IGCSE CHEMISTRY OL EDEXCEL SUMMARIES 2024

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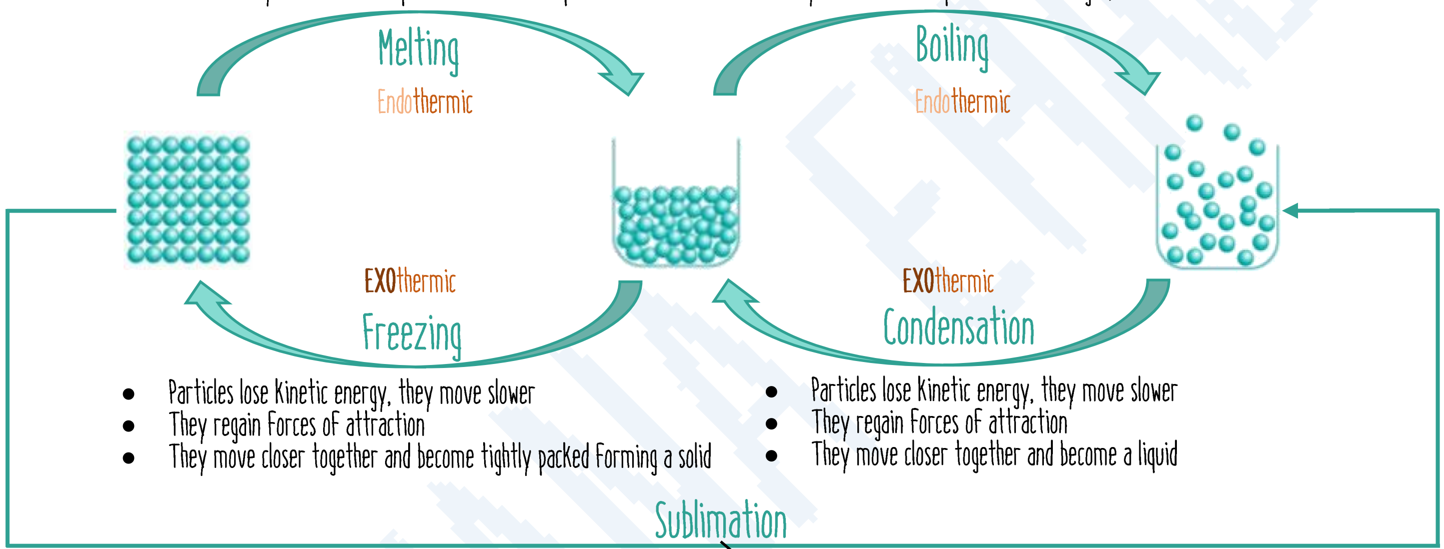
Summary Chapter 1

	Solid	Liquid	Gas
Shape	Fixed	Not Fixed, takes shape of its container	Not Fixed, takes shape of its container
Volume	Fixed	Fixed	Not Fixed
Arrangement	regular	random	Random
Separation	Tightly packed	Loosely packed	Far
Forces of attraction	Strong Forces of attraction	Less Forces of attraction	Very little
Motion	Vibrate in Fixed positions	Slide over each other	Randomly moving
Kinetic energy	Very low	High	Very high
Compressibility	Not compressible	Not compressible	Compressible

Melting:
- Particles gain Kinetic energy, they vibrate Faster
- Until energy is enough to overcome Forces of attraction
- They move Further apart and become a liquid

Boiling:
- Particles gain Kinetic energy, they move Faster
- Until energy is enough to overcome Forces of attraction
- They move Further apart to become a gas, then bubble rise to the surFace



Freezing:
- Particles lose Kinetic energy, they move slower
- They regain Forces of attraction
- They move closer together and become tightly packed Forming a solid

Condensation:
- Particles lose Kinetic energy, they move slower
- They regain Forces of attraction
- They move closer together and become a liquid

Sublimation → Examples: carbon dioxide, iodine (black solid, purple gas)

3 ways to ↑ pressure

- ↓ volume: When volume decrease particles get closer together more Frequent collisions with the inside of the wall thus, pressure increase
- ↑ temperature: particles gain Kinetic energy they move Faster thus, collide more Frequently
- add more gas

4 rules of Kinetic theory

Rules

1. Particles move all the time
2. Higher temperature → Faster movement
3. Heavier and bigger particles move slower
4. A matter's state can change by heating or cooling, but particle size doesn't change

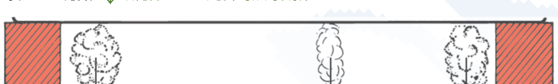
Definition: DiFFusion: Particles move randomly From areas of high concentration to areas of low concentrations

Liquid in liquid	e.g. ink in water
Gas in gas	e.g. perFume in air

IF solid in liquid, solid must dissolve First
IF liquid in gas, liquid must evaporate First

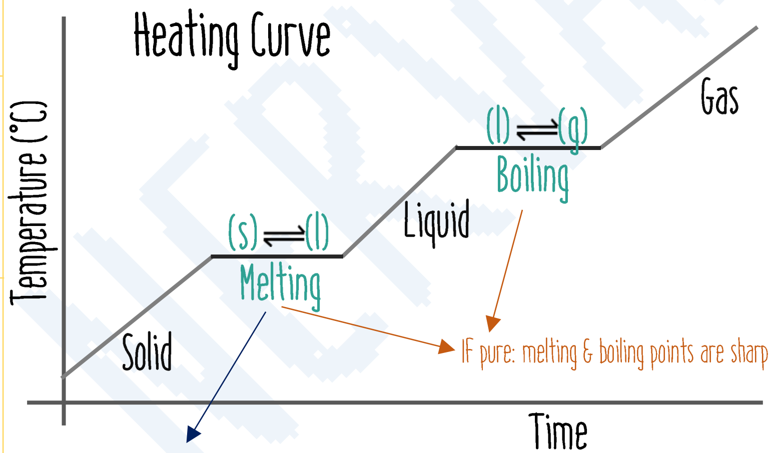
2 Factors aFFect rate of diFFusion

1. Temperature: ↑ temperature → Fast diFFusion
2. Mass: ↓ mass → Fast diFFusion



Lighter gas — Reaction occurs closer to the heavier gas — heavier gas

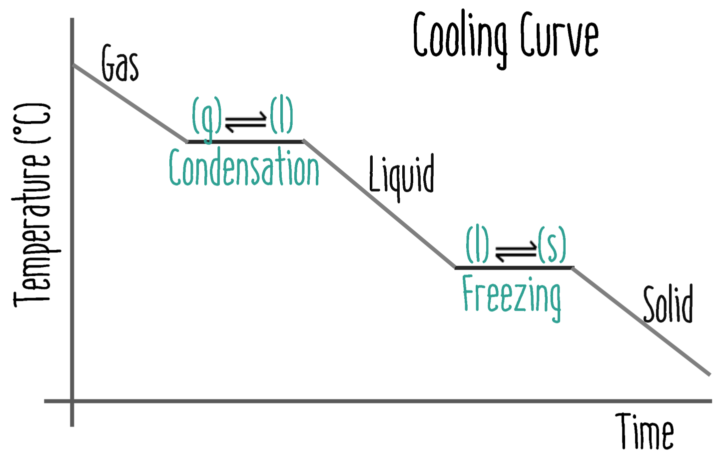
Heating Curve



IF pure: melting & boiling points are sharp

Temperature doesn't change For some time during melting & boiling because energy is being used to overcome attractive Forces between particles

Cooling Curve



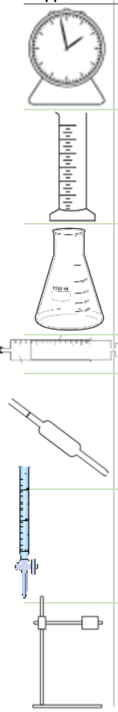
IF impurities are present:

Rules

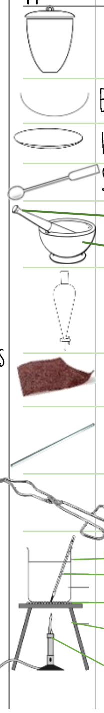
- melting and boiling points are not sharp → range
- Melting point ↓
- Boiling point ↑
- The more impurities, the bigger the changes in m.pt & b.pt

Evaporation	Boiling
Slow	Rapid
Occurs at all temperatures (between melting and boiling point)	Occurs only at boiling point
Occurs only at the surFace	Occurs throughout the liquid

