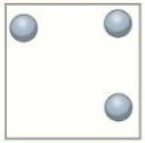
C1.1 The Particle Model

C1.1.1 Introducing Particles

Table 1 *Arrangement and movement of particles in the three states of matter.*

State	Diagram of particles	Arrangement of particles	Relative distance between particles	Main movement of particles
solid		regular	very close	vibrate about fixed positions
liquid		random	close	move around each other
gas		random	far apart	move quickly in all directions

The particle model can be used to explain the **properties** of solids, liquids and gases:

- **Solids** have **a fixed shape** because their **particles** are in **fixed positions**.
- **Liquids** can **flow** because their **particles** can **move around each other**.
- **Gases can be compressed** (squashed) because there is **space between particles.**

An **isometric diagram** shows the **3D structure** and arrangement of particles in a solid substance.

An isometric diagram of particles in a solid.

C1.1.2 Chemical and Physical Changes

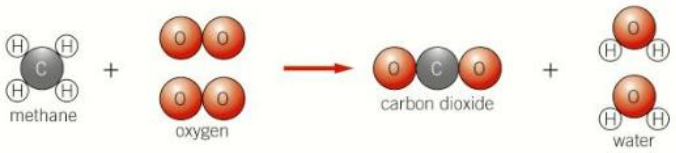
Physical Changes

- These happen when a **substance changes state**, **changes shape**, **breaks into pieces**, or is **mixed with another substance**.
- Most physical changes are **easily reversible**.
- **Particles stay the same**, but may have **changed arrangement** and/or **changed movement**.
- Physical changes include: **sugar dissolving in water**, **ice melting** and **mixing paints**.

Chemical Changes

- These **form new products**.
- In a chemical change you may see: **colour change**, **new smell**, **bubbles**, **bang or pop** noises, **light released** or **temperature change**.
- **Particles break apart**; their **atoms rearrange** and **join together** to **form new particles**.
- Chemical changes are **not easily reversible**.
- Chemical changes include: **cooking food**, **metal rusting** and **burning fuels**.

Physical changes

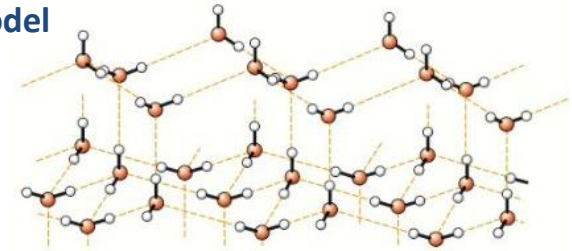


Chemical change

C1.1.3 Limitations of the Particle Model

The **particle model** is helpful, but not perfect. It **does not take into account**:

- the **forces between particles**
- the **size of particles**
- the **space between particles**.

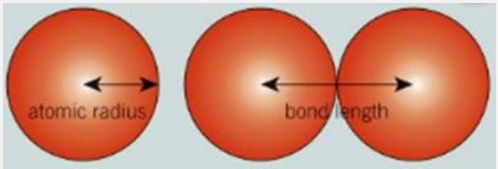


The forces between particles are drawn as solid or dashed lines.

C1.2 Atomic Structure

C1.2.1 Atomic Structure

Atoms are the **building blocks** of all substances.
They are extremely small and cannot be seen.



The **atomic radius** and **bond length** of a typical atom are in the **order of 10^{-10}m**.

Atoms are made up of three **sub-atomic particles**:

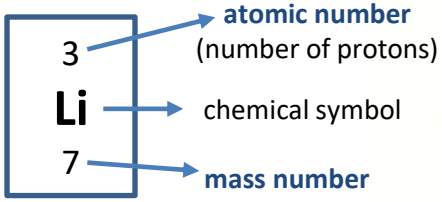
Subatomic particle	Relative mass	Relative charge
proton	1	+1
neutron	1	0
electron	0.0005	–1

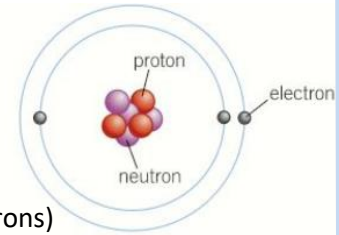
Protons and neutrons are contained within the **nucleus** of the atom, which is **positively charged**.

Negatively charged electrons are contained within **electron shells** which surround the nucleus.

The **radius of the nucleus** is around **100,000 times smaller** than the **radius of the atom**.

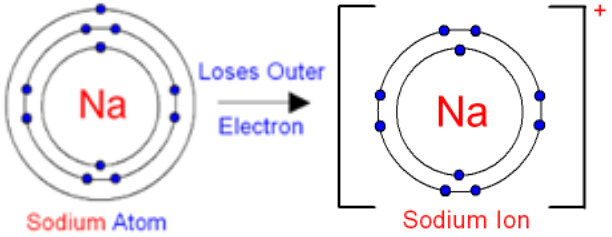
The **nucleus contains most of the mass of the atom**.



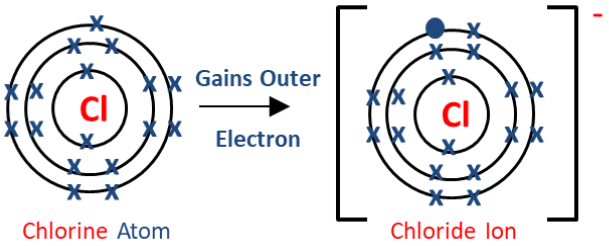


C1.2.2 Ions and Isotopes

Ions are **charged particles** which form when atoms lose or gain electrons.

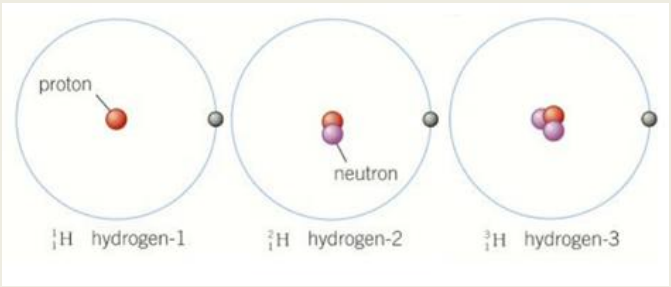


Atoms of **metals** **lose electrons** to form **positively charged ions**, e.g. Na^+.



Atoms of **non-metals** **gain electrons** to form **negatively charged ions**, e.g. Cl^-

Isotopes are **atoms of an element** which contain the **same number of protons**, but have a **different number of neutrons**.

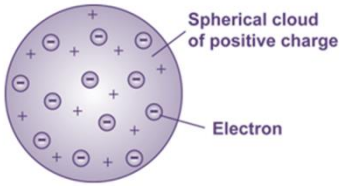


C1.2.3 Developing the Atomic Model

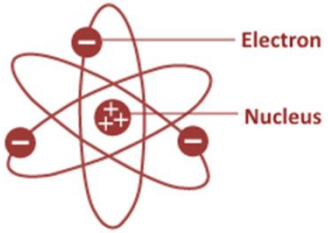
The model of the atom has changed over time. When experimental results do not match an atomic model, the model must be improved to better explain the atom.

Dalton (1803)

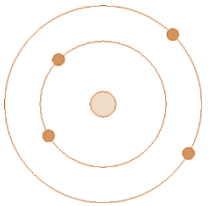
'plum-pudding model'



Thomson (1897)



Rutherford (1909)



Bohr (1913)