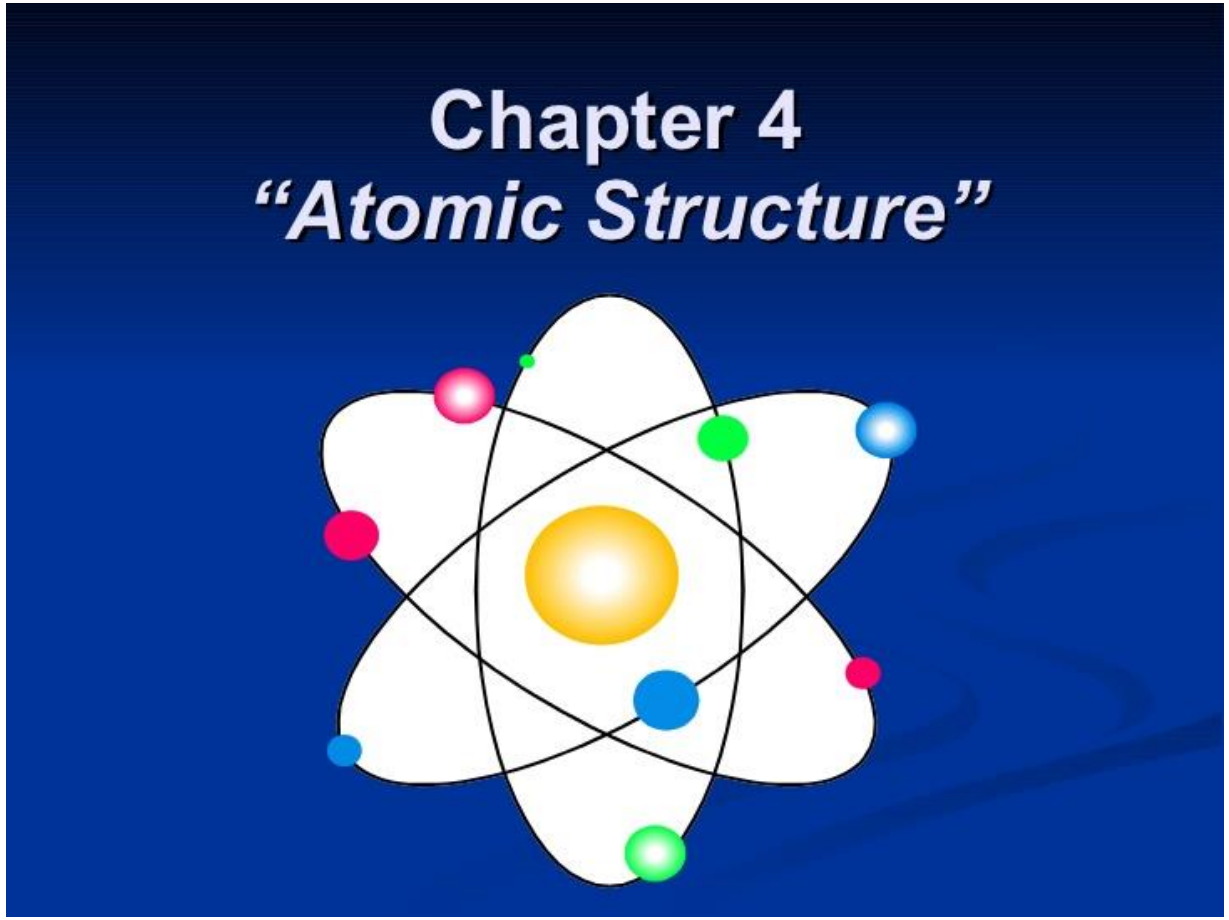
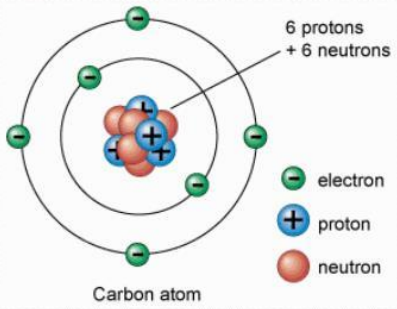
THE ATOMIC STRUCTURE



LEARNING OBJECTIVE

- By the end of the lesson, student will be able to;
- Relate atomic numbers, mass numbers, and Isotopes

Atomic Structure



Atoms are composed of

protons – positively charged particles
neutrons – neutral particles

nucleus

electrons – negatively charged particles in orbitals surrounding the nucleus.

What is the structure of an atom?