Summary Chapter 2

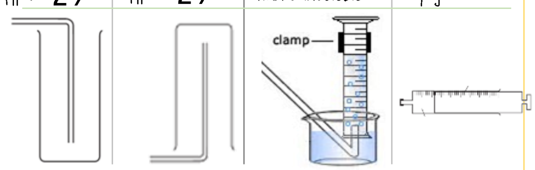


Apparatus	Name & Use
	Stopwatch: to measure time
	Measuring cylinder to measure volume to the nearest 1 cm^3. Easy & quick to use
	Conical Flask: to put liquids in it, For mixing & swirling
	Gas syringe: to measure volume of gas
	Pipette: to measure a Fixed volume of liquid accurately. Sizes: 10, 25, 50 cm^3. Slow to use
	Burette: measures volume of liquid to the nearest 0.1 cm^3. Slow to use. Used For titration experiments
	Retort stand: to hold other apparatus



Apparatus	Name & Use
	Crucible with lid: to heat solids
	Evaporating dish: to evaporate solutions
	Watch glass: to hold solids, to cover a beaker
	Spatula: to transFer solids
	Pestle / Mortar: to crush solids
	Separating Funnel to separate immiscible liquids
	Sandpaper: to clean metal surFaces
	Glass rod: to stir
	Tongs: to liFt hot items
	Beaker: to store, mix, & heat liquids Thermometer: to measure temperature Wire gauze: to support apparatus Tripod stand: to support apparatus Bunsen burner: to heat substances

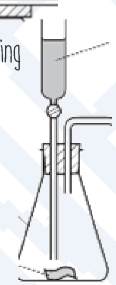
Downward delivery	Upward delivery	Over water	Gas syringe
gas is heavier than air $M_r > 29$	gas is lighter than air $M_r < 29$	To measure volume of gas that's insoluble	To measure volume of any gas



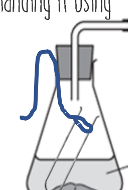
Separating chemicals:

- Hold liquid in ceramic wool or cotton

- Separate a liquid using separating Funnel



- Separate a liquid by putting it in a test tube and handing it using a thread

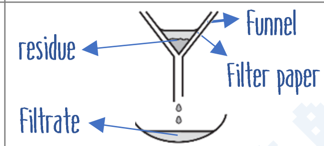
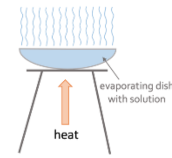
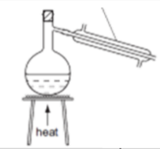
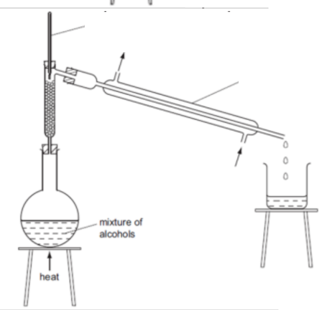
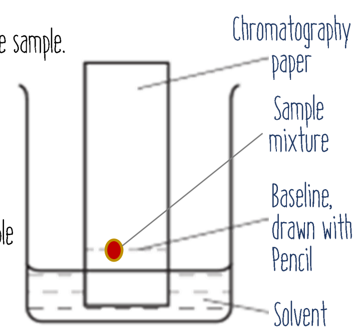


- Place a divider inside a conical Flask to separate 2 chemicals

SaFety measures:

- No running, eating, or drinking, tie hair
- Wear lab coat, gloves, & goggles
- Do not look into an apparatus containing chemicals
- Point test tube away when heating
- Do **not heat alcohols** using Bunsen burner, because they are Flammable. Use electric heater or water bath
- Use **Fume cupboards** or well-ventilated area when dealing with toxic gases
- Prevent suck-back by removing delivery tube From the liquid beFore stopping heating

Corrosive Flammable

	Method used For	Notes
Filtration	Obtain an insoluble solid From a mixture E.g., Sand From sea water	 Decantation: pouring oFF the liquid leaving the solid behind CentriFugation: heavier solid settles at the bottom due to spinning the tube at high speed
Evaporation	Obtain a soluble solid From a solution. IF it's a salt, the anhydrous Form will be obtained E.g., salt From sea water	Heat the mixture in an evaporating dish. Solvent will evaporate. Solids will be leFt behind. Definitions Solute: the substance dissolved in a solvent, to make a solution Solvent: the liquid in which a solute is dissolved, to make a solution Solution: a mixture obtained when one or more solutes are dissolved in a solvent 
Crystallization	Obtain a soluble solid From a solution, in the hydrated Form, the less soluble solute will crystallize First E.g., most soluble salts	Heat until crystallization point, cool, Filter out the crystals, dry them on a Filter paper Definitions Crystallization is the process in which crystals Form as a saturated solution cools down Saturated solution: a solution that contains the maximum concentration oF a solute dissolved in the solvent at a speciFic temperature Solubility: the amount oF solute that dissolves in 100 grams oF a solvent, at a given temperature
Simple distillation	Obtain a solvent From a solution E.g., obtain pure water From a solution	Make sure the Flask is sealed at the top with a bung to prevent loss oF vapour Condenser is Filled with cold water From bottom up, so water would Fill it up 
Fractional distillation	Obtain a liquid From a mixture oF miscible liquids, (or obtain a gas From a mixture oF gases, e.g. air) E.g., Ethanol From a mixture oF ethanol and water	• Method works because the liquids have diFFerent boiling points • The liquid with lower boiling point will be obtained First • Fractionating column provides high surFace area to condense liquids with higher boiling points • Thermometer helps tell you which liquid is being collected Fractional distillation is used to separate: 1. LiquiFied air 2. Petroleum 
Chromatography	Separate a mixture oF soluble substances E.g., A mixture oF colors, mixture oF amino acids, mixture oF simple sugars, components oF ink	• On a chromatography paper draw a line near the bottom with pencil. • On this line, place Few drops oF the sample. • Place the chromatography paper in a beaker containing a suitable solvent so that the pencil line is above the solvent level. • Allow the solvent to run up the paper to separate the substances. • Individual spots will indicate the number oF colored substances in the sample. • IF the sample is colorless, use a locating agent to reveal the spots Purpose oF chromatography is to separate & identiFy To identiFy: 1. Measure R_f value 2. Compare sample spot level with Known substances Solvent level should be lower than baseline, to prevent wash away oF sample Baseline drawn in pencil because pen would get separated Where the solvent reaches (near the top) is called: Solvent Front $RF = \frac{\text{distance traveled by spot}}{\text{distance traveled by solvent}}$ 

Summary Chapter 3

Net charge = 0 (p⁺ = e⁻)

Atom

	Protons	neutrons	electrons
Charge	+1	no charge	-1
Mass	1 unit	1 unit	1/1840
Location	inside nucleus	inside nucleus	outside nucleus in shells

Definition Isotopes: different atoms of the same element that have the same number of protons but different numbers of neutrons

Electronic configuration

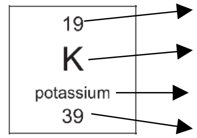
1st shell → 2 max
2nd shell → 8 max
3rd shell → 18 max

Rules
Outer shell → 8 max (except 1st shell)
8 electrons in outer shell → stable
except shell #1: 2 electrons → stable

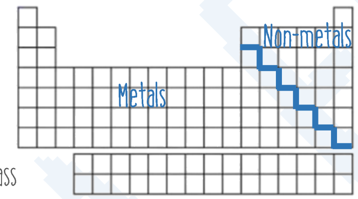
Periodic table

Definition Element: a pure substance containing only one type of atom, and cannot be split into anything simpler

Rules
Elements are arranged in order of proton #
Columns = Groups → determines # of outer electrons (valency electrons), except H (not in Group I) & He (not in Group II)
Rows = periods → determines # of shells



→ Proton # = atomic # → identifies the element
→ Symbol → 1 or 2 letter, 1st letter always uppercase
→ Name
→ Mass # = nucleon # = p + n = Ar = relative atomic mass



Average A_r of isotopes = (mass)(% abundance/100) + (mass)(% abundance/100)

Groups	I	II	III	IV	V	VI	VII	VIII
Valency	+1	+2	+3	+/-4	-3	-2	-1	0

Metals vs. non-metals

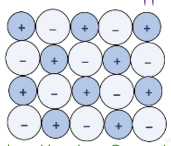
	Metals	non-metals
Physical properties	Good conductors High m.pt & b.pt Hard, strong, high density Malleable & ductile Shiny, sonorous	Non-conductors Low m.pt & b.pt Soft, low density Brittle Dull, non-sonorous
Chemical properties	Loses electrons, Forms +ve ions (cations)	Gains electrons, Forms -ve ions (anions)

