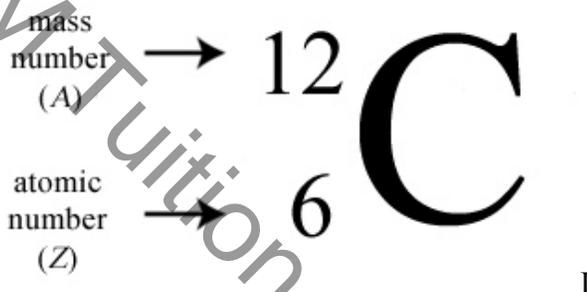


## Isotopes

### 1- Definition:

- **Isotopes** are atoms of the same chemical element, with the **same number of protons**, same number of electrons but **differ only in the number of neutrons** they contain.
- **Isotopes are different to atoms.** The isotope of an element will have a different mass number to an atom of an element. This means that an isotope affects various physical properties of the element, but not the chemical properties.
- **Mass number of an atom = number of proton + number of neutrons**



- Atomic number means number of proton in an atom, so in carbon atomic number = 6 = no of protons.
- We can find out the number of neutrons by

**Mass number of an atom = number of proton + number of neutrons**

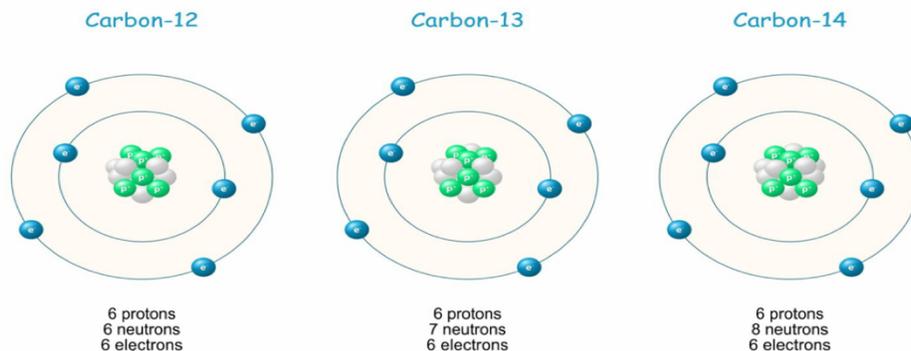
$$12 = 6 + \text{no of neutrons}$$

$$\text{No of neutrons} = 12 - 6 = 6$$

### 2- Properties of Isotopes

- **The physical properties of isotopes can vary.** Several physical properties are determined by the **mass** of the atom. Such as, **density**, **boiling point** and the **melting point**.
- **The chemical properties of isotopes are similar.** They are determined by the number and arrangement of **electrons** which do not change.

Isotopes of carbon



Three isotopes of hydrogen

- ▶ All hydrogen atoms contain one proton (and one electron), but they can contain different numbers of neutrons. Hydrogen-1 is the most **abundant**(most common) isotope of hydrogen.

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

**3- Relative Atomic Mass**

▶ **Definition:**

It is an average mass taking into account the different masses and abundances of all isotopes that makeup the element.

- ▶ Relative atomic masses can be found in the periodic table. They have the symbol  $A_r$

Take care not to confuse mass numbers and relative atomic masses:

- mass numbers are always whole numbers (protons or neutrons cannot be split into parts)

## C2: Atomic Structure

### And Periodic Table

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- relative atomic masses are often rounded to the nearest whole number, but are actually not whole numbers
- For example, the relative atomic mass of chlorine is 35.5 rather than a whole number. This is because chlorine contains two different isotopes, chlorine-35 and chlorine-37.
- **Formula of relative atomic mass =  $\frac{\text{sum of ( isotopes abundance * isotope mass number)}}{\text{Sum of abundance of all isotopes}}$**

**Sum of abundance of all isotopes**

#### 4- Calculating relative atomic mass

- The carbon-12 atom, is the standard atom against which the masses of other atoms are compared. The relative atomic mass of an element is the average mass of its atoms, compared to 1/12th the mass of a carbon-12 atom. The relative atomic mass,  $A_r$ , of an element is calculated from:
- the mass numbers of its isotopes
  - the abundance of these isotopes

► **Example**

Chlorine naturally exists as two isotopes, (chlorine-35) and (chlorine-37). The abundance of chlorine-35 is 75% and the abundance of chlorine-37 is 25%. In other words, in every 100 chlorine atoms, 75 atoms have a mass number of 35, and 25 atoms have a mass number of 37.

To calculate the relative atomic mass,  $A_r$ , of chlorine:

$$\text{relative atomic mass} = \frac{\text{sum of ( isotopes abundance * isotope mass number)}}{\text{Sum of abundance of all isotopes}}$$

**Sum of abundance of all isotopes**

$$= (75 * 35) + (25 * 37) / 75 + 25$$

$$= 2625 + 925 / 100$$

$$= 3550 / 100 = 35.5$$