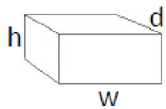
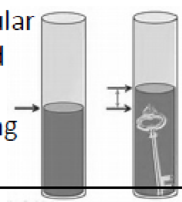
Trilogy: Molecules and matter

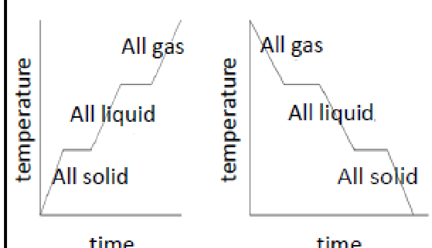
Collins rev guide: Particle model of matter

Knowledge Organiser

Key points to learn

1. Mass, m	Amount of matter in something. Measured in kg
2. Volume, V	Amount of space something takes up. Measured in m^3
	Volume of a cuboid = w x d x h 
	Volume of an irregular object can be found by dropping in a liquid and measuring displacement. 
3. Density, ρ	Mass per unit volume. Measured in kg/m^3
	$density = \frac{mass}{volume}$
4. Floating	An object that has a lower density than the fluid will float
5. Sinking	An object that has a higher density than the fluid will sink
6 Evaporation	Happens at any temperature
7 Sublimation	Solid turns straight into gas
8. Solid	Particles held together in fixed positions by strong forces. Least energetic state of matter.
9. Liquid	Particles move at random and are in contact with each other. More energy than solids, less than gas
10. Gas	Particles move randomly and are far apart. Weak forces of attraction. Most energetic.

Key points to learn

11. Melting point	Temperature when solid turns into liquid. Same as freezing point.
12. Boiling point	Temperature when liquid turns into gas. Same as condensation point.
13. Condensation point	Temperature when gas turns into liquid. Same as boiling point.
14. Freezing point	Temperature when liquid turns into solid. Same as melting point.
15. Latent heat	Energy transferred when a substance changes state but temperature doesn't change
16. Specific latent heat of fusion	Energy needed to melt 1kg of solid into liquid
17. Specific latent heat of vaporisation	Energy needed to boil 1kg of liquid into gas
18. At state changes...	Temperature and kinetic energy of particles stays constant.
	Internal energy increases due to an increase in potential energy as particles move further apart
19. Heating and cooling curves	
20. Gas pressure	Caused by particles hitting surfaces. Increases when temperature increases

Big picture (Physics Paper 1)

- Energy and energy resources
  - Conservation and dissipation of energy
  - Energy transfer by heating
  - Energy resources
- Particles at work
  - Electric circuits
  - Electricity in the home
  - **Molecules and matter**
  - Radioactivity

Background

The particle model is widely used to predict the behaviour of solids, liquids and gases. It helps us to design vehicles from submarines to spacecraft. It even explains why it is difficult to make a good cup of tea high up a mountain!

Maths skills

$$density = \frac{mass}{Volume}$$

(You need to remember this.)

$[kg/m^3]$ $\rho = \frac{m}{V}$ $\frac{[kg]}{[m^3]}$

Latent heat: *Energy = mass x specific latent heat*

$E = m \times L$

[J] [kg] [J/kg]

(You are given this)

Trilogy P6: Radioactivity

Collins rev guide: Atomic Structure

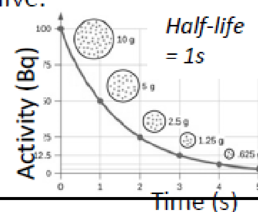
Knowledge Organiser

Key points to learn

1. Radioactive decay	Unstable nuclei emitting a type of radiation (α, β , γ or neutron)
2. Random event	You cannot predict or change when decay might happen.
3. Ionising	The ability to charge atoms
4. Alpha particle (α) $^{4}_{2}He$	Two neutrons and two protons. The same as a helium nucleus.
	Stopped by paper or skin.
	Range of a couple of cm in air
	Highly ionising: has charge of +2
	Parent atom mass drops by 4 and atomic number drops by 2.
5. Beta particle (β) $^{0}_{-1}e$	A high speed electron made when a neutron turns into a proton.
	Stopped by thin aluminium.
	Range of up to one metre.
	Mid ionising: has charge of -1.
	Parent atom mass remains same and atomic number rises by 1
6. Gamma ray (γ) $^{0}_{0}\gamma$	An electromagnetic wave.
	Stopped by thick lead.
	Unlimited range.
	Low ionising: has no charge.
	Parent atom mass and atomic number remains same.
7. Neutron (n)	Neutron ejected from the nucleus