Definition molecules: a unit of two or more atoms bonded together

Definition compound: containing 2 or more different atoms, chemically bonded together

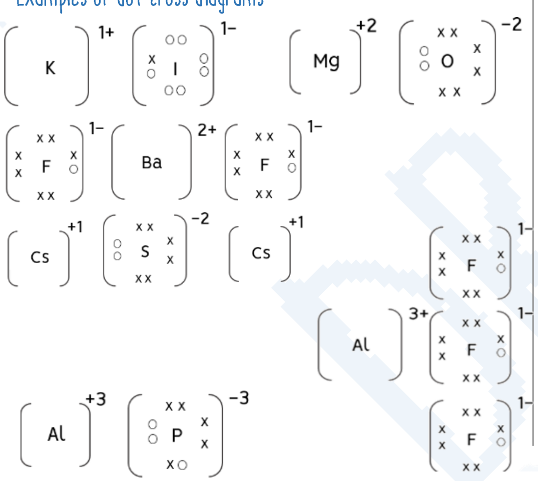
Ionic

Definition transfer of electrons from metal to non-metal forming strong electrostatic attraction between oppositely charged



Properties
1. ↑ m.pt & b.pt
Due to strong electrostatic attractive forces b/w oppositely charged ions ⇒ requires lot of energy to overcome
2. Soluble in water
3. Conduct electricity when molten or dissolved
Due to free ions

Examples of dot-cross diagrams



Simple covalent

Definition Formed when a pair of electrons is shared between two non-metals leading to noble gas electronic configurations

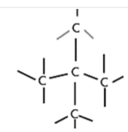
Properties
1. ↓ mpt & bpt
Due to the weak intermolecular forces of attraction
2. Insoluble in water
Except NH_3, acids, alcohols, sugars
3. Doesn't conduct electricity
No free electrons, no free ions

Group IV	Group VI	Group V	Group VII
4 outer electrons 4 shared 0 unshared	6 outer electrons 2 shared 4 unshared	5 outer electrons 3 shared 2 unshared	7 outer electrons 1 shared 6 unshared
Bonding options	Bonding options	Bonding options	Bonding options
—C— (four single bonds)	O=	N≡	Cl—
—C=	—O—	—N=	Hydrogen 1 outer electrons 1 shared 0 unshared Bonding options
=C=		—N— (three single bonds)	H—
—C≡			

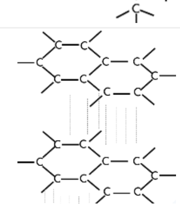
Carbon molecules

Properties of macromolecules
1. ↑ mpt & bpt.
Due to the large # of covalent bonds, requires a lot of energy to break
2. Insoluble in water.
Due to the large structure
3. Not conduct electricity.
No ions, no free electrons
Except graphite: each carbon forms 3 covalent bonds, the 4th electron is free
4. Hard.
Due to the giant tetrahedral structure
Except graphite: soft due to weak forces of attraction between layers ⇒ can slide over each other

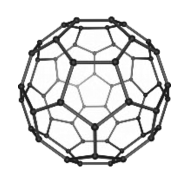
Describe diamond: each carbon atom is covalently bonded to 4 other carbon atoms tetrahedrally
Uses: cutting & drilling, cz hard



Describe graphite: each carbon atom is covalently bonded to 3 other Carbon atoms forming layers
Uses:
- lubricant & pencil, cz soft
- Electrodes, cz conducts electricity

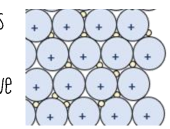


Describe Fullerene: each carbon atom is covalently bonded to 3 other carbon atoms forming a hollow shape of 60 total carbons
Use: Drug delivery, lubricant



Metallic

Describe
Lattice of regularly arranged cations surrounded by a sea of delocalized electrons. There's a strong attractive forces b/w cations and electrons



Properties of metals
1. Conduct electricity
due to the free delocalized electrons
2. Malleable
Layers of regularly arranged cations can slide over each other when force is applied
3. ↑ m.pt & bpt
Due to the strong attractive forces b/w cations and electrons

Definition Alloy: mixture of metal & another element
Brass: Cu + Zn
Bronze: Cu + Sn
Steel: Fe + C

Properties of alloys
1. Harder
due to the different size atoms which makes sliding of layers harder
2. Resists corrosion
3. Better appearance

Summary Chapter 4

Relative molecular mass – Mr: The sum of relative atomic masses.
Calculated by adding up the Ar of all atoms in the compound

Calculation

$$\% \text{ of an element in a compound} = \frac{A_r \text{ of the element} \times \text{number of atoms}}{M_r \text{ of the compound}} \times 100$$

Name	Formula	Name	Formula	Name	Formula
sulfate	SO_4^{2-}	sulfite	SO_3^{2-}	Silver	Ag^{+1}
nitrate	NO_3^{1-}	nitrite	NO_2^{1-}	Ammonium	NH_4^{+1}
phosphate	PO_4^{3-}	phosphite	PO_3^{3-}	Zinc	Zn^{+2}
carbonate	CO_3^{2-}			Lead	Pb^{+2}
hydroxide	OH^{-1}			Nickel	Ni^{+2}

Writing Formula

M^{+1} NM^{2-}

Definition A mole of any substance is its M_r (or A_r) expressed in grams

Rules Balancing #s = mole ratio

Knowing moles of 1 substance, you can find the moles of all other substances in a balanced equation using mole ratio

Finding oxidation state

Example: Find oxidation state of N in NO_3^{-1}

$N\,O_3^{\,-1}$ — the whole compound has a -1 charge

There are 3 atoms of oxygen, so multiply by 3

x -(2)(3) = -1

+x - 6 = -1   x = +5

Example:

	$2Pb(NO_3)_2$	→	$2PbO$	+	$4NO_2$	+	O_2
Mole ratio:	2	:	2	:	4	:	1
Actual moles	n = 0.02		x = 0.02		x = 0.04		x = 0.01

Calculation

$$n = \frac{\text{mass}}{M_r}$$

mol; mass in grams; Unit: g/mol

M_r → Mass of 1 mol

If both reactants are given, find which is excess & which is limiting

3 steps
1. Find moles of each reactant
2. Divide by mole ratio
3. Compare: bigger is excess

Rule Limiting reactant determines the amount of products

Classic question: given mass of 1 substance, find mass of another substance in a balanced equation

$2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

Mass = ✓   mass = ?

3 steps
1. Find moles of the given substance
2. Find moles of the unknown substance
3. Find mass of the unknown substance

Rule Mass of reactants is equal to mass of products

1 mole = 6.02×10^{23} particles (Avogadro's constant)

Calculation $n = CV$ — For aqueous solutions ONLY (mol, mol/dm³, dm³)

$1\ dm^3 = 1000\ cm^3$

Converting concentration units

mol/dm³ → Multiply by M_r → g/dm³

g/dm³ → divide by M_r → mol/dm³

Classic question: given C & V of 1 substance, find the C of another substance in a balanced equation

Acid + base → salt + water

C = ✓   C = ?

V = ✓   V = ✓

3 steps
1. Find moles of the given substance
2. Find moles of the unknown substance
3. Find C of the unknown substance

Calculation $V = 24\,n$ — For gases ONLY (dm³)

1 mole of any gas occupies 24 dm³ at r.t.p

Rule Gas volume ratio = mole ratio = balancing numbers

Definition <u>Empirical Formula</u>: the simplest whole number mole ratio of the different elements in a compound

Classic questions: given masses or percentages of the different elements, find empirical formula

2 steps
1. Find moles of the different elements (mass/A_r)
2. Simplify by dividing by the smallest ratio

Given empirical formula & M_r, find the molecular formula

Calculations

$$x = \frac{M_r}{\text{empirical mass}}$$

x: integer

MF = x [EF]

MF: Molecular Formula; x: integer; EF: Empirical Formula

$$\%\ \text{yield} = \frac{\text{actual yield}}{\text{Theoretical yield}} \times 100$$

$$\%\ \text{purity} = \frac{\text{mass of pure}}{\text{Total mass}} \times 100$$

Summary Chapter 5

Definition Electrolysis: the decomposition (or break down) of a substance by the passage of electricity

Electricity is conducted because of the:

