random chemistry shit ♡

made by SAAHIL P.

NOTES Format

Titles and Subheadings

Units

Important Concepts

SS content [Triple]

Important

~ anything highlighted twice is in 2 sections at once

if ydk what a word means

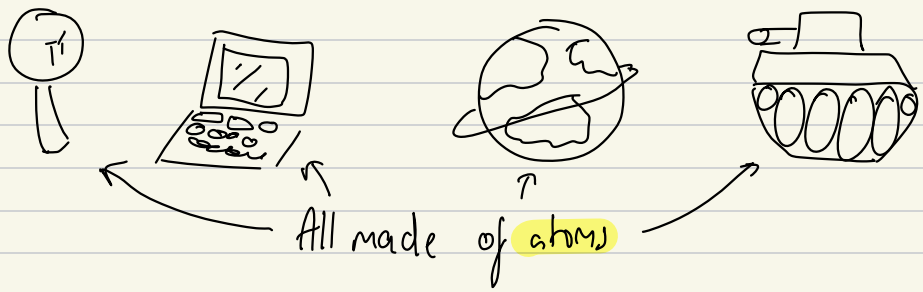
SEARCH. IT. UP.

Don't say that these notes are your own

Redistribution is allowed

C1 - Atomic Structure and Periodic Table

everything is made out of atoms. Yes, everything



An atom is the smallest part of an element that can exist while retaining its properties and characteristics

Atoms of Each element have a symbol to represent it. The first letter is capitalized and each symbol has 1, 2 and sometimes 3 letters (before some elements got renamed)

e.g. Hg - Mercury

H - Hydrogen

A chemical formula is used to represent an element or compound in balanced chemical equations.

Some elements, it's just their symbol

He Na Au

Others only exist as molecules (these specific elements)

I_2 Br_2 Cl_2 F_2 O_2 N_2

A compound is a substance with 2 or more elements chemically combined

The elements of a compound are present in fixed proportions

e.g. CO_2 will always have 2.6g of oxygen for every gram of Carbon

A subscript (small number) shows how many atoms of that element are in that compound

e.g. H_2O means 2 hydrogen, 1 oxygen

We can make compounds by reacting them, or they can be found naturally

Breaking compounds isn't easy. We can only react it to get its elements.

!! ACHTUNG !!

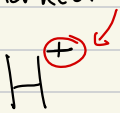
In non-metal compounds only, the second word is ALWAYS prefixed with:

(1) mon-
(2) di-
(3) tri-

e.g. Carbon monoxide
1-C
1-O

Ions

An ion is a charged atom, it has either more or less electrons than protons
a 'charge' of an ion is marked here:



ACHTUNG!

elements in group one will lose one electron
elements in group two will lose two electrons

elements in group 6 gain 2 electrons
elements in group 7 gain 1 electron.

e.g.

Li^{+} - group 1

O^{2-} - group 6

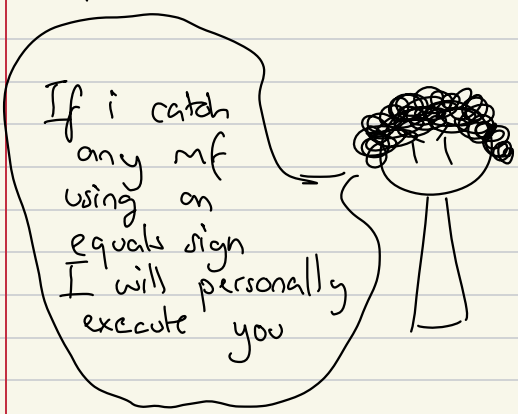
Ca^{2+} - group 2

Cl^{-} - group 7

These ions would form ionic bonds.

Word equations

- shows words (names) of substances involved
- '+' seperates reactants and products
- reactants → products form used



vs.

