Topic 1: Atomic Structure And The Periodic Table

Atoms

- Nucleus: Proton + Neutrons
- Shells: Electrons (2, 8, 8)
- Electron structure of Na = 2,8,1 ⬅ practice more of this (especially of ions)

Particle	Mass	Charge
Proton	1	+1
Neutron	1	0
Electron	Very Small	-1

- Atom is neutral (protons = electrons) charges cancel out
- Ion is a charged atom (+/-)
- When atom gains e- ➡ (-) anion
- When atom loses e- ➡ (+) cation

Protons define the element

- Mass No (BIG) = Proton + Neutron
- Atomic (SMALL) = Proton OR Electron
- To find Neutrons (Mass – Atomic)
- Element: made up of only ONE TYPE of atom
- Isotopes: Same Protons but different Neutrons.

Mass | 23 Na | 11 P
Atomic | 11 Sodium | 11 E
12 N

Example:
Copper has two stable isotopes. Cu-63 has an abundance of 69.2% and Cu-65 has an abundance of 30.8%.
Calculate the relative atomic mass of Cu to 1 decimal place.

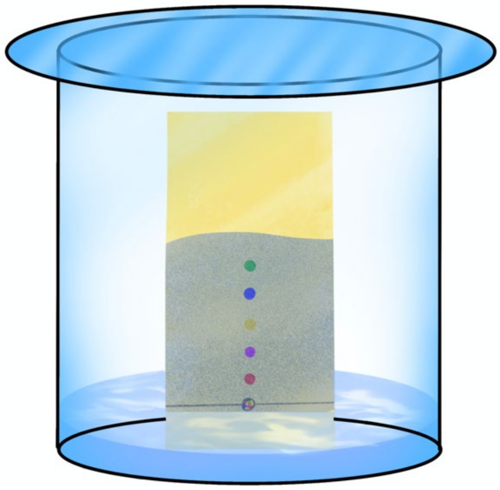
$$\text{Relative atomic mass} = \frac{(69.2 \times 63)+(30.8 \times 65)}{69.2+30.8} = \frac{4359.6+2002}{100} = 63.616 = 63.6$$

- Mixture: NOT chemically bonded, can be separated. (Na + Cl_2), Seawater and Air.
- Compound: chemically bonded. (NaCl)
- Properties change when: Mixture ➡ Compound

Word Equation :	*magnesium*	*+*	*oxygen*	➡	*magnesium oxide*
Symbol Equation :	*2 Mg*	*+*	*O_2*		*2MgO*

Paper Chromatography

- Paper chromatography – separates different dyes from an ink
- Stationary phase: paper
- Mobile phase: water/solvent



Method:

1. Draw line with pencil on filter paper (pencil is insoluble)
2. Add spot of ink on the line
3. Place in beaker and fill up with solvent e.g. water (just below the line)
4. Place lid (stop solvent from evaporating)
5. Solvent sweeps up the paper
6. Dyes separate out and you get a chromatogram

What do you want from the mixture

- The Solid
  - Insoluble
    - Filtration
  - Soluble
    - Crystallisation (Heat-sensitive)
    - Evaporation
- The Liquid
  - One
    - Simple Distillation
  - Mixture
    - Fractional Distillation

Distillation

Method :

1. Liquids have different BPs
2. Start with lowest temperature
3. Liquid with lowest BP will evaporate and then condense out
4. Increase temperature to the next BP
5. Repeat until all the liquids have separated

- Problem: Some liquids will have similar BPs so might evaporate at the same time.
- Solution: Fractional column is cooler near the top, so liquids with higher BPs will turn back to liquid and fall back into mixture

History of the Atom

Dalton

- Everything is made of tiny spheres
- Each element has its own sphere
- Didn't know anything about charges (+/-)

J.J Thompson

- Plum pudding model
- Entire atom is positive (+)
- Random areas within atom are negative (-)

Bohr

- Nuclear model
- Realised that Rutherford's atom would collapse as electrons are (-) and nucleus is (+)
- But since atoms don't collapse, it means that electrons must be in FIXED energy levels = shells

Rutherford

- Gold foil experiment: Shot alpha particles (+) at sheet of gold foil with a detector at other side Expected: a.ps (+) to deflect (as he thought the atom was all +)
  Observed: most a.ps (+) went through and few deflected back
- Most of the atom must be empty space
- Small area in the middle is (+) Nucleus causing a.ps(+) to deflect
- Electrons orbit around nucleus

Development of the Periodic table

Early Periodic tables

- Early periodic tables based on:
  1) Chemical properties
  2) Atomic mass
  (Had no idea of electronic structure or protons)
- Problems: Elements put in the wrong groups

Mendeleev's table

- Developed my Mendeleev

What did he do better?

- Based on atomic mass but also takes into account chemical properties
- Left GAPS for undiscovered elements
- Was able to predict properties of new elements with the gaps

Modern periodic table:

- Groups: No. of e^- in outer shell (similar properties)
- Periods: number of shells

Metals vs Non-metals

Metals	Non-metals
• LHS • Lose e^- ➡ (+) cations • More reactive DOWN the group • High MP/BP • Conduct electricity – delocalised e^- • Metallic bonding	• RHS • Gain e^- ➡ (-) anions • More reactive UP to group • Low MP/BP • Don't conduct electricity (except Graphite) • Covalent bonding

Transition metals – similar to metals but with SPECIAL properties

- More than one IONIC state e.g. Fe^{+2} or Fe^{+3}
- Form coloured compounds – purple/red/blue etc…
- Catalysts – e.g. Iron for Haber process

Group 1 – Alkali metals

"Soft and shiny little metals that make a big bang when wet"

Trends DOWN the group:

- More reactive (easier to lose outer electron)
- Heavier (more atomic mass)
- Lower MP/BP

REACTIONS:

1) WATER

$2Na_{(S)}$ + $H_2O_{(l)}$ ➡ $2NaOH_{(aq)}$ + $H_{2\,g)}$
Sodium + Water ➡ Sodium hydroxide + Hydrogen

- White solids that dissolve in water (will see fizzing and flames)
- Fizzing due to the gas (H2) – squeaky pop test!

2) CHLORINE

$2Na_{(S)}$ + $Cl_{2(g)}$ ➡ $2NaCl_{(s)}$
Sodium + Chlorine ➡ Sodium Chloride

- Forms metal chloride salt

3) OXYGEN

- Forms an oxide layer – makes it dull looking

Group 7 – Halogens

"Give me one more"

Flourine (Most reactive)	Yellow gas
Chlorine	Green gas
Bromine	Orange liquid
Iodine (Least reactive)	Grey solid

Displaces ALL (Big Daddy)

Gets Displaced by ALL (baby)

Reactivity:

- Gain e^- ➡ -1 ion (anion)
- Most reactive at the top
- Outer shell closer to nucleus, easier to gain e^-

$Cl_{2(g)}$ (Pale Green) + $2KI_{(aq)}$ ➡ $I_{2(aq)}$ (Brown) + $2KCl_{(aq)}$

$Cl_{2(g)}$ (Pale Green) + $2KBr_{(aq)}$ ➡ $Br_{2(aq)}$ (Orange) + $2KCl_{(aq)}$

Group 8 – Noble gases

"No thank you, we're full"

<u>Inert = not reactive</u>

- Full outer shell
- Non-flammable

<u>Trends:</u>

- BP increases when you go DOWN the group
- More electrons = more intermolecular forces