- Free electrons in wires and electrodes
- Free ions in the electrolyte

Electrolysis is an <u>endothermic</u> process because it absorbs energy

In electrolysis, electrical energy is converted to chemical energy

Electrolysis of molten

At cathode (-ve electrode)	At anode (+ve electrode)
Metal ions + e- → Metal element e.g. $Pb^{2+}{}_{(l)}$ + 2 e^- → $Pb_{(l)}$	Nonmetal ion - e- → Non-metal element e.g. $2Br^{-1}{}_{(l)}$ - $2e^-$ → $Br_{2(g)}$
Observation Deposits of metal All metals are silvery grey, except • Gold → yellow • Copper → red brown	Observation: Bubbles of gas • Fluorine → pale-yellow gas • Chlorine → yellow-green gas • Bromine → red-brown liquid • Iodine → black solid, purple gas • Oxygen, nitrogen, hydrogen → Colorless gas • Carbon dioxide, carbon monoxide → Colorless gas
Gain of electrons → reduction	Loss of electrons → oxidation

Extraction of aluminium

Ore:
Bauxite, Al_2O_3

Cryolite, Na_3AlF_6 is used to:

- Reduce melting point, thus save energy & cost
- Increase conductivity
- Act as solvent

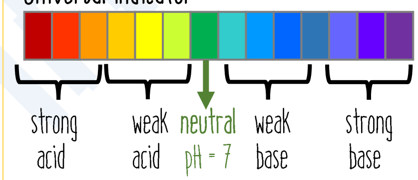
At graphite cathode (-ve electrode)	At graphite anode (+ve electrode)
$Al^{3+}{}_{(l)}$ + 3 e- → $Al_{(l)}$	$2O^{-2}{}_{(l)}$ - $4e^-$ → $O_{2(g)}$
Observation: Silvery grey aluminium sinks to the bottom	Observation: Bubbles of colorless gas
Gain of electrons → reduction	Loss of electrons → oxidation
	Four Gases are produced at anode: 1. Oxygen, O_2, due to oxidation of O^{-2} 2. Carbon dioxide, CO_2, due to burning of anode 3. Carbon monoxide, CO, due to incomplete combustion of anode 4. Fluorine, F_2, due to oxidation of F^- from cryolite

Solubility rules:

1. All Group I & ammonium salts NH_4^+ are soluble
2. All nitrates NO_3^- are soluble
3. All halides are soluble except Ag^+ & Pb^{2+}
4. All sulfates SO_4^{2-} are soluble except Ca^{2+}, Ba^{2+} & Pb^{2+}
5. All carbonates are insoluble except Group I & NH_4^+
6. All hydroxides are insoluble except Group I & NH_4^+, Calcium hydroxide is sparingly soluble
7. All oxides are insoluble except Group I, NH_4^+, Ca^{2+}, Mg^{2+}

Indicator	acid	neutral	base
Litmus	red	no change	blue
Methyl orange	red	orange	yellow
Thymolphthalein	colorless	colorless	blue

Universal indicator



Inert electrodes	active electrodes
Graphite or platinum	not graphite or platinum
Cathode: less reactive cation discharged	cathode: less reactive cation discharged
Anode: OH^- discharged except conc. halide	anode: metal dissolves producing cations
Electrolyte changes (e.g. Cu^{2+} blue color fades)	electrolyte stays the same: cations deposited at cathode gets replaced by cations produced from anode

Reactivity series

More reactive → more likely to be ions

K
Na
Ca
Mg
Al
Zn
Fe
Pb
H
Cu
Hg
Ag
Au
Pt

Less reactive → less likely to be ions

Electrolysis of aqueous solutions

Rules

1. Less reactive cation gets discharged at cathode
2. OH- gets discharged at anode except concentrated halide

$4OH^-{}_{(aq)}$ - $4e^-$ → $2H_2O_{(l)}$ + $O_{2(g)}$

Electrolysis of conc. NaCl produces 3 products:

Cl_2 (at anode)	H_2 (at cathode)	NaOH (remains)
bleach plastic disinfectant	Fuel margarine make HCl & NH_3	soap paper detergents

Test for Cl_2: bleaches damp litmus paper
Test for H_2: pops with a lighted splint
Test for O_2: relights a glowing splint

Electrolysis using active electrodes

Purification

Rules

1. Anode: impure metal: M - $2e^-$ → M^{2+}
2. Cathode: pure: M^{2+} + $2e^-$ → M
3. Electrolyte: soluble salt of the metal being purified

electroplating

Rules

1. Anode: pure metal
2. Cathode: Object
3. Electrolyte: soluble salt of the metal

Purpose: 1. Give shiny appearance, 2. Prevent corrosion

Considerations:

1. Clean object with sandpaper
2. Completely immerse object
3. Rotate object for even coating

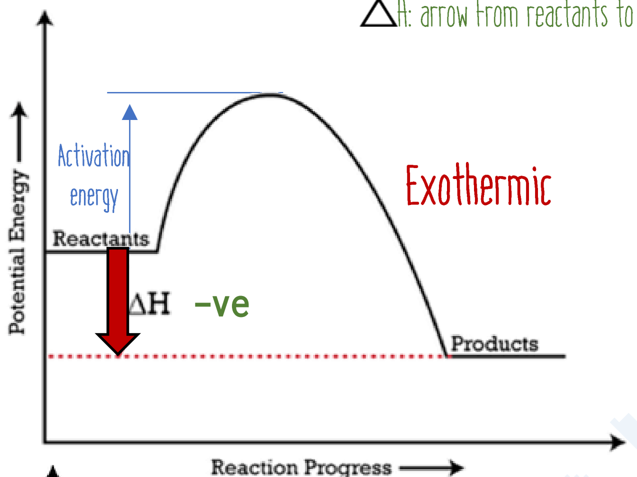
Summary Chapter 6

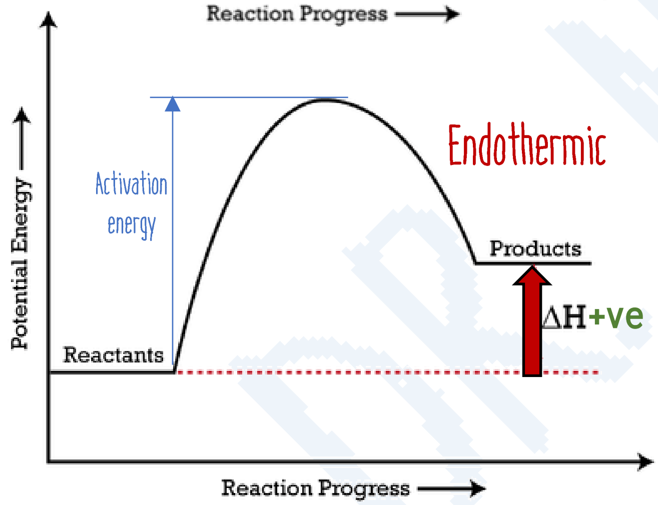
Exothermic	Endothermic
Energy is released, heat given out	Energy is absorbed, heat taken in
Reaction mixture becomes hot	reactions mixture becomes cold
Energy released when bonds formed is more than energy absorbed to break bonds	Energy absorbed to break bonds is greater than energy released to form bonds
Products have lower energy level than reactants	Products have higher energy level than reactants
Examples: Neutralization, Displacement, Combustion, Fermentation, Hydrogen-oxygen fuel cell, Condensation, Freezing	Examples: thermal decomposition, electrolysis, cracking, photosynthesis, melting, boiling

Energy level diagrams

Ea: arrow from reactants to peak

△H: arrow from reactants to products



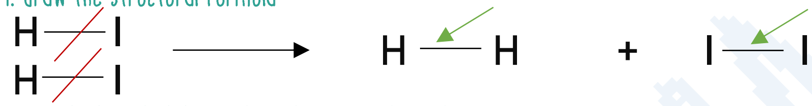


Calculations

Exam question style #1: Classic, asks for △H (enthalpy change)

$2HI \rightarrow H_2 + I_2$

Step #1: draw the structural formula



Step #2: in a table, calculate bonds broken & bonds made

Bonds broken	Bonds made
H-I = 300*2 = 600	H-H = 440*1 + I-I = 150*1 = 440+150 = 590

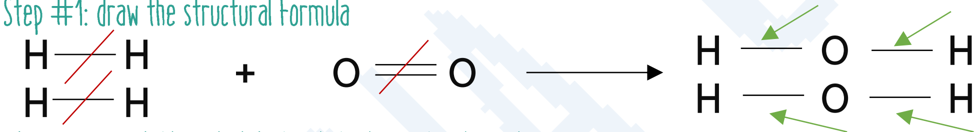
Step #3: bond breaking - bond making △H = 600 - 590 = +10

bond	bond energy kJ/mol
H-H	440
I-I	150
H-I	300

Exam question style #2: unknown bond energy, △H given

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ Reaction releases 486 kJ/mol