Symbol equations

- uses the chemical formulae of substances
- shows the state of matter of a substance
  - (s) solid
  - (l) liquid
  - (g) gas
  - (aq) aqueous (dissolved in water)
- shows number of compounds and molecules
- '+' seperates reactants and products
- reactant → product form used

examples:

word → carbon dioxide + water $\xrightarrow{\text{light}}$ glucose + oxygen

symbol → $6\,CO_{2\,(g)} + 6H_2O_{(l)} \xrightarrow{\text{light}} C_6H_{12}O_{6\,(s)} + O_{2\,(g)}$

Pure Substances and Mixtures

a "pure" substance only consists of 1 element or compound.

a mixture is multiple elements and/or compounds not chemically joined together.

e.g.

air 

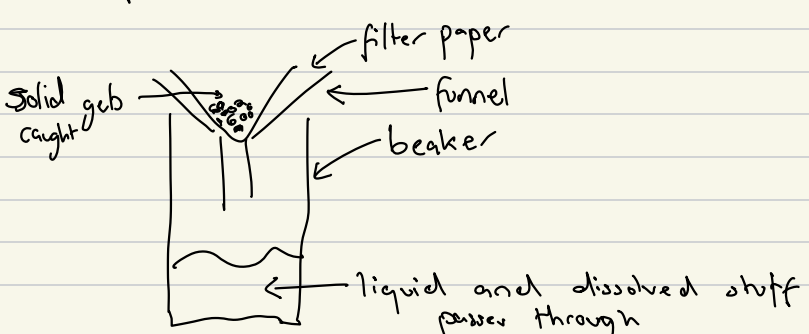
 the ocean

Contents of mixtures can be seperated without the need of chemical reaction. No new substances are made.

There are many ways to seperate mixtures:

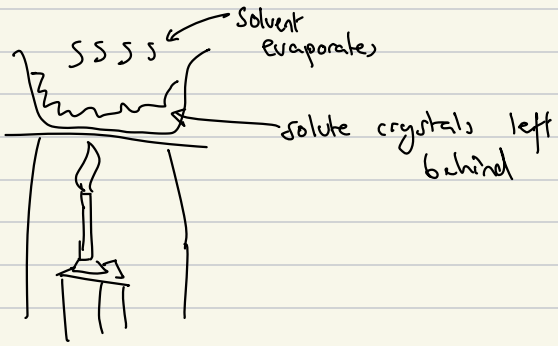
Filtration

used to seperate an insoluble solid from a liquid.



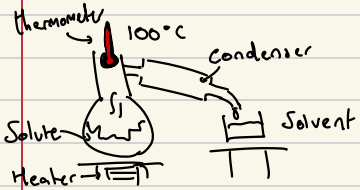
Crystallization

- used to produce solid crystals from a solution
- seperates dissolved stuff from a liquid

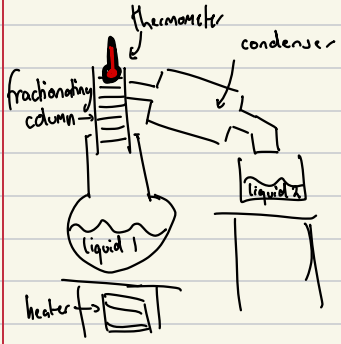


Distillation

seperates any solution into its composition.
Simple distillation works similarly to crystallization
Fractional distillation seperates 2 or more liquids w/ different boiling points.



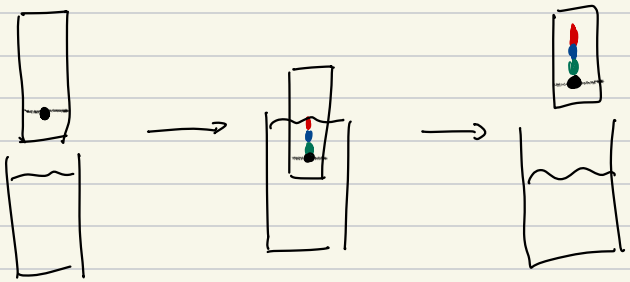
Simple Distillation
lets you reclaim the solute and solvent



Fractional Distillation
is often used for seperating mixtures with more components (e.g. crude oil)

Chromatography

seperates ink / dyes / pigments into their individual colors by dipping into water



It can be used to identify substances by comparing them to known substances.

2 substances are likely to be the same if
- The same spots are produced (number and color)
- The spots travel the same distance up the paper

Atomic Structure

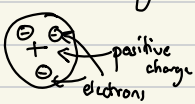
The model of the atom has evolved over many years.

