



Synergy Science Knowledge Organiser

2 Atomic Structure

Development of the atom

- The **atomic model** has changed over time.
- Dalton atoms (1804) – spherical atoms that cannot be split up to explain the properties of gases and the formulae of compounds

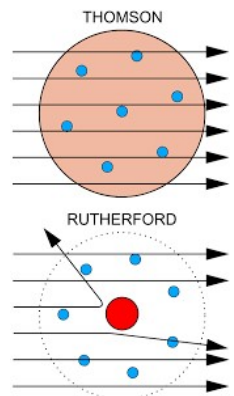
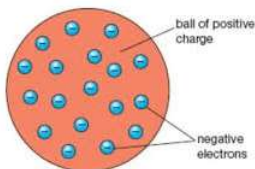


John Dalton's symbols

- ⊙ Hydrogen
- Carbon
- Oxygen
- ⊕ Sulphur
- ① Iron
- ⊙ Copper
- Ⓛ Lead
- Ⓞ Gold



- Plum Pudding Model (1897) – JJ Thomson found the mass of electrons, and said that atoms consisted of rings of negative electrons embedded in a sphere of positive charge



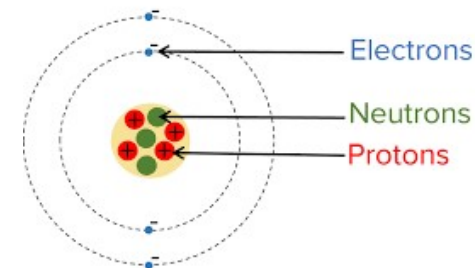
- Rutherford's Nuclear Atom (1911) – showed that most of the alpha particles directed at thin gold foil passed through but a few bounced back, suggesting the positive charge was concentrated at the centre of each gold atom



- Chadwick discovered neutrons in the nucleus (1932) this explained why the mass of atoms was greater than could be accounted for by the mass of the protons.

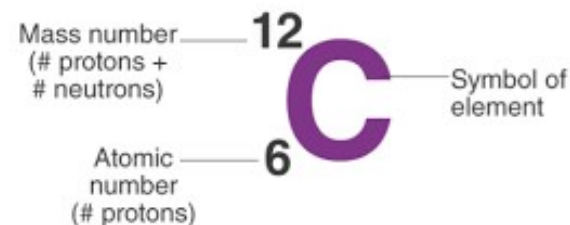
Sub-atomic particles

- Positively charged **nucleus** containing positively charged protons and neutral neutrons
- Electrons are negatively charged and surround the nucleus



Subatomic Particle	Relative Charge	Relative Mass
Proton	1	1
Neutron	0	1
Electron	-1	Negligible (1/2000)

- The number of protons in an atom of an element is its **atomic number**
- All atoms of the same element have the same number of protons.
- In an atom, the number of electrons is equal to the number of protons in the nucleus.
- Mass number is the number of protons + number of neutrons



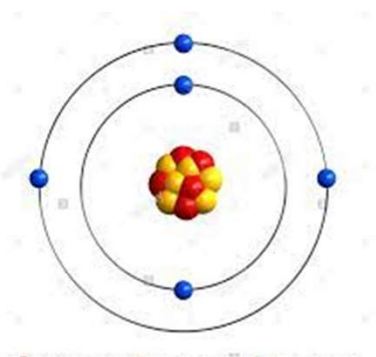
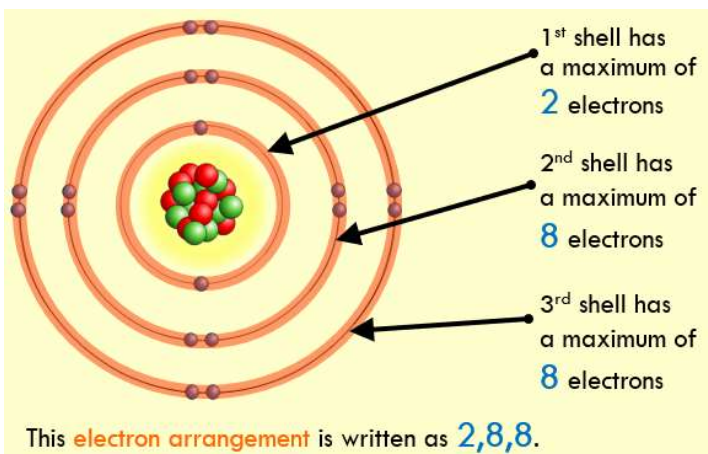


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Electronic Structure

- The number of electrons is equal to the number of protons in the nucleus, so is the same as the atomic number.
- Each shell has a maximum number of electrons that it can hold. Electrons will fill the shells nearest the nucleus first.

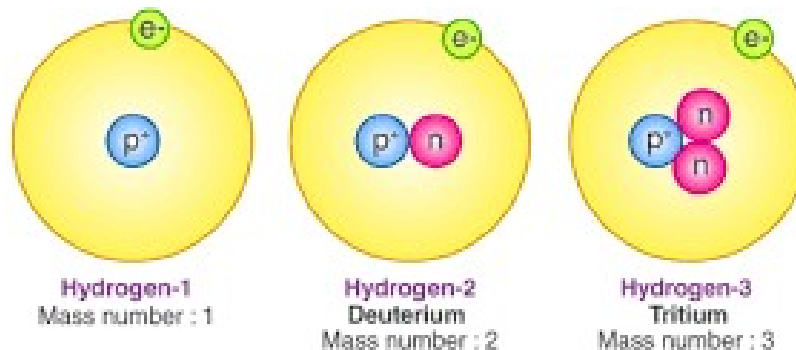


Electrons = 5
 Protons = 5
 Atomic number = 5
 Name = Boron
 Mass number = 11
 Neutrons = 11 - 5 = 6
 Electron configuration = 2, 3