- Nucleus - center of the atom
  - ❖Home of Protons and Neutrons
  - ❖Has a positive charge
  - Proton
    - ❖Has a relative mass of 1
    - ❖Has a positive (+) charge
    - ❖Determines the atomic number
    - ❖Found inside the nucleus

p

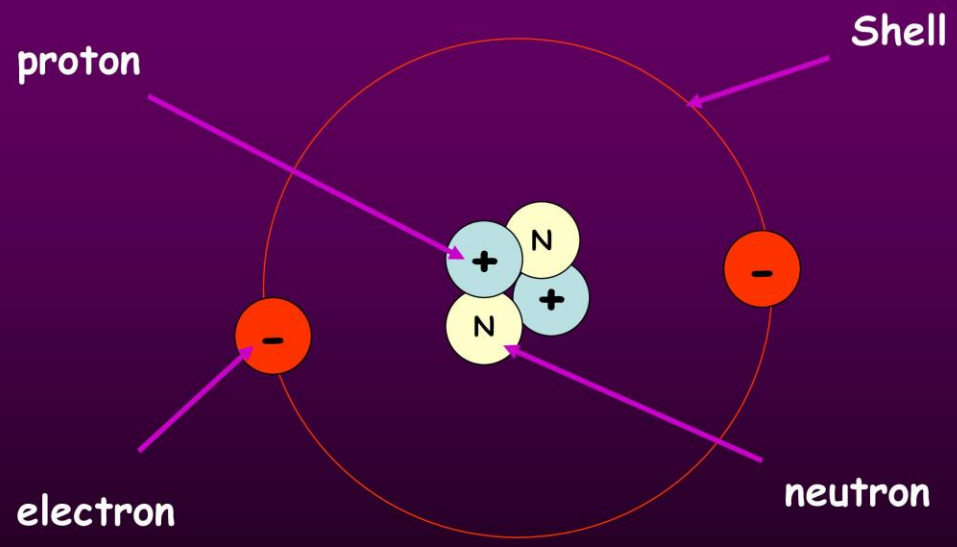
What is the structure of an atom?

- Electron
  - ❖Has a negative (-) charge
  - ❖Found outside the nucleus
    - Rutherford atom model - electrons are around the nucleus
    - Bohr model – electrons are in specific energy levels called shells

What is the structure of an atom?

- Neutron
  - ❖Has no (0) charge
  - ❖Has a relative mass of 1
  - ❖Found inside the nucleus

HELIUM ATOM



What do these particles consist of?

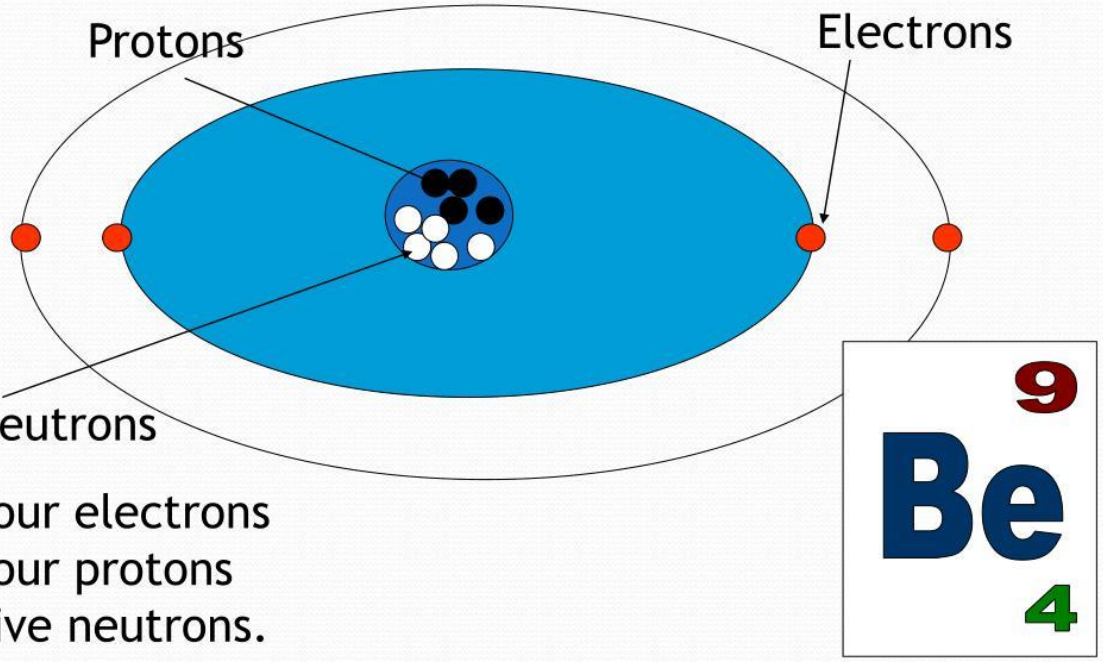
- The nucleus: The nucleus is at the centre of the atom and contains the proton and neutrons. Protons and neutrons are collectively known as **nucleons**. Virtually, all the mass of the atom is concentrated in the nucleus, because the electrons weigh so little.

- **Atomic number (z):** This is the number of protons in the nucleus of an atom. In an atom, the number of protons is equal to the number of electrons. The atomic number is also given a more descriptive name of proton number

- **Mass number (A):** is the sum of the number of protons and neutrons in the nucleus of an atom. Number of protons + Number of neutrons = mass number of the atom. The mass number is also called the **nucleon number**.