1803

John Dalton thought about Atoms

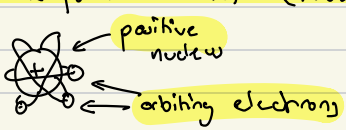
1904

Plum Pudding Model (J.J. Thomson)



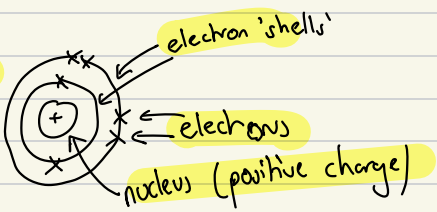
1911

Rutherford's model (Nuclear)



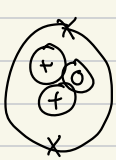
1913

Bohr model



1932

Chadwick's model



A helium-3 isotope

Structure of an Atom

an atom has a nucleus, surrounded by electrons arranged in shells

The atom is VERY (99.9999%) empty

A nucleus is 10^{-14} m big
An atom is 10^{-10} m big (10000× the nucleus)

(Size given is radius)

If the nucleus was a soccer ball
The atom would be 1.3 burj khalifas in radius

The atom is comprised of subatomic particles:

	mass	charge
proton	1	+1
neutron	1	0
electron	negligible	−1

Atoms would have an equal amount of protons and electrons

The atomic number of an element is how many protons they have

The atomic mass is how many protons and neutrons the "average" element would have

e.g.

$^{23}_{11}Na$

Sodium has a mass of 23 and a number of 11. Therefore it has:

11 protons
12 neutrons
11 electrons

Isotopes

Atoms with a different mass than the majority of atoms of the element

They will have more or less neutrons

Groups in the Periodic Table

Group 1 - Alkali Metals

PROPERTIES

- can be cut and moulded very easily
- soft
- low densities
- low melting points

As you go down, group 1 elements melt at cooler temperatures

When mixed with water, they produce a lot of heat and energy, and a metal hydroxide + hydrogen.

e.g.

$$2Li_{(s)} + 2H_2O_{(l)} \longrightarrow 2LiOH_{(aq)} + H_{2(g)}$$

When exposed to oxygen, a metal oxide forms (same happens w/ chlorine)

e.g.

$$4Li + O_2 \rightarrow 2Li_2O$$
$$2Li + Cl_2 \rightarrow 2LiCl$$

(That's why they're stored under oil)

The further down you go, the more vigorous they react with the aforementioned substances

Group 0 - Noble Gases

All noble gases have really low boiling points
The boiling points increase as you go down
(stronger intermolecular forces, so more energy needed to boil)

They are also very inert, because of their full outer shells

Group 7 - Halogen

They are non metals and form simple covalent bonds among one another

F_2 Cl_2

As you go down, melting and boiling point increase
(same reason as noble gases)

When reacted with a metal, they make metal salts with ionic bonds.

e.g.

$2Na + Cl_2 \rightarrow 2NaCl$

As you go down, they become more reactive.

If a more reactive halogen reacts with a salt with a less reactive halogen, the more reactive ones kick out the less reactive one from the bond

eg.

$Cl_2 + 2KI \longrightarrow I_2 + 2KCl$

Transition metals

- In between groups 2 & 3
- Conduct electricity as solids + liquids
- Shiny when freshly cut

Compared to group one:

- Higher melting point
- Higher densities
- Stronger and Harder

When reacted with oxygen, they form metal oxides

e.g. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

They barely react with water.

Some metals may react with halogens

They also form ions with different charges:

e.g.

Mn^{2+} Mn^{3+}

Cu^{+} Cu^{2+}

They also form colored compounds

C3 - Quantitative Chemistry

Moles

(woo short unit!)

a mole is a unit (symbol is mol.)
one mole of a substance is equal to the relative atomic or formula mass in grams.

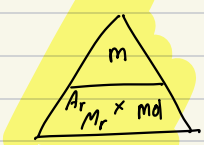
e.g.

one mole of hydrogen is 1g
one mole of water is (1+1+16)g or 18g

Avogadro's constant is how many atoms or compounds are present in 1 mole of a substance

$\sim 6.02 \cdot 10^{23}$

Formula Triangle!



relative atomic/formula × number of moles = mass

most of C3 is just maths... so there isn't much to write.

