

CHAPTER 1: Atomic Structure

1.1 Inside the Atom

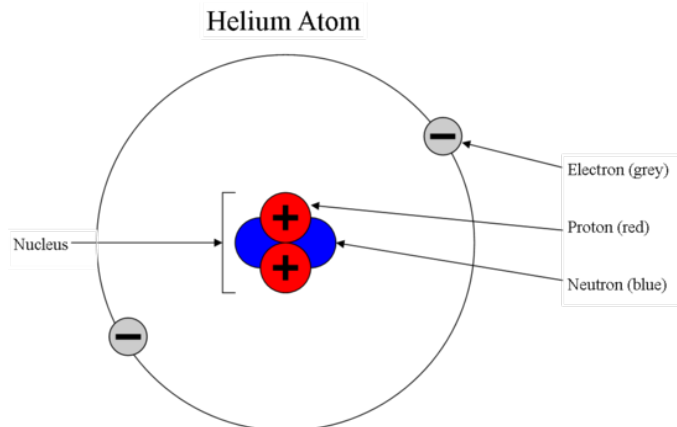
1.2 Isotopes

Learning outcomes:

- (a) identify and describe protons, neutrons and electrons in terms of their relative charges and relative masses.
- (b) deduce the behaviour of beams of protons, neutrons and electrons in electric fields.
- (c) describe the distribution of mass and charges within an atom.
- (d) deduce the numbers of protons, neutrons and electrons present in both atoms and ions given proton and nucleon numbers (and charge).
- (e)
 - (i) describe the contribution of protons and neutrons to atomic nuclei in terms of proton number and nucleon number.
 - (ii) distinguish between isotopes on the basis of different numbers of neutrons present
 - (iii) recognise and use the symbolism ${}^x_y\text{A}$ where x is the nucleon number and y is the proton number.

1.1 Inside the Atom

Sub-atomic particles

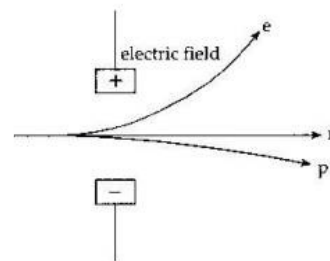


- 1) Electrons revolve around in region of space called orbitals.
- 2) Electrons **do not** move in fixed orbits.
- 3) The nucleus is made up of **protons and neutrons** which contains almost all the mass of the atom. This is because the mass of electrons is very small compared to others.
- 4) The nucleus is positively-charged because of the protons. Electrons, being negatively-charged, surround the nucleus.

Particles	Relative mass	Relative Charge	Charge / C
Protons, p	1	+1	$+1.6 \times 10^{-19}$
Neutron, n	1	0	0
Electron, e	$\frac{1}{1836}$	-1	-1.6×10^{-19}

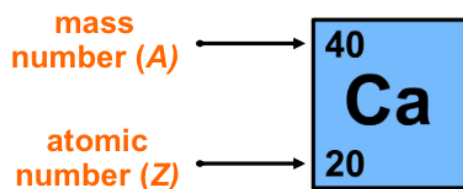
Behaviour of sub-atomic particles in electric field

- 1) Proton will be deflected towards the **negative plate** because it is **positively-charged**.
- 2) Electron will be deflected towards the **positive plate** because it is **negatively-charged**.
- 3) Neutron will **not** be deflected and continue in their direction of motion because it is **neutral**(not charged).
- 4) **Angle of deflection of electron > Angle of deflection of proton** because the mass of electron is smaller than proton. (angle of deflection is inversely proportional to charge/mass ratio)
- 5) Conclusion:
 - i. Protons are positively-charged
 - ii. Electrons are negatively-charged
 - iii. Neutrons are neutral
 - iv. Protons are much heavier than electron



Nucleon number and proton number

- 1) *Proton number* is the total number of protons in an atom.
- 2) *Nucleon number* is the total number of protons and neutrons in an atom.
- 3) Proton number is also known as atomic number while nucleon number is also known as mass number.
- 4) In a neutral atom, the total number of protons **equals** to the total number of electrons.



- 5) When an atom gains or loses electrons, a cation or anion will be formed.
- 6) *Cation* is a positively-charged ion. It is formed when an atom **loses** electron(s).
In cation, the number of protons is more than the number of electrons.
- 7) *Anion* is a negatively-charged ion. It is formed when an atom **gains** electron(s).
In anion, the number of electrons is more than the number of protons.
- 8) An atom or ion is said to be
- i. **isoelectronic** if they have the same number of electrons.
 - ii. **isotonic** if they have the same number of neutrons.
 - iii. **isotopic** if they have the same number of protons.

To deduce the number of protons, neutrons and electrons in an atom/ion

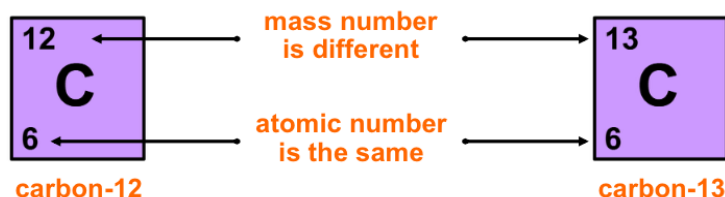
<i>Atom/Ion</i>	<i>no. of protons</i>	<i>no. of neutrons</i>	<i>no. of electrons</i>
${}^{16}_8\text{O}$	8	$16 - 8 = 8$	$8 + 0 = 8$
${}^{17}_8\text{O}$	8	$17 - 8 = 9$	$8 + 0 = 8$
${}^{18}_8\text{O}$	8	$18 - 8 = 10$	$8 + 0 = 8$
${}^{16}_8\text{O}^{2-}$	8	$16 - 8 = 8$	$8 + 2 = 10$
${}^{35}_{17}\text{Cl}$	17	$35 - 17 = 18$	$17 + 0 = 17$
${}^{37}_{17}\text{Cl}$	17	$37 - 17 = 20$	$17 + 0 = 17$
${}^{35}_{17}\text{Cl}^{-}$	17	$35 - 17 = 18$	$17 + 1 = 18$
${}^{14}_7\text{N}$	7	$14 - 7 = 7$	$7 + 0 = 7$
${}^{14}_7\text{N}^{3-}$	7	$14 - 7 = 7$	$7 + 3 = 10$
${}^3_3\text{Li}^{+}$	3	$7 - 3 = 4$	$3 - 1 = 2$
${}^{23}_{11}\text{Na}^{+}$	11	$23 - 11 = 12$	$11 - 1 = 10$
${}^{27}_{13}\text{Al}^{3+}$	13	$27 - 13 = 14$	$13 - 3 = 10$
${}^{63}_{29}\text{Cu}^{+}$	29	$63 - 29 = 34$	$29 - 1 = 28$

1.2 Isotopes

Isotopes

1) *Isotopes* are atoms of the same element with the same number of proton but different number of neutron.

Example:



2) Isotopes have the **same**:

- i. number of protons and electrons
- ii. electronic configuration
- iii. chemical properties (because they have the same number of electrons)

3) Isotopes have **different**:

- i. number of neutrons and nucleon number
- ii. mass
- iii. density
- iv. molecular speed

4) Isotopes can be stable or unstable. Unstable isotopes are called radioactive isotopes (radioisotopes).

Isotopic symbol	${}^1_1\text{H}$	${}^2_1\text{H}$	${}^3_1\text{H}$
Name	Protium	Deuterium	Tritium
Proton	1	1	1
Neutron	0	1	2
Electron	1	1	1

