'O' Level Chemistry
Chapter 5 – Structure of Atoms

The Model of an Atom

- Atoms are made up of smaller particles called ***subatomic* particles**.

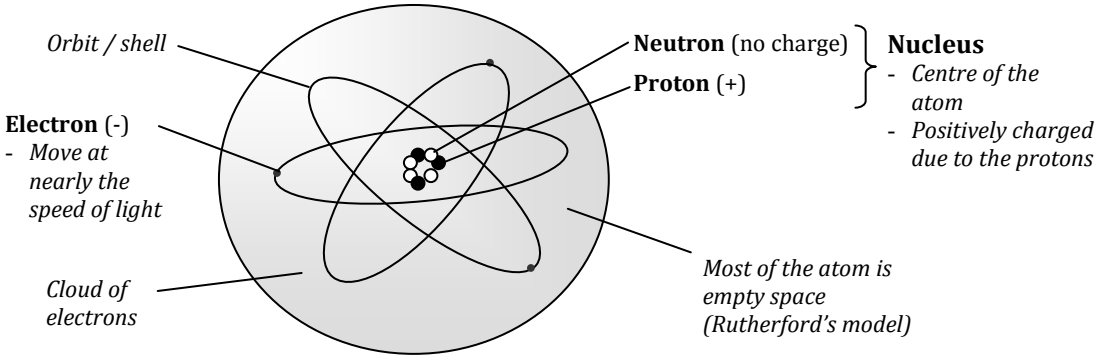

Fig. 1: New model of an Atom (Lithium Atom: 3 protons, 4 neutrons, 3 electrons)

- The protons and neutrons are called the **nucleons** which are found in the nucleus.
- The **nucleus** is **surrounded** by a ***'cloud' of electrons***. (Fig. 1)
- The electrons are arranged in shells (energy levels).
- An atom's mass is contained in the nucleus as electrons have very tiny mass compared to protons and neutrons.
- An atom is **electrically neutral** when the number of protons = number of electrons.

Subatomic particle	Symbol	Relative mass	Charge
Proton	p	1	1+
Neutron	n	1	0 (neutral or no charge)
Electron	e^-	$^1/_{1840}$	1-

Differences among Atoms

- Each element has its own structure of atoms. (Fig. 2)
  - **Proton Number** (Atomic number): symbol **Z**
    - Number of protons in an atom, OR
    - Number of electrons in an electrically neutral atom
  - **Nucleon Number** (Mass number): symbol **A**
    - number of protons + number of neutrons in the nucleus of an atom
  - These numbers can be obtained from the **Periodic Table**.
  - Hence, the number of protons, neutrons and electrons of an element can be determined from the Periodic Table

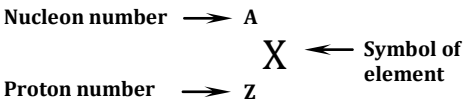

Fig. 2: Symbol of an atom

- **Isotopes:**
  - Atoms of the **same element** but with **different number of neutrons**.
  - **Same proton number** but **different nucleon number** for the same element.
  - Isotopes of the same element have same chemical properties but slight difference in physical properties.
    - Example: they react in the same way but have different melting/boiling point.

Exercise 1

Given that an element has a proton number of 4 and nucleon number of 9, write down the number of protons, neutrons and electrons present in an atom of the element.

Solution:

No. of protons = 4

No. of neutrons = 9 – 4 = 5

No. of electrons = 4

Electron Arrangement

- Bohr suggested that electrons are arranged in **orbits (shells)** around the nucleus in an atom. (Fig. 3)
- Each shell is numbered 1, 2, 3 and so on, going outwards from the nucleus.
- The inner shells are filled up first.
- Each shell can only hold a certain maximum number of electrons.
- After the 20th element, other elements can hold up to 18 electrons in the 3rd shell.