C2 – Bonding, Structure and Properties of Matter

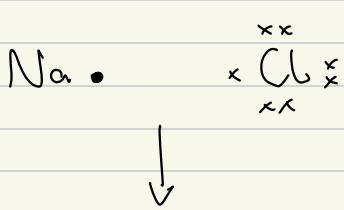
Ionic compounds

ACHTUNG!!

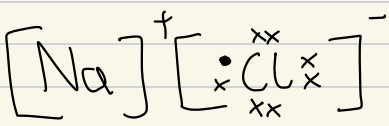
Metals LOSE electrons to form ion
Non-Metals gain electrons to form ion

The charge of the compound WILL be 0.

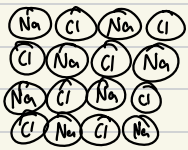
you can represent Ionic bonds with dot cross diagrams



The x's mark the electrons in each atom's outer shell.



Ionic compounds will have a regular repeating arrangement.



(in the example before)

Ionic compounds have a really high melting and boiling point because of the strength of the bonds.

If they (the particles) can move, then they can conduct electricity. This usually happens when

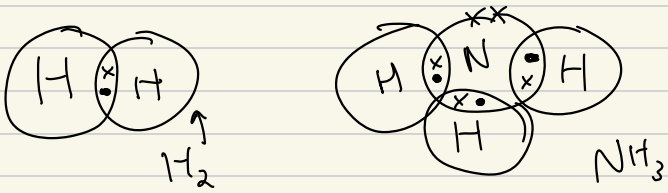
- They've melted
- They've dissolved

Covalent Bonds

This is when 2 atoms share a pair of electrons in their outer shells.

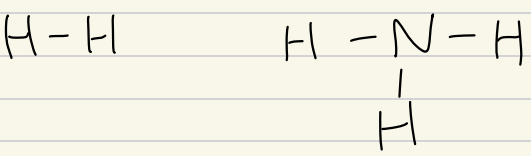
This is seen mostly in non metals and compounds comprised of non metals

This can be represented by a dot-cross diagram



or structually

(1 covalent bond is 1 line)



These above are examples of small molecules.

Giant Covalent Bonds

A giant covalent structure is many atoms joined together with covalent bonds to form a regular network.

an example:

silica (SiO_2)
makes a giant covalent structure

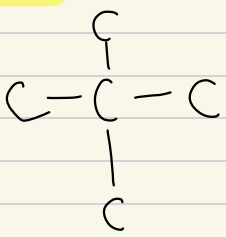
These structures have high melting and boiling point because you need a SHIT ton of energy to break all those bonds

Diamond and Graphite

Even though they are both made of carbon, they still have different physical properties because the carbon inside them is arranged differently

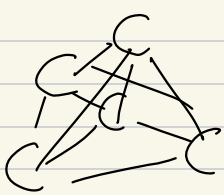
Diamond

each carbon atom is joined with 4 covalent bonds



no free electrons, thus doesn't conduct electricity

They form a tetrahedral network structure

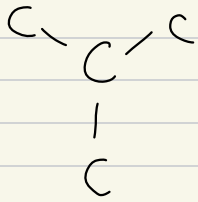


Because of this, diamonds are really hard and are used for cutting tools.

Diamond has a high melting point

Graphite

each carbon has a covalent bond with 3 other carbon atoms



These are arranged into hexagonal layers with one delocalized electron

The delocalized electron lets it conduct electricity and is useful as electrodes in batteries or electrolysis

Graphenes

a single layer of graphite
it can conduct electricity like graphite so it's useful in electronics and making composites

Fullerenes

giant molecules of carbon with hollow shapes. Their structure is based off hexagonal rings of carbon joined by covalent bonds. Some fullerenes have pentagonal and/or septagonal rings of carbon.

Buckminsterfullerene

Made of 60 carbon atoms to make a spherical C_{60} molecule

The intermolecular forces are weak so it melts easily and is slippery

im not drawing diagrams for these ♡

Nanotubes

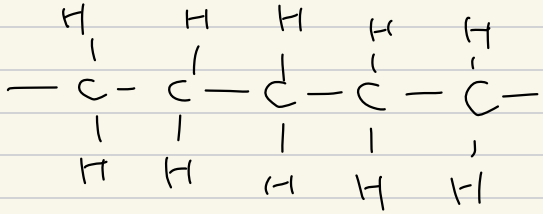
A layer of graphene rolled into a cylinder very long but very thin.

