CHAPTER 1: Atomic Structure

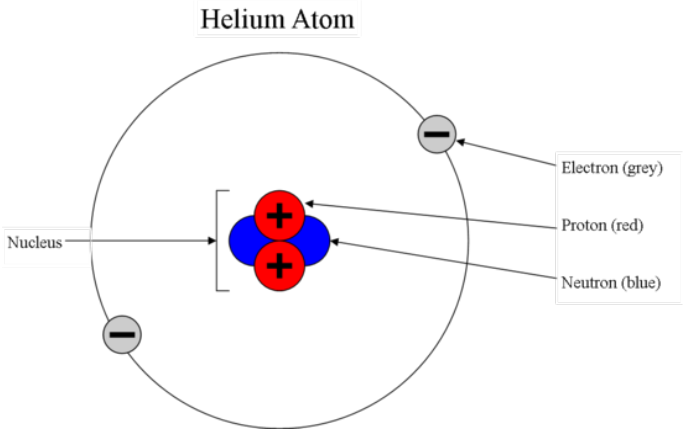
1.1 Inside the Atom
1.2 Isotopes

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 ${}^{x}_{y}A$ *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.

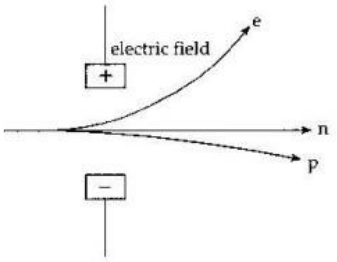
2) Electrons **do not** move in fixed orbits.

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

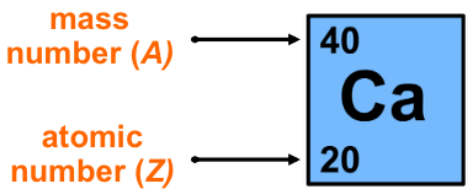
Nucleon number and proton number

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.

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

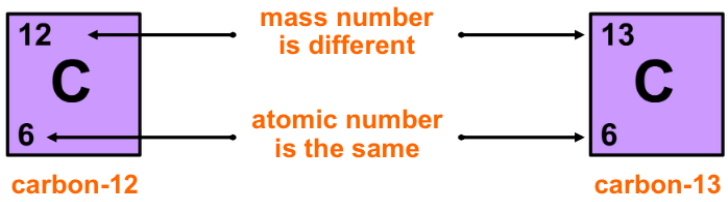
Atom/Ion	*no. of protons*	*no. of neutrons*	*no. of electrons*
$^{16}_{8}O$	8	16 – 8 = 8	8 + 0 = 8
$^{17}_{8}O$	8	17 – 8 = 9	8 + 0 = 8
$^{18}_{8}O$	8	18 – 8 = 10	8 + 0 = 8
$^{16}_{8}O^{2-}$	8	16 – 8 = 8	8 + 2 = 10
$^{35}_{17}Cl$	17	35 – 17 = 18	17 + 0 = 17
$^{37}_{17}Cl$	17	37 – 17 = 20	17 + 0 = 17
$^{35}_{17}Cl^{-}$	17	35 – 17 = 18	17 + 1 = 18
$^{14}_{7}N$	7	14 – 7 = 7	7 + 0 = 7
$^{14}_{7}N^{3-}$	7	14 – 7 = 7	7 + 3 = 10
$^{7}_{3}Li^{+}$	3	7 – 3 = 4	3 – 1 = 2
$^{23}_{11}Na^{+}$	11	23 – 11 = 12	11 – 1 = 10
$^{27}_{13}Al^{3+}$	13	27 – 13 = 14	13 – 3 = 10
$^{63}_{29}Cu^{+}$	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	$^{1}_{1}H$	$^{2}_{1}H$	$^{3}_{1}H$
Name	Protium	Deuterium	Tritium
Proton	1	1	1
Neutron	0	1	2
Electron	1	1	1