Step #1: draw the structural formula



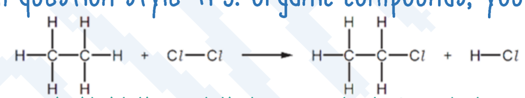
Step #2: in a table, calculate bonds broken & bonds made

Bonds broken	Bonds made
H-H = 436*2 = 872 + O=O = x, broken = 872+x	H-O = 464*4 = 1856

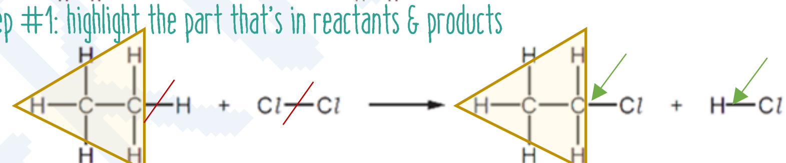
Step #3: bond breaking - bond making △H = 872 + x - 1856 = -486 thus x = 498

bond	bond energy kJ/mol
H-O	464
H-H	436
O=O	?

Exam question style #3: organic compounds, you don't break all bonds & make them again



Step #1: highlight the part that's in reactants & products



Step #2: in a table, calculate bonds broken & bonds made

Bonds broken	Bonds made
C-H = 410 + Cl-Cl = 240 = 650	C-Cl = 340 + H-Cl = 430 = 770

Step #3: bond breaking - bond making △H = 650 - 770 = -120

bond	bond energy kJ/mol
C-Cl	340
C-H	410
Cl-Cl	240
H-Cl	430

Fuels Any substance that provides energy

hydrogen

Q = mC△T

△H = Q/n

ethanol

$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

Used in car engines

Combustion reactions

Burning of fuel in oxygen, it's exothermic

$C + O_2 \rightarrow CO_2$

$2H_2 + O_2 \rightarrow 2H_2O$

$C_xH_y + O_2 \rightarrow CO_2 + H_2O$

Complete: excess O_2, produces CO_2

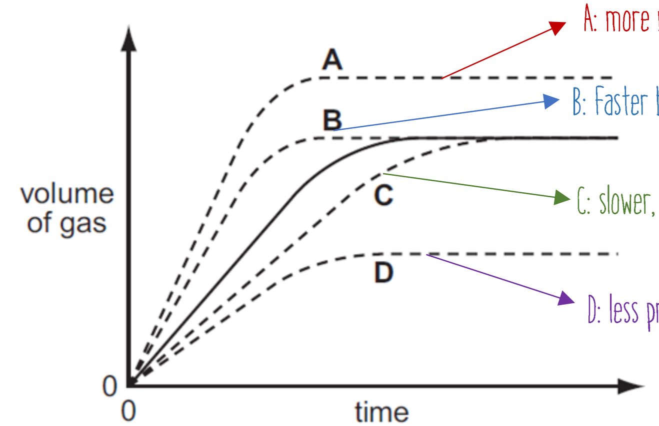
Incomplete: insufficient O_2, produces CO

Fossil Fuels

- Coal → Mainly carbon + sulfur impurities
- natural gas → Mainly methane
- petroleum crude oil → Mainly hydrocarbons

Summary Chapter 7

Physical change	Chemical change
No new substance is formed	new substance is formed
Easy to reverse	not easily reversed
Changes in state	neutralization, redox, combustion
Dissolving in a solvent	displacement, decomposition

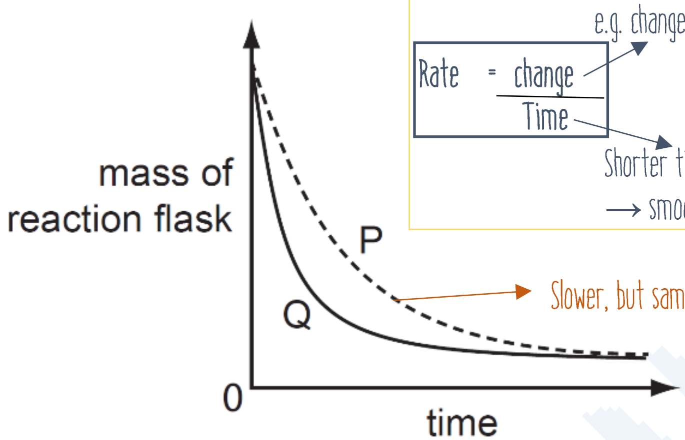


A: more product, thus more limiting reactant

B: Faster but same amount of limiting reactant

C: slower, but same amount of limiting reactant

D: less product, thus less limiting reactant



$\text{Rate} = \dfrac{\text{change}}{\text{Time}}$

e.g. change in volume, mass, temperature, ppt

Shorter time interval ⟶ more data points ⟶ smoother graph ⟶ more accurate

Slower, but same amount of limiting reactant

2 conditions are needed for a reaction to occur: 1. Collision, 2. Collision with sufficient energy

Factors affecting rate of reaction:

1. Concentration: more particles per unit volume, thus more frequent collisions per unit time
2. Temperature: particles have more kinetic energy, they move faster, so they collide more frequently per unit time. Particles also have energy more than activation energy thus more successful collisions
3. Pressure: pressure ↑ volume ↓ so particles get closer together, they collide more frequently per unit time
4. Surface area: more particles exposed, so more frequent collisions per unit time
5. Stirring: more frequent collisions
6. Catalyst: increase rate without being used up. Catalyst decreases the activation energy of the reaction
7. Light: e.g. photosynthesis, substitution of alkanes with halogen
8. Reactivity: more reactive metals ⟶ faster reaction

Examples of reversible reactions:

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

$2SO_2 + O_2 \rightleftharpoons 2SO_3$

$CaCO_3 \rightleftharpoons CaO + CO_2$

Hydrated salt ⇌ anhydrous salt + water

$CuSO_4.5H_2O \rightleftharpoons CuSO_4 + 5H_2O$

Observation of forward rx: blue to white, condensed water at top

Observation of backward rx: white to blue, tube gets warm

$CoCl_2.6H_2O \rightleftharpoons CoCl_2 + 6H_2O$

Examples of catalysts:

1. MnO_2: $2H_2O_2 \longrightarrow 2H_2O + O_2$
2. Iron: $N_2 + 3H_2 \rightleftharpoons 2NH_3$
3. V_2O_5: $2SO_2 + O_2 \rightleftharpoons 2SO_3$
4. Platinum: catalytic converters
5. Nickel: $CH_4 + H_2O \longrightarrow CO + 3H_2$
6. Nickel: addition of hydrogen to alkenes
7. Conc. H_2SO_4: esterification
8. Al_2O_3: cracking
9. H_3PO_4: addition of steam to alkene
10. Yeast (enzyme): Fermentation
11. Chlorophyll: photosynthesis

Definition Equilibrium: a reversible reaction in which the rate of forward reaction is equal to the rate of backward reaction and amounts of all substances remain constant

Effect of concentration on equilibrium:

- if a substance is added, equilibrium shifts to the direction that gets rid of this substance.
- If a substance is removed, equilibrium shifts to the side that forms that substance

Effect of temperature on equilibrium:

- If exothermic: ↑ temperature shifts equilibrium backward, ↓ temperature shifts equilibrium forward
- If endothermic: ↑ temperature shifts equilibrium forward, ↓ temperature shifts equilibrium backward

Effect of pressure on equilibrium:

- ↑ pressure shifts equilibrium to the side with less gas moles
- ↓ pressure shifts equilibrium to the side with more gas moles

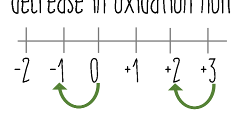
Why not use higher temperature: equilibrium will shift backward (if exo)

Why not use lower temperature: reaction will be slow

Why not use higher pressure: expensive & dangerous

Why not use lower pressure: equilibrium will shift backward

Oxidation	Reduction
Gain of oxygen	loss of oxygen
Loss of electrons	gain of electrons
Increase in oxidation number	decrease in oxidation number



Oxidizing agents	Reducing agents
$KMnO_4$ purple ⟶ colorless	KI colorless ⟶ brown
$K_2Cr_2O_7$ orange ⟶ green	Carbon, carbon monoxide
Oxygen, H_2O_2, HNO_3	Hydrogen, H_2S
less reactive cations	Reactive metals
reactive non-metals	Non-reactive anions