Key points to learn

8. Activity	Rate of unstable nuclei decay. Measured in Becquerel (Bq)
9. Irradiated	Exposed to radiation but does not become radioactive.
10. Radioactive contamination	Unwanted presence of radioactive material.
11 Geiger counter	Nuclear radiation detector.
12. Half-life	Time it takes for the radioactive nuclei to halve. Or, the time it takes for the activity to halve.
13. Nuclear model of the atom	Very small, radius of ≈$1x10^{-10}$m Most of mass in the nucleus. Number of electrons = protons
14. Mass number	Number of neutrons + protons → $^{4}_{2}He$
15. Atomic number	Number of protons → $^{4}_{2}He$
16. Isotope	Same number of protons different number of neutrons.
17. Ion	Atom where number of protons is not equal to electrons (+'ve or –'ve)
18. Plum pudding atom model	Early model: ball of positive charge with electrons stuck in it.
19. Bohr Model	Idea that electrons have to be at certain distances from nucleus.
20. Chadwick	Discovered neutrons

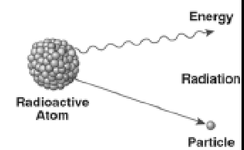


Big picture (Physics Paper 1)

- Energy and energy resources
  - Conservation and dissipation of energy
  - Energy transfer by heating
  - Energy resources
- Particles at work
  - Electric circuits
  - Electricity in the home
  - Molecules and matter
  - **Radioactivity**

Background

Researched by Henri Becquerel and Marie Curie around 1900 it remains mysterious and frightening.

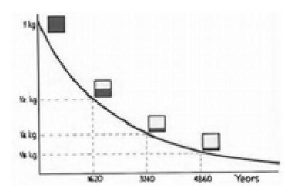


Maths skills

- *Nuclear decay equations:* Balance top and bottom numbers on RHS and LHS.

$$^{226}_{88}\mathrm{Ra} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{222}_{86}\mathrm{Rn}$$

- *Finding Half-life using a graph*
  Find how long It takes until you have half what you started with



Trilogy C5: Chemical Changes

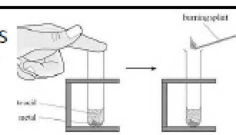
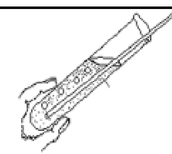
Collins rev guide: Chemical Changes

Knowledge Organiser

Key points to learn

1 Chemical reaction	Reactants → Products *'turn into'*
2 Oxidation	Losing electrons (or gaining oxygen)
3 Reduction	Gaining electrons (or losing oxygen)
4. OiL RiG	Oxidation is Loss of electrons Reduction is Gain of electrons
5 Reactivity Series	List of metals with most reactive at top and least reactive at bottom The most reactive metals are most likely to lose electrons
6. Metals and oxygen	**Metal + Oxygen → Metal Oxide** Eg Iron + oxygen → iron oxide
7. Metals and water	**Metal + Water → Metal + Hydrogen hydroxide** Eg Sodium + Water → Sodium + Hydrogen hydroxide
8. Metals and acid	**Metal + Acid → Metal salt + hydrogen** Eg Zinc + Hydrochloric acid → Zinc + Hydrogen chloride
9. Metal carbonates and acids	**Metal + Acid → Metal + Water + Carbon carbonate salt dioxide** Eg Lead + Nitric → Lead + Water + Carbon carbonate acid nitrate dioxide
10. Metal salts	• Hydrochloric acid makes …chloride • Sulfuric acid makes ….sulfate • Nitric acid makes …nitrate
11. State symbols	(s) solid; (l) liquid; (g) gas; (aq) aqueous solution