Isotopes

- Atoms of the same type of element with different numbers of neutrons
- Atoms will have the same atomic number but different mass numbers
- Sometimes extra neutrons make the nucleus unstable (radioactive)

Name of isotope	Symbol	Protons	Neutrons	Electrons
Hydrogen-1	${}^1_1\text{H}$	1	1 - 1 = 0	1
Hydrogen-2	${}^2_1\text{H}$	1	2 - 1 = 1	1
Hydrogen-3	${}^3_1\text{H}$	1	3 - 1 = 2	1



Isotopes of Hydrogen

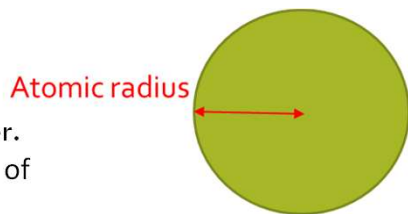


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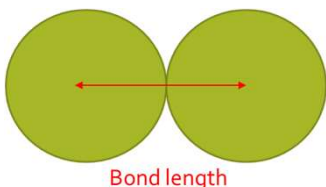
2 Atomic Structure

Size of an Atom

- The size of an atom is given by its atomic radius, which is half its diameter.
- Atoms are very small, having a radius of about 0.1 nm (1×10^{-10} m).



- A bond length is the distance between the centres of two joined atoms.
- Atomic radii and bond lengths are typically around 10^{-10} m.



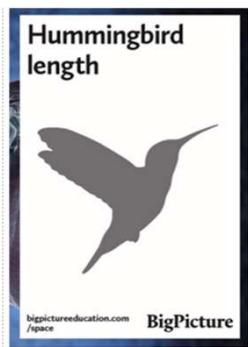
- The radius of a small molecule such as methane, CH_4 , is about 0.5 nm (5×10^{-10} m).

Isotopes

Giga	$\times 10^9$	1 000 000 000
Mega	$\times 10^6$	1 000 000
Kilo	$\times 10^3$	1 000
Centi	$\times 10^2$	1 00
Milli	$\times 10^{-3}$	0.001
Micro	$\times 10^{-6}$	0.000001
Nano	$\times 10^{-9}$	0.000000001

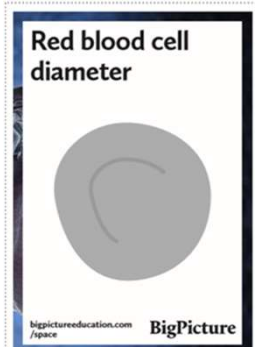
0.1m

1×10^{-1} m



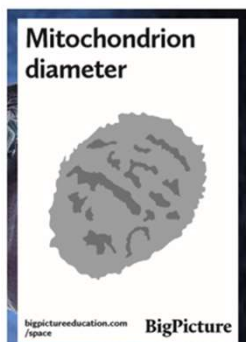
0.000007m

7×10^{-6} m



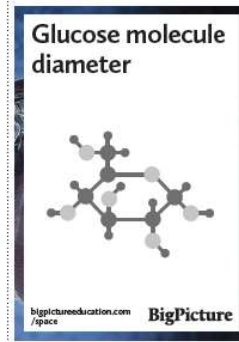
0.000004m

4×10^{-6} m



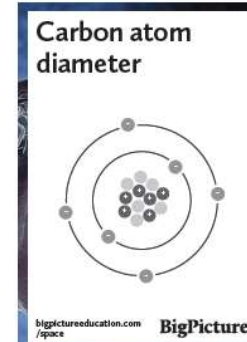
0.0000000010 m

8×10^{-10} m



0.0000000016 m

1.6×10^{-10} m





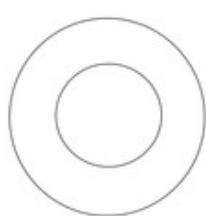
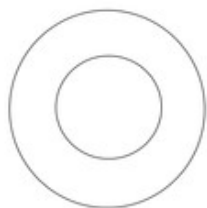
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Electron Arrangement

Task: Draw the electron structure of each element below:

Li Mg Ne S

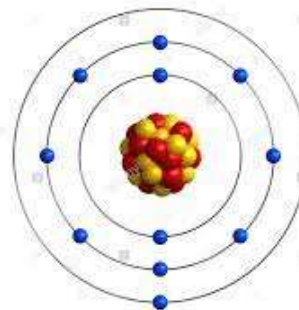


Development of the atom

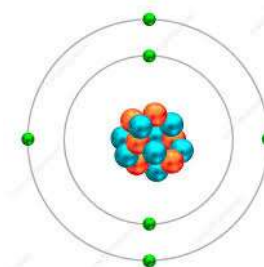
Task: Describe the difference between the plum pudding and the nuclear model of an atom

Atomic Structure

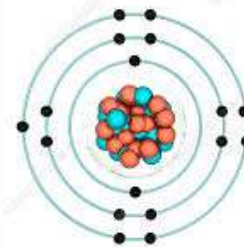
Task: Calculate the number of sub atomic particles for the following atoms



Electrons =
Protons =
Atomic number =
Name =
Mass number =
Neutrons =
Electron configuration =



Electrons =
Protons =
Atomic number =
Name =
Mass number =
Neutrons =
Electron configuration =



Electrons =
Protons =
Atomic number =
Name =
Mass number =
Neutrons =
Electron configuration =

Highlight the keywords: atoms, radius, nm, nucleus, protons, neutrons, electrons, atomic number, mass number, isotope