Summary Chapter 8

Rules

4 reactions:

metals below H do not react
do not use metals above Mg (explosive)
do not use Al (slow due to protective layer)

1. Acid + metal → salt + hydrogen

Type: displacement/redox
Observation: metal dissolves, bubbles of colorless gas

2. Acid + MO/MOH → salt + water

Type: neutralization
Observation: MO/MOH dissolves (if insoluble), solution becomes colored if transition

3. Acid + MCO_3 → salt + water + carbon dioxide

Type: neutralization
Observation: MCO_3 dissolves (if insoluble), bubbles of colorless gas, solution becomes colored if transition

4. Base + NH_4^+ salt → salt + water + ammonia

Type: displacement
Observation: base dissolves (if insoluble), pungent gas that turns damp red litmus paper blue

5 ways to differentiate strong vs. weak acid:

1. Measure pH using pH meter/universal indicator, strong acid will have lower pH
2. Measure electrical conductivity using voltmeter, strong acid will have higher conductivity
3. Add Zn or Mg, strong acid will produce faster bubbles
4. Add calcium carbonate (or any metal carbonate), strong acid will produce faster bubbles
5. Titrate with NaOH, strong acid will need a greater volume of NaOH for neutralization

3 ways to differentiate strong vs. weak alkali:

1. Measure pH using pH meter/universal indicator, strong alkali will have higher pH
2. Measure electrical conductivity using voltmeter, strong alkali will have higher conductivity
3. Titrate with HCl, strong alkali will need a greater volume of HCl for neutralization

Types of oxides

Basic	acidic
Metal oxides	non-metal oxides
MgO, CaO, Fe_2O_3	SO_2, CO_2, NO_2
Basic oxide + HCl ✓	acidic oxide + HCl ✗
Basic oxide + NaOH ✗	acidic oxide + NaOH ✓
	e.g. CO_2 + limewater gives milky appearance of $CaCO_3$ (neutralization reaction)

Flame test

- Na^+ yellow
- Li^+ red
- K^+ lilac
- Cu^{2+} blue-green
- Ca^{2+} orange-red

Preparation of salts

- Salt
  - Salt soluble
    - Acid + base reaction
      - Base insoluble → **Neutralization method**
      - base soluble → **Titration method**
  - Salt insoluble
    - Start with 2 aqueous solutions → **Precipitation Method**

Neutralization method

1. Add excess base to acid
2. Heat (if insoluble MO or MOH)
3. Filter to remove excess base
4. Heat filtrate to crystallization point
5. Cool, filter off crystals, dry

Titration method

1. Place 25 cm^3 of acid in conical flask
2. Add methyl orange → red
3. Using burette, titrate with alkali
4. until red turns orange
5. Record volume of alkali used
6. Repeat without indicator using same volumes
7. Heat to crystallization point, cool, filter, dry

Precipitation Method

1. Mix the 2 aqueous solutions in a beaker
2. Ppt will form
3. Filter
4. Wash residue with distilled water
5. Dry between filter paper

Cation	+ $NaOH_{(aq)}$	ionic equation
NH_4^+	ammonia produced on warming	$OH^-_{(aq)} + NH_4^+{}_{(aq)} \rightarrow H_2O_{(l)} + NH_{3(g)}$
Cu^{2+}	light blue ppt., insoluble in excess	$Cu^{2+}{}_{(aq)} + 2OH^-{}_{(aq)} \rightarrow Cu(OH)_{2(s)}$
Fe^{2+}	green ppt., insoluble in excess	$Fe^{2+}{}_{(aq)} + 2OH^-{}_{(aq)} \rightarrow Fe(OH)_{2(s)}$
Fe^{3+}	red-brown ppt., insoluble in excess	$Fe^{3+}{}_{(aq)} + 3OH^-{}_{(aq)} \rightarrow Fe(OH)_{3(s)}$

Test for gases

- CO_2: turns limewater milky
- NH_3: turns damp red litmus paper blue
- Cl_2: bleaches damp litmus paper
- H_2: pops with a lighted splint
- O_2: relights a glowing splint

Anion	Test	Test result
CO_3^{2-}	add dilute acid	effervescence, carbon dioxide produced
Cl^-	acidify with dilute HNO_3, add aq.$AgNO_3$	white ppt.
Br^-	acidify with dilute HNO_3, add aq.$AgNO_3$	cream ppt.
I^-	acidify with dilute HNO_3, add aq.$AgNO_3$	yellow ppt.
SO_4^{2-}	acidify, add aqueous barium nitrate	white ppt.

Summary Chapter 9

Columns → group # → determines # of electrons in outermost shell = valency electrons
Rows → period # → determines # of shells

Metals	non-metals
↓	↓
Tendency to lose electrons	tendency to gain electrons
+ve ions	-ve ions (except H)

Metallic property ↑ down the group
Metallic property ↓ across the period

Alkali metals - Group I

Physical properties:

1. Conduct electricity
2. Slivery grey in color
3. Malleable, ductile, Forms alloys
4. Density < 1 g/cm^3 (Floats)

Density ↑ down the group

5. Lower m.pt & b.pt than other metals

M.pt & b.pt ↓ down the group

6. Soft, softness ↑ down the group

Chemical properties:

1. 1 outer electron, loses 1 electron,
   - Forms valency +1
2. Forms ionic compounds with non-metals
   - Soluble in water
   - White solid
   - Colorless solution
3. 3 Reactions: all are redox reactions

M + water → MOH + H_2
Observation: Fizzing, solid disappears, Floats on water
Li: slow, Na: shoots across the beaker, K: sparks with flames, Rb: bursts into flames, Cs: explosive

M + O_2 → M_2O
Observation: metal tarnish quickly when exposed to air → must store under oil

M + halogen → metal halide

Atomic number	Symbol	Name	Mass
3	Li	lithium	7
11	Na	sodium	23
19	K	potassium	39
37	Rb	rubidium	85
55	Cs	caesium	133

Reactivity increases down the group
M.pt & b.pt decrease down the group
Density increases down the group
Softness increases down the group

Halogens - Group VII

Properties:

1. Exists as diatomic molecules
2. Toxic
3. Color gets darker down the group
4. M.pt & bpt ↑ down the group
5. Density ↑ down the group
6. Reactivity ↓ down the group
7. Reaction: displacement reaction, also redox

Rule
More reactive halogen displaces the less reactive halogen from its compound

Examples:
$2KBr + Cl_2 \rightarrow 2KCl + Br_2$ [Observation: colorless to red-brown]
$Cl_2 + 2KF \rightarrow$ no reaction
$Cl_2 + 2NaI \rightarrow 2NaCl + I_2$ [Observation: colorless to brown]

Atomic number	Symbol	Name	Mass	Color / state
9	F	fluorine	19	Yellow gas
17	Cl	chlorine	35.5	yellow-green gas
35	Br	bromine	80	red-brown liquid
53	I	iodine	127	grey-black solid
85	At	astatine	–	black solid

Density increases down the group
M.pt & b.pt increase down the group
Reactivity decreases down the group

Noble gases, group VIII

Properties:

1. Non-metals
2. Colorless gases
3. Stable due to full outer electrons: 8 electrons
   - except He → 2 electrons
4. Unreactive, doesn't form compounds, monatomic
5. Occurs naturally in air in small amounts

Atomic number	Symbol	Name	Mass
2	He	helium	4
10	Ne	neon	20
18	Ar	argon	40
36	Kr	krypton	84
54	Xe	xenon	131

M.pt & b.pt increase down the group
Density increases down the group

Colors

Metals: silvery gray
Except: Cu & Au
Ionic compounds
Non-transition: white solid, colorless solution
Carbon - black

Summary Chapter 10

Properties of metals

Physical properties	Chemical properties
Conduct electricity & heat (no exception)	Forms +ve ions
High melting & boiling point (transition: higher, group I: lower)	reacts with acid → salt + hydrogen
Hard & strong (except group I: soft)	reacts with oxygen → metal oxide
Malleable & ductile	(except Ag, Au, Pt)
High density (transition > 4 gm/cm^3, group I < 1)	
Can form alloys	Forms basic oxide
Silvery gray in color (Cu: pink-brown, Au: yellow)	(except Al, Zn, Cr: Forms amphoteric)

Apparent unreactivity of aluminium

Due to the protective layer of Al_2O_3 that acts as a barrier & protects Al from further oxidation.