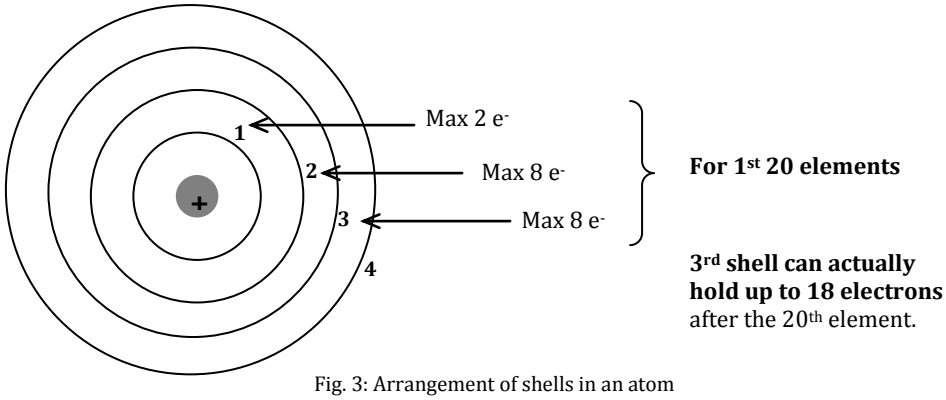

Fig. 3: Arrangement of shells in an atom

- The arrangement of electrons in the atom can be written as the **electronic configuration** or arrangement shown below:
  - Oxygen: 2, 6
  - Calcium: 2, 8, 8, 2
- The electronic structure of an atom can be shown and drawn as a **"dot and cross"** diagram. (Fig. 4)
- The shell furthest from the nucleus is called the outermost shell or **valence shell**.
- Electrons in this shell are called the **valence electrons**.
  - they are involved in the chemical bonding between atoms
  - they are important in chemical reactions
  - they determine the chemical properties of the element
- The **further the distance from the nucleus**, the **weaker the attraction** of the electrons.

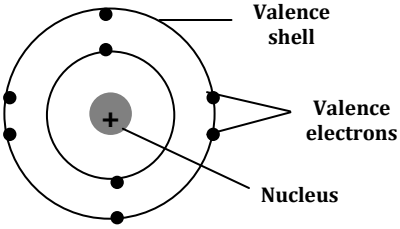

Fig. 4: Electronic structure of an oxygen atom (2, 6)

The Periodic Table

- A way of arranging elements in the order of their **proton numbers**
- **Group**: a vertical column of elements
  - **Same number of valence electrons** for elements in the same group

- E.g. Group 0 elements have 8 valence electrons. They have very **stable noble gas electronic structure**. Hence, they are unreactive (inert) and prefer to remain as atoms.
- Elements become bigger as we go down the group.

- **Period**: a horizontal row of elements
  - Elements in the same period have the ***same number of shells***

From Atoms to Ions

- The **electronic structure of noble gas** atoms is **very stable**.
- Atoms of other elements can obtain this stability by gaining or losing their valence electrons.
- When they do so, the no. of protons ≠ no. of electrons. Hence, they formed **charged particles** called **ions**.
- **Metals** have few valence electrons. So they tend to **lose electrons** to form **positive ions**. (Fig. 5)
- **Non-metals** have more valence electrons than metals. So they tend to **gain electrons** to obtain the electronic structure of noble gas to give **negative ions**. (Fig. 6)

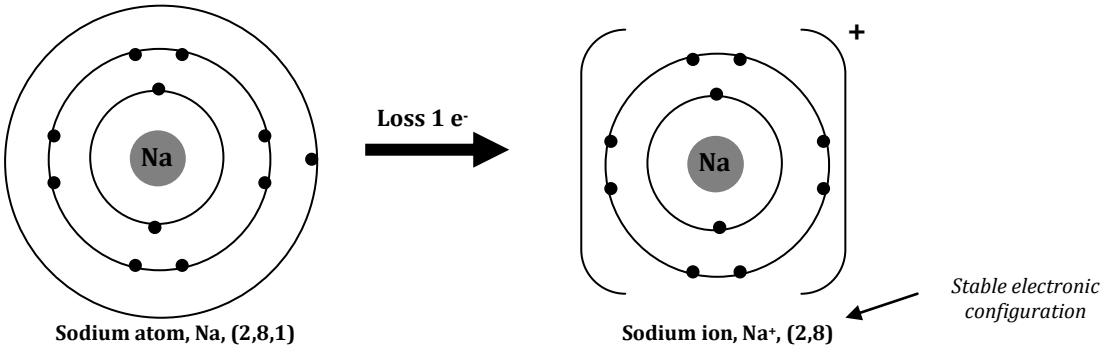

Fig. 5: Formation of sodium ion

	Na	Na^+
No. of Protons	11	11
No. of Electrons	11	10

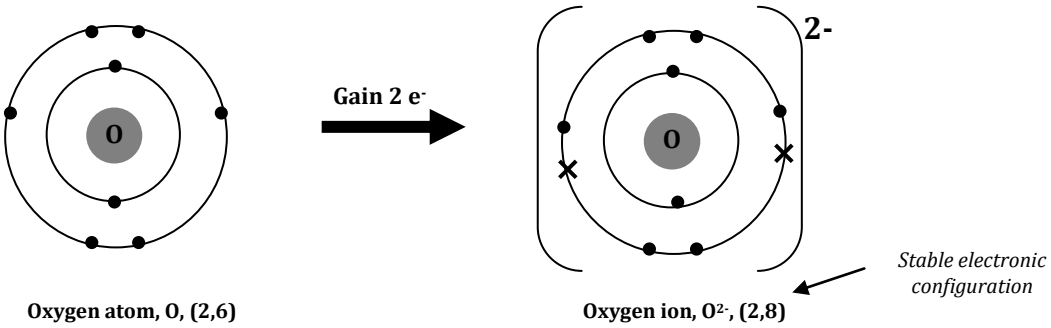

Fig. 6: Formation of oxygen ion

	O	O^{2-}
No. of Protons	8	8
No. of Electrons	8	10

KiMiYA LEARNING PLACE

Summary