***Bohr atomic model***

In 1913, Bohr suggested that, *positively charged nucleus is at the centre and negatively charged electrons revolve round the nucleus in various circular orbit*. The electrons revolving round the nucleus only in certain permitted orbits are called *energy levels*. Each energy level has a certain *fixed amount of energy*. The larger the orbit (i.e. larger radius), the greater is the energy of electrons. Electrons gives out energy in the form of electromagnetic radiation when it jumps from *higher to lower level*.

***Postulates of Bohr atomic model***

Bohr atomic model is based on the following postulates:

1. An atom consists of positively charged nucleus at the centre.
2. The negatively charged electrons move round the nucleus in various orbits known as stationary energy levels. The electrons can’t emit radiations when moving in their own stationary level
3. The Coulombian and Newtonian forces are applicable in the domain of the atom.
4. The electrons revolve round the nucleus in various circular orbits and the angular momentum

where *n* (= 1, 2, 3, 4,….. ) is called the quantum number, and h is the Planck’s constant.

1. When an electron jumps from a higher energy level to a lower energy level, it gives out electromagnetic radiations of a particular frequency

where is the energy of the upper level and is the energy of the lower level and is the frequency of the electromagnetic radiation.

***Radius of and total energy of atom on the basis of Bohr atomic model***

Let us consider the motion of an electron of mass ‘*m’* and charge ‘*e’* moving uniformly with speed ‘*v’*, in a circular orbit of radius *‘r’* around a nucleus of charge *Ze*. Then it experiences an acceleration *v2/r* towards the centre of the circle.

The electrostatic force of attraction acts between the nucleus and the revolving electron and tend to attract the electron towards the nucleus. According to Coulomb’s law this force is given by

The centripetal force is holding the electron in the orbit from the nucleus is provided by the electrostatic force between them.

Bohr’s postulates states that, the electrostatic force of attraction provides necessary centripetal force for revolution of electron in the orbit, *i.e.*

Again according to the Bohr postulate, the orbital angular momentum of the revolving electron must be equal to the integer multiple of *i.e.,*

where *n* (= 1, 2, 3, 4,….. )

Equating equations (2) and (3) we get

Where is the radius of the nth orbital electron.

For Hydrogen atom *Z =1.* Thus, the radius of the nth orbit of Hydrogen atom is

Now substituting the value of *r* from equation (4) in equation (2) we get

Where is the velocity of the nth orbital electron.

The kinetic energy of the revolving electron is

and the potential energy of the electron is

The total energy *E* of the revolving electron in a stable orbit is given by

Now substituting the value of *r* from equation (4) in equation (9) we get

Where is the energy of the nth orbital electron.

For Hydrogen atom *Z =1.* Thus, the energy of the nth orbit of Hydrogen atom is

For *n =1,* we can write equation (11) as

From equation (11) and (12) we can write

When an electron jumps from upper energy level *n2* to lower energy level *n1*, we can write

From equation (10) we can write

From equation (13), (14) and (15) we can write

Where, is the energy of the emitted photon.

For Hydrogen atom *Z =1.* Thus, the energy of the Hydrogen atom in this case is

***Mathematical Problems***

***Problem-1:*** *Calculate the radius of the first Bohr orbit for H and He atoms.*

***Solution:*** We know,

Here,

For Hydrogen atom *Z =1*

For Helium atom *Z =2*

***Problem-2:*** *Calculate the radius of the third orbit of hydrogen atom. Also calculate the energy of electrons in that orbit. (Given c)*

***Solution:*** We know, for Hydrogen atom

Here,

Energy of an atom is

For Hydrogen atom *Z =1*

***Problem-3:*** *How much energy is required to remove an electron from n=3 or n=2 state in Hydrogen atom.*

***Solution:*** We know, Energy of an atom is

Here,

For Hydrogen atom *Z =1*