Iron when exposed to air, forms rust, which is flaky & doesn't protect underlying iron

Properties of alloys

1. Harder (less malleable)
2. Better appearance
3. Less likely to corrode

Uses of metals & alloys

Metal/alloy	Use & reason
Copper	Electric wires: ductile good electric conductor, high melting point Cooking utensils: good heat conductor, malleable Making brass
Aluminium	Aircraft: low density (also high strength, doesn't corrode) Overhead cables: low density, doesn't corrode, conducts electricity (steel core) Food containers & cans: doesn't corrode Window frames: doesn't corrode Cooking utensils: doesn't corrode, conducts heat, high melting point
Zinc	Galvanizing iron: more reactive than iron, thus protects iron
Mild Steel	Car bodies, machines, screws: hard
High carbon steel	railway tracks, hammers, drills, cutting tools: harder than mild steel
Stainless steel	cutlery, saucepans, surgery tools, pipes in chemical factory: doesn't rust

Calcium compounds

Compound	Common name
$CaCO_3$	Limestone
CaO	Lime
$Ca(OH)_{2(s)}$	Slaked lime
$Ca(OH)_{2(aq)}$	Lime water

Reaction of limewater with carbon dioxide

$CO_{2(g)} + Ca(OH)_{2(aq)} \rightarrow CaCO_{3(s)} + H_2O_{(l)}$ Type: Neutralization, precipitation

Reaction of calcium oxide with water

$CaO + H_2O \rightarrow Ca(OH)_2$ Type: hydration, addition

Uses of limestone: in extraction of Fe, making cement, making lime, neutralization of acidic soil

Uses of lime & slaked lime: neutralization of acidic soil, desulfurization

Reactivity series

Reaction with acid	Metal	Reaction with H_2O
Violent, do not attempt!	K, Na, Ca	+ water → Metal hydroxide + H_2
M + acid → salt + H_2	Mg, Al, (C), Zn, Fe, Pb	Mg, Al, (C), Zn, Fe: +steam → Metal oxide + H_2
No reaction	(H), Cu, Hg, Ag, Au, Pt	Pb, (H), Cu, Hg, Ag, Au, Pt: No reaction with steam or water

Reduction with Carbon	Metal	Extraction
Metal oxide cannot be reduced by carbon	K, Na, Ca, Mg, Al	Electrolysis of molten salt
$MO + C \rightarrow M + CO_2$	(C), Zn, Fe, Pb, (H), Cu, Hg, Ag, Au, Pt	Zn, Fe, Pb: Reduction of metal oxide with carbon
		Cu, Hg, Ag, Au, Pt: Occurs naturally

Thermal decomposition

4 Rules

1. Metal carbonate → metal oxide + CO_2 except group 1 — Obs: size ↓, color change if transition
2. Metal hydroxide → metal oxide + H_2O except group 1 — Obs: size ↓, color change if transition
3. Metal nitrate → metal oxide + NO_2 + O_2 except group 1 — Obs: size ↓, color change if transition, brown fumes
4. Metal nitrate (group 1) → metal nitrite + O_2 — Obs: size ↓

Extraction of iron

$C + O_2 \rightarrow CO_2$ Exothermic: heats up the furnace

$CO_2 + C \rightarrow 2CO$

$2C + O_2 \rightarrow 2CO$

$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

$CaCO_3 \rightarrow CaO + CO_2$

$CaO + SiO_2 \rightarrow CaSiO_3$ Slag: Floats on molten iron & protects Fe from oxidation

4 raw materials:

1. Ore: hematite (Fe_2O_3)
2. Limestone
3. Coke (carbon)
4. Hot air

Making steel

Cast iron from blast furnace contains 4% carbon

Cast iron poured into oxygen furnace

Oxygen is blown over iron to remove C, S, P, Si

$C + O_2 \rightarrow CO_{2(g)}$ gas escapes

$S + O_2 \rightarrow SO_{2(g)}$ gas escapes

Si/P + O_2 → oxides of Si/P (solid, removed by neutralization with CaO → Slag

Summary Chapter 11

Chemical tests for water

- turns anhydrous $CuSO_4$ from white to blue
- turns anhydrous $CoCl_2$ from blue to pink

Treatment of water

Stage	Reason
1. Filtration	Remove insoluble solids
2. Add carbon	Remove tastes & odors
3. Chlorination	Kill bacteria

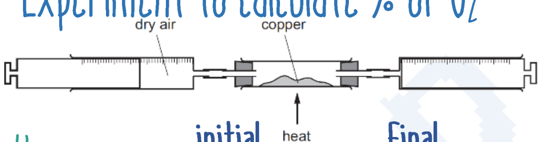
Substances in water

1. dissolved oxygen: for aquatic life
2. metal cations: essential minerals, some are toxic
3. plastics: harms aquatic life
4. sewage: harmful microbes, cause disease
5. harmful microbes
6. NO_3^- & PO_4^{3-} from fertilizers: deoxygenation of water & damage aquatic life

Composition of air

- Nitrogen: 78%
- Oxygen: 21%
- Argon: 1%
- CO2: 0.04%
- Noble gases & water vapor

Experiment to calculate % of O_2



Use cross multiplication to find x

initial	Final
100	79
x	given
given	x

Separation of oxygen & nitrogen

Water vapor: removed by condensing into liquid
Acidic gases (CO_2, SO_2, NO_2): removed by passing through NaOH
Fractional distillation of liquid air

Uses of oxygen

1. Steel making
2. Breathing apparatus
3. Welding: oxygen mixed with C_2H_2

Advantage of C_2H_2 (acetylene)

- Gas: easy to mix with O_2
- Produces hot flame

Air pollution

Pollutant	Source	Adverse effect
CO	Incomplete combustion	Toxic
SO_2	Burning fossil fuels	Acid rain & respiratory problems
oxides of nitrogen	O_2 & N_2 in car engine react due to high temperature	Acid rain, respiratory problems
CO_2	Complete combustion	Greenhouse gas
Particulates	Incomplete combustion	Respiratory problems
CH_4	animal waste	Greenhouse gas

Acid rain

1. Damages trees
2. Damages limestone buildings
3. Acidify lakes
4. Increases acidity of soil
5. damage metal works

How to reduce acid rain

1. Use catalytic converters
2. Using low-sulfur fuels
3. Flue gas desulfurization with CaO

Fertilizers

N P K

Help crops grow

Farmer considerations:

1. Use carefully
2. Avoid rainy days
3. Use far from rivers

Rusting

Needs O_2 & H_2O

iron + oxygen + water ⟶ hydrated iron(III) oxide
rust: red-brown flaky solid

Preventing rusting

Cover with a barrier

- Paint: cars, railings, bridges
- Grease: machines
- Plastic
- Another metal: tin can
- Zinc: galvanization, protective even if scratched

Electrochemical

Sacrificial protection E.g. Zn, Mg
Zn is more reactive than Fe, thus, it loses electrons more readily than Fe and corrodes in preference to Fe

Cathodic protection
Connect to negative terminal

Greenhouse gases CO_2 & CH_4

They absorb energy from earth & prevent energy from escaping

Global warming

1. melting ice caps
2. extreme weather
3. Flooding
4. temperature increase
5. habitat loss

How to reduce global warming

1. plant trees
2. reduce livestock farming
3. decrease use of fossil fuels
4. use H_2 & renewable energy (solar, wind)

	CO_2	CH_4
Properties	Colorless, odorless gas Insoluble in water Denser than air Doesn't burn, puts off fire	Colorless, odorless gas Slightly soluble in water Lighter than air Burns in air
Uses	Fire extinguisher Fizzy drinks, dry ice	Fuel Making organic chemicals
Sources	Combustion, Respiration acid + MCO_3, Fermentation MCO_3 decomposition $MO + C \rightarrow M + CO_2$	Decomposition of vegetation Waste gases from animals Natural gas is methane

Summary Chapter 12

Petroleum
Mixture of hydrocarbons
Separated by Fractional distillation

	Name	Use
Gas 1 - 4 carbons	Refinery gas	Bottled gas for cooking/heating
Liquid 5 - 30 carbons	Gasoline	Petrol for cars
	Kerosene (paraffin)	Fuel for aircraft & home stoves
	Diesel oil (gas oil)	Fuel for diesel engines
	Fuel oil	Fuel for power stations, Factories, ships
Thick Liquid 30 - 50 carbons	Bitumen	Road surfaces & roofs
Solid > 50 carbons		