Key points to learn

12. Displacement reaction	A more reactive metal will displace a less reactive metal from a chemical compound Eg *$CuCl_2 + Zn \rightarrow ZnCl_2 + Cu$* 
13. Ion	Atom where number of protons is not equal to electrons (+'ve or –'ve)
14 Neutralisation reaction	Acid + Alkali → Metal + Water salt
15. pH scale	1 – Strong acid 7 – Neutral 14 – Strong alkali
16. Universal indicator	• Turns red in strong acid • Turns green in neutral • Turns purple in strong alkali
17. Acids	Contains H^+ ions. Opposite of a base
18. Base	Usually contains OH^- ions. Opposite of an acid
19. Alkali	A base that has dissolved in water
20. Test for hydrogen	Hydrogen makes a squeaky 'pop' when lit with a splint 
21. Test for carbon dioxide	If you bubble carbon dioxide through limewater it will turn milky (cloudy white)  *Clear → milky*
22. Ionic equation	Ions making neutral product Eg $Cu^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Cu(OH)_{2\ (s)}$

Big picture (Chemistry Paper 1)

- Atoms, molecules and moles
  - Atomic structure
  - The periodic table
  - Structure and bonding
  - Chemical calculations
- Chemical changes and energy changes
  - **Chemical changes**
  - Electrolysis
  - Energy changes

Background

In the past, scientists would discover reactions by trial and error. This was time-consuming and dangerous. Today we can use patterns to predict the outcomes of a whole range of reactions. This has allowed us to develop new materials and understand reactions that happen inside all living things.

Additional information

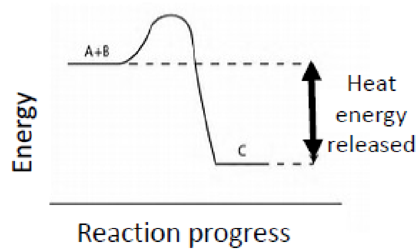
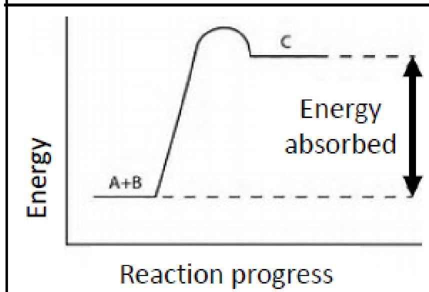
You need to be able to work out how many electrons an atom wants to lose or gain using the periodic table group number. This will be its ion charge.

Trilogy C7: Energy Changes

Collins rev guide: Energy Changes

Knowledge Organiser

Key points to learn

1. Exothermic reaction	One that transfers energy to the surroundings so the temperature of the surroundings increases
	
	Used in handwarmers and self-heating cans
	Examples: combustion, respiration, oxidation, neutralisation
2. Endothermic reaction	One that absorbs energy from the surroundings so the temp. of the surroundings decreases
	
	Used in cold packs for injuries
	Examples: Photosynthesis, thermal decomposition, citric acid and sodium hydrogen carbonate

Key points to learn

3. Reactant	Used in a reaction
4. Product	Made in a reaction
5. Conservation of energy	Energy is never created or destroyed it is just transferred from one form to another
6. Activation Energy	Is the energy required to start a reaction
7. Catalyst	Chemical which speeds up a reaction without being used itself
	Reduces the activation energy required to start a reaction
8. Breaking and making bonds	This is what happens during a chemical reaction
	Require energy in to break bonds (Endothermic)
	Energy is released when bonds are made (Exothermic)
	Bonds between different atoms need different amounts of energy

Additional information

- Collision theory: chemical reactions occur when particles collide with enough energy
- Chemical reactions are all due to electrons moving or being shared
- An enzyme is a biological catalyst
- *Higher Tier content is written in italics*

Big picture (Chemistry Paper 1)

- Atoms, molecules and moles
  - Atomic structure
  - The periodic table
  - Structure and bonding
  - Chemical calculations
- Chemical changes and energy changes
  - Chemical changes
  - Electrolysis
  - **Energy changes**

Background

The interaction of particles in chemical reactions often involves transfers of energy. These produce heating or cooling effects that are used in a range of everyday applications.

Maths skills

- *Using bond energies, calculate energy difference in a reaction eg*

$2H_2 + O_2 \rightarrow 2H_2O$

Reactants bond energy (kJ/mol)

$(2x436) + 498) = 1370$

Products bond energy (kJ/mol)

$2x(2x4\ 64) = 1856$

Energy released (kJ/mol)

1370-1856 = –486 kJ/mol

Therefore exothermic

Bond	Bond energy (kJ/mol)
H-H	436
O=O	498
H-O	464