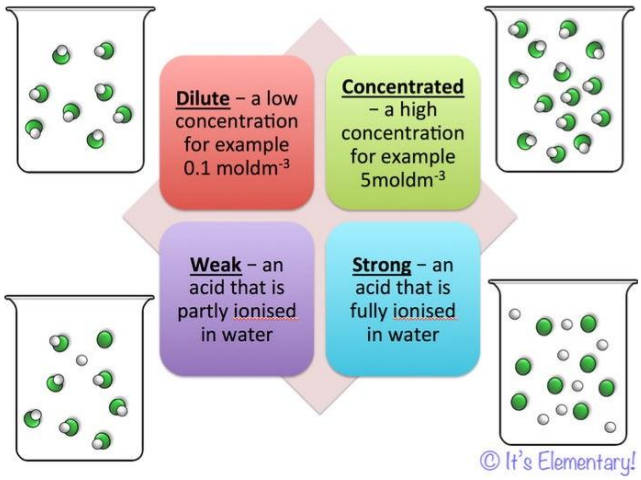
- Release Hydrogen Ions (H^+)
- Below pH 7 (Red → Orange → Yellow)

and Alkali (bases):

- Release Hydroxide (OH^-)
- pH above 7
- Neutralize acids

*Some bases are soluble and water → alkali

Strong vs Concentrated:



Strong Acid:

- Molecules completely break up.

Weak Acid:

- Most molecules are intact, only few are broken.

Concentrated:

- Lots dissolved.

Dilute:

- Small amount dissolved.