They have high tensile strength and can conduct electricity

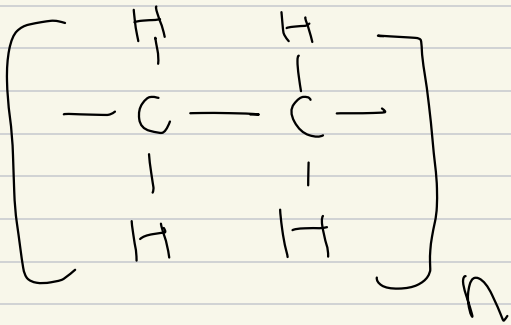
Makes it useful for nanotechnology, electronics and specialized materials

Polymers

Long chains which make a very large molecule atoms are joined with strong covalent bonds amount of atoms in a polymer is variable.



a small part of polyethylene



n varies, but this is always a large number

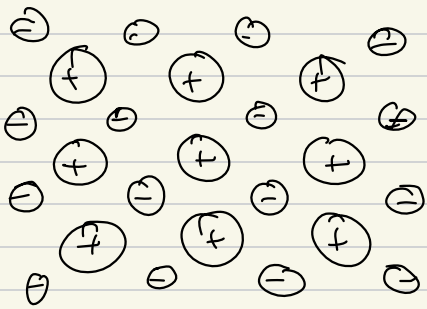
STRUCTURE and BONDING in metals

Metallic Bonding

Metals consist of giant structures of atoms in a regular pattern

The electrons in the valence shells of the metals are delocalized and are free to move around.

These delocalized electrons and metal ions create a strong bond



a layer of Metal there are many of these stacked on each other (important later)

It also lets the metal conduct electricity

Alloys

An alloy is a mixture of a metal and an element.

Many pure metals are too soft for everyday use, so we make alloys to fit our needs

e.g.

Stainless steel

Fe + Cr → durable
→ doesn't rust easily

In pure metals, layers can slide over each other easily (which means they are malleable)

In alloys, the atoms have different sizes, which distort the layers. Thus the layers need greater force to slide over each other, adding strength and hardness to the metal.

a layer of an alloy (grossly oversimplified)

NANOPARTICLES [SS ONLY]

nanoparticles are in between 1-100nm in size

most nanoparticles are only made up of a few hundred atoms

These have insanely high surface area to volume ratios

They are also really tiny

This gives them many uses
- Medical Treatments
- Cosmetics
- Deodorants
- Sunscreens
- Catalysts (large surface area)
- Electronics

examples

sunscreen uses ZnO, which normally looks white nanoparticles have no cosmetic affect whilst still blocking out UV light

silver has antibacterial properties, so silver nanoparticles are used in dressing wounds

CQ - Chemistry of The Atmosphere

The atmosphere today is

78% Nitrogen
21% Oxygen
1% Other Gases
0.04% Carbon Dioxide

It's composition has greatly changed over the billions of years of Earth's history.

One theory suggests the early atmosphere formed as a result of intense volcanism. This created an atmosphere that was largely CO_2 gas with trace amounts of other gases.

Volcanoes also released large amounts of water vapor, and this combined with the Late Heavy Bombardment formed Earth's oceans

For 200 million years ago to today, Earth's atmospheric composition has remained largely the same.

How Oxygen Increased & How CO_2 Decreased

Cyanobacteria and Algae evolved roughly 2.7 billion years ago, and they started carrying out photosynthesis which led to Oxygen soaring in proportion and CO_2 levels plummeting.