- This information can be given simply as illustrated below;
- A particular element, X can be depicted as $^{A}{}_{Z}\mathbf{X}$ where the superscript **A** is the nucleon number and the subscript is **z**, which is the atomic number.
- Mathematically, **A = Z+N**

Beryllium



four electrons
four protons
five neutrons.

Example

- fluorine atom, $^{19}_{9}\mathbf{F}$ (how many protons, and neutrons has this atom got?)

Atomic number (z)=9;

mass number(A)=19

A=Z+N

A-Z=N

19-9=10 Neutrons

EXAMPLES

- The atomic number of an atom Y is 17 and the mass number is 35. Indicate the number of (i)protons (ii) electrons (iii) neutrons in the atom.

(i)The number of protons is 17 (because the number of protons is the same as the atomic number.

(ii)The number of the electrons is 17 (because the number of protons is equal to the number of electrons in a neutral atom.

(iii)The number of Neutron(N)=mass number(A)- Atomic number (2)

$$N=A-Z$$

$$N=35-17=18$$

I. An atom has 17 protons and 11 neutrons in its nucleus. Find the ff. for the atom

(i) mass number

(ii) number of electrons.

DIFFERENCES BETWEEN PROTONS AND ELECTRONS.

PROTONS	ELECTRONS
Have positive charge	have negative charges
Protons reside inside nucleus	Electrons reside outside the nucleus
Protons do not take part in bonding	Electrons are used in bonding
the relative mass is 1 unit	the mass is negligible

ISOTOPES

- **<u>ISOTOPES</u>**: are defined as atoms of the same element having different mass numbers due to differences in number of the neutrons of the atoms.

OR

- Atom of the same element with the same number of protons but different number of neutrons

EXAMPLES

- chlorine exists naturally with 2 isotopes namely chlorine -35 or $^{35}_{17}$**Cl** and chlorine -37 $^{37}_{17}$**Cl**.
- In $^{35}_{17}$**Cl** atom there are 17 protons and 18 neutrons so that the atom has a mass number of 35. In $^{37}_{17}$**Cl** atom, there are 17 protons and 20 neutrons so that this atom has a mass number of 37. Other common elements which have isotopes are:
- Oxygen [$^{16}_{8}O$, $^{17}_{8}O$, $^{18}_{8}O$]
- Carbon [$^{12}_{6}C$, $^{13}_{6}C$, $^{14}_{6}C$]
- Hydrogen [$^{1}_{1}H$, $^{2}_{1}H$,$^{3}_{1}H$]
- Magnesium [$^{24}_{12}Mg$, $^{25}_{12}Mg$, $^{26}_{12}Mg$]

ELECTRONIC CONFIGURATION

- The arrangement of electrons in the shells of an atom is called electronic configuration.
- A shell is the path through which an electron moves or energy level of electrons. Every nucleus has shell around it and every shell has a name assigned to it. The shell with the lowest energies is nearest to the nucleus and those with largest energy are further away from the nucleus.

The shell and their capacities

- K shell is the first shell. It can take a maximum of 2 electrons.
- L shell is the second shell. It can take maximum of 8 electrons.
- M shell is the third shell can take a maximum of 18 electrons.
- For stability, the M shell can contain a maximum of 8 electrons instead of 18. This exception is according to a rule called **octet rule.**
- N shell, is the fourth shell and takes a maximum of 32 electrons.

Bohr's Model of the Atom

- each orbit can hold a specific maximum number of electrons

Shell	maximum no: of electrons
1 - K	**2**
2 - L	**8**
3 - M	**18**
4 - N	**32**

Relative Atomic Mass (Ar)

- Is **ratio** of the average mass of atoms of an element (from a single given sample or source) to 1/12 of the mass of an atom carbon – 12 (known as the unified atomic mass unit). It is also known as atomic weight. **OR** **Ar** of an element is the number of times an atom is heavier than one twelfth the mass of one atom of carbon-12.

- Thus, Relative atomic mass (Ar) = $\frac{mass\ of\ one\ atom\ of\ an\ element}{\frac{1}{12} of\ the\ mass\ of\ the\ carbon{-}12\ atom}$

- Hence, we may define **relative atomic mass (Ar)**, of an element as the weighted average mass of the various isotopes of an element compared with one twelfth the mass of an atom of carbon-12 isotopes.

- Some elements have relative masses which are whole numbers. Eg; Ar of oxygen is 16.0, AL 27.0. The **Ar** of these two elements are the same as their mass numbers.

Illustration

- Carbon has 2 main isotopes, carbon 13 ${}^{13}_{6}C$ and carbon 12 ${}^{12}_{6}C$. Their relative abundance are 11.11% and 98.89% R.P.T Hence, Ar of carbon s expressed as
- $\frac{13\times11.11}{100} \times \frac{12\times98.89}{100}$ = 12.01
- Chlorine has 2 isotopes, chlorine – 35 ${}^{35}_{17}C$ and chlorine-37 ${}^{35}_{17}Cl$.
- Hence, Ar = $\frac{35\times3}{4} + \frac{37\times1}{4} = \frac{142}{4}$ = 35.5

- **NB;** The Ar mass of an element is a pure number and it does not have a unit