Small molecules:
1. Few carbons
2. Low boiling points
3. Light in color
4. Flows easily
5. Flammable
6. Many uses

Large molecules:
1. Many carbons
2. High boiling points
3. Dark in color
4. Viscous
5. Doesn't burn easily
6. Few uses

Disadvantages of using petroleum
1. Non-renewable resource
2. Production of greenhouse gas CO_2
3. Acid rain, production of toxic gases

Naming organic compounds

First part: # of carbons
Middle part: Position of Functional group
Last part: Functional group

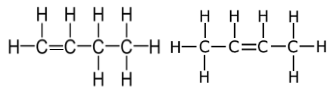
1 C → meth-
2 C → eth-
3 C → prop-
4 C → but-
5 C → pent-

Ending	Class
-ane	Alkanes C-C
-ene	Alkenes C=C
-ol	Alcohols -OH
-oic acid	Carboxylic acids -COOH

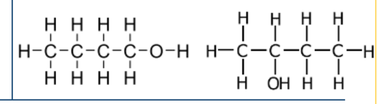
Homologous series
1. same general formula
2. same functional group
3. similar chemical properties
4. physical properties have a trend
5. consecutive members differ by $-CH_2-$
6. can be prepared by similar methods

Isomers
1. Change position of Functional group

but-1-ene & but-2-ene

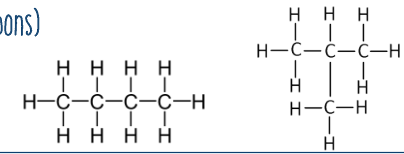


butan-1-ol & butan-2-ol



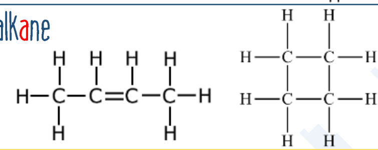
2. Branch (minimum 4 carbons)

Butane & 2-methyl propane



3. Change alkene to cycloalkane

Butene & cyclobutane



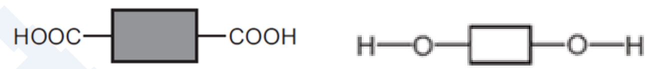
Problems of synthetic polymers (plastics)
Non-biodegradable: not decomposed by bacteria
1. Animals get trapped
2. Fills landfill sites
3. Produces poisonous vapors when burned
4. Litter and visual pollution
5. Sticks in throats of animals
6. Blocks drains & watercourses

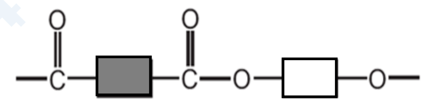
Making ethanol

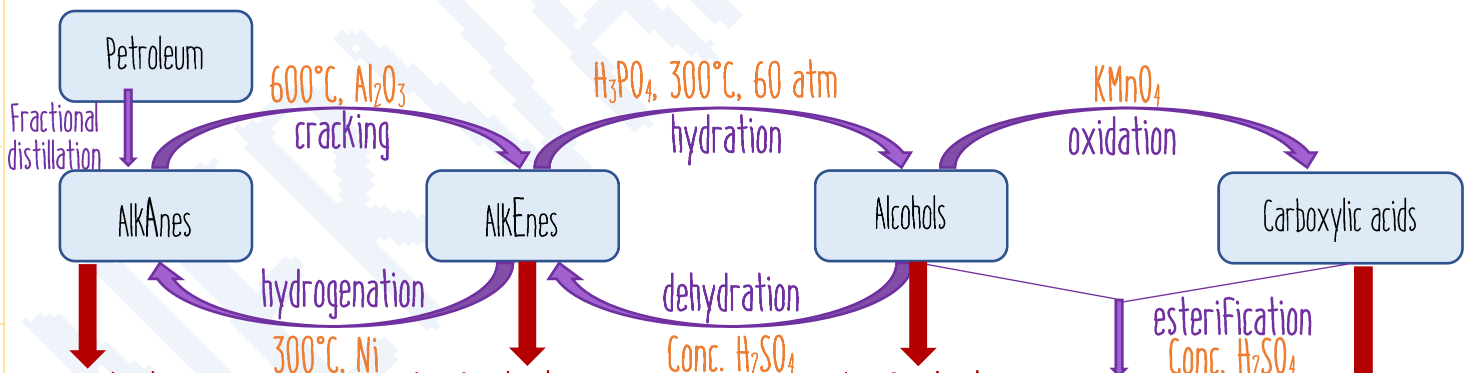
Catalytic addition of steam to ethene	Fermentation
$C_2H_4 + H_2O \rightarrow C_2H_5OH$	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$
H_3PO_4, 300°C, 60 atm	37C, yeast (enzyme), no oxygen, aqueous glucose
1. Fast 2. Pure product 3. Continuous	1. Uses renewable resource 2. cheap
1. Uses non-renewable resource 2. Costly (high temp & pressure)	1. Slow 2. Low yield 3. Impure products

Condensation polymerization
Polyester — Polyester linkage

Monomers: di-carboxylic acid + di-ol







Alkanes
1. Combustion
2. Substitution UV light

2 products: chloroalkane + HCl

3. Cracking

Alkanes → alkene + alkane
Alkanes → alkene + H_2

Reasons for cracking:
- Higher demand for short-chain hydrocarbons
- Small molecules are more useful, alkenes used to make polymers

Alkenes
1. Combustion
2. Addition

Remove double bond, add to each C

3. Addition polymerization

Draw box around C=C
Put stuff above & below each C
Remove double bond
put extension bonds

Alcohols
1. Combustion
2. Dehydration
3. Oxidation

Esters

Name: -yl (From alcohol), -oate (From carboxylic acid)

Carboxylic acids
1. + metal → salt + H_2
2. + base → salt + H_2O
3. + MCO_3 → salt + H_2O + CO_2

An isomer of ester must have the same number of total carbons

Free Notes & Videos

Summary of Reactions:
https://youtu.be/FaMpEQlWhzE
Summary of Uses:
https://youtu.be/D56WE8N2Z9w
Definitions:
https://youtu.be/-8NlqvS3ctg

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Salma:200/200


Ahmed:A*/9


Nour:A*/9


Basant:A*/9


Jana:A*/9

Hana: 193/200
Jana: 193/200
Qusai: 189/200
Ali: 187/200
Yara: 183/200

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+20 109 398 4514

Thank you so much
5:31 PM

I've struggled with Chemistry for as long as I can remember, but after joining your course not only did you make it simple and fun, but Chemistry became one of my favourite subjects!
5:38 PM

OMG thank you so muc
😍😍😍 yo
music

You
1:10

Thanks a lottt Miss Nervana 💖💖
You are the best ❤️ and the summaries were just amazing and they helped me a lotttttt till the last minute when I entered
They helped me brainstorm the ideas ❤️

0:51 6:52 PM

Today

ربنا يحفظك يا د.نيرفانا
بتبذلي مجهود خرافي فوق
العادي والله.
تسلمي بجد
يارب يفرحك بنجاحهم يارب
3:28 AM

Today

انا بس عايزه اقولك انك انسانه
جميله واخلاقك في منتهي
الرقي.. انا احساسي بيقولي انك
حتبقي زي زويل واعلي كمان..
you have got the full
package.. شكرا علي كل حاجه
وبالنسبالي الجانب المعنوي
الايجابي الي سيبتيه في هانيا اكتر
من الجانب التعليمي

والله الواحد مش عارف
يشكركم ازاي
ربنا يجزيكم خير وشكرا علي
التعب والمتابعه والالتزام
والاحترام مع الطلبه واولياء
الامور
كل الشكر للتيم معاكم وربنا
يوفق الجميع
2:15 PM

مساء الخير د.نيرفانا حابه
أشكر حضرتك كتير على
مجهودك ودعمك وكل التيم
طول السنه بجد بذلتوا مجهود
جبار ومكنتيش بتتأخري عن
الرد عن أي سؤال في اي وقت
وبكل رحابه كل الشكر والتقدير
وربنا يكمل فرحتنا ❤️🌹
بنجاحهم وبالاستار ياارب 😃🙏
ان شاءالله
12:47 PM

And I'm so glad I joined your class and watched your recordings because they were SOOOOO HELPFUL 🥹💞 I feel like I did way better than I did for the last two years in chemistry and your future students are going to be so lucky to have you. You really are everyones dream teacher 🙁💞
11:38 AM

Thank you very much, miss ! It was really fun to attend your classes and now I like chemistry. Words cannot express how much I appreciate your work and support! 🌚