Furthermore, large amounts of CO_2 dissolved in Earth's ocean and formed carbonate compounds (most sedimentary rocks)

The Greenhouse Effect

If there were no greenhouse gases in the atmosphere, Earth's average temperature would be -18°C (too cold for life)

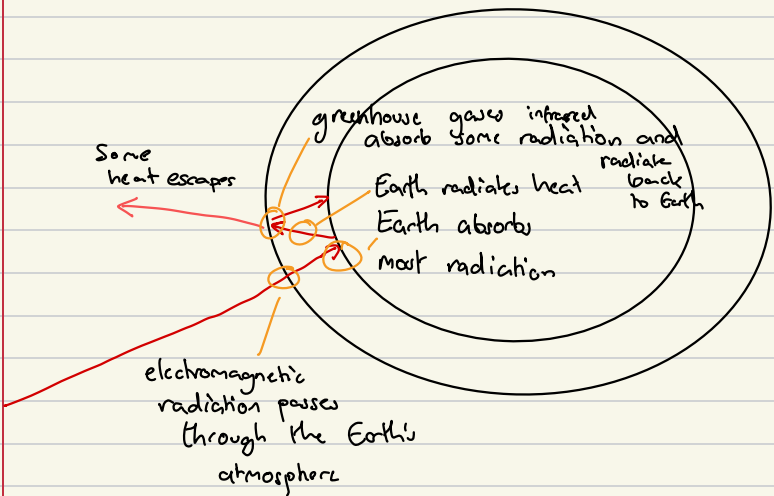
Greenhouse Gases absorb heat radiated by earth then release it in many directions - keeping Earth warm → known as "The Greenhouse Effect"

3 MAIN GASES

H_2O water vapor

CO_2 carbon dioxide

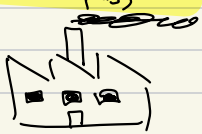
CH_4 methane



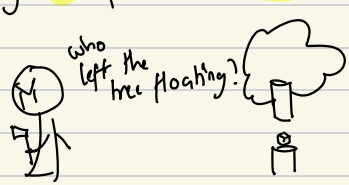
Human activities are increasing the amount of Greenhouse gases in the atmosphere

e.g. agriculture and livestock

e.g Industry (burning fossil fuels)



e.g deforestation



This can be a problem, as the more greenhouse gases, the stronger the greenhouse effect which will heat up earth.

ACHTUNG!!

Global Warming ≠ Climate Change

Climate Change is used to describe how the weather is changing over Earth's history and future

Global Warming is used to describe the rise in temperature in the past 200 years

Carbon Footprint

A product's carbon footprint is the total amount of CO_2 and other Greenhouse gases released in that product's life cycle.

e.g. a human's carbon footprint might include
- electricity used (that might've originated from a fossil fuel power plant)
- using a gas boiler
- eating rice or beef (the crop or cow released methane)

Combustion of Hydrocarbon Fuels

most fuels have carbon and/or hydrogen
when hydrogen is in a fuel, it gets oxidized to water (a harmless substance)

If there's lots of Oxygen, all the carbon reacts into CO_2. If there isn't a lot of carbon, incomplete combustion can happen, producing carbon monoxide and particulate carbon (soot)

COMPLETE COMBUSTION
(Using methane as fuel)

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

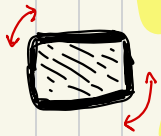
methane + oxygen → carbon dioxide + water

INCOMPLETE COMBUSTION
(using methane as fuel)

$$2CH_4 + 3O_2 \longrightarrow 2CO + 4H_2O$$

However, these reactions release atmospheric pollutants

rotate your device!



Pollutant	Source	Problems Caused
CO_2	Complete Combustion	Strengthens greenhouse effect causing global warming.
CO	Incomplete Combustion	Causes Carbon Monoxide poisoning, which can be fatal
C (soot)	Incomplete Combustion	Primary cause of Haze and acidification of Lakes + Rivers
Uncombusted Hydrocarbons	Hydrocarbons which haven't combusted (oxidized)	e.g. Methane is a more powerful greenhouse gas than CO_2
SO_2	Fuels with sulfur impurities	kinda fucks up your respiratory system if inhaled. causes acid rain*
NO_x	when nitrogen reacts with oxygen	also fucks your respiratory system and increases vulnerability and severity of condition like Asthma

* $S + O_2 \rightarrow SO_2$ $\quad 2SO_2 + 2O_2 \rightarrow 2SO_3$ $\quad SO_3 + H_2O \rightarrow H_2SO_4$

we're fucking done