Module 1

DIODE

STRUCTURE OF AN ATOM

The most fundamental unit of matter which can exist independently is an atom.

An atom consists of

- Electrons
- Protons
- Neutrons

- Protons and neutrons are found there in the nucleus.
- The nucleus of all the elements contains two type of particles protons and neutrons.
- There is an exception to this fact which is
- Hydrogen atom
- Hydrogen has only one proton in its nucleus with no neutron
- Electron moves in approximately elliptical orbits around the nucleus.

STRUCTURE OF AN ATOM

Protons and neutrons have almost the same mass.

Proton is positively charged

Neutron is neutral i.e. no charge.

Electron is much lighter than proton and neutron .

Electrons is negatively charged.

Since atom in its normal state is electrically neutral. It means number of orbiting electrons must be equal to number of protons in the nucleus.

Atomic Number :

The number of protons in an atom is called as its atomic number.

STRUCTURE OF AN ATOM

- All the electrons do not move in the same orbit.
- Electrons are arranged in different shells or orbits.
- Electrons are distributed among the orbits by the rule $2n^2$ where n is the number of shells.

n	$2n^2$	Maximum number of electrons
1	2	First shell can contain maximum number of 2 electrons
2	8	Second shell can contain maximum number of 8 electrons
3	18	Third shell can contain maximum number of 18 electrons
4	32	Fourth shell can contain maximum number of 32 electrons
And so on ……		

- But there is an exception to this rule.

STRUCTURE OF AN ATOM

If any shell happens to be an outermost shell then it can not contain more than 8 electrons.

Outermost shell is also called as **valence shell.**

And electrons belonging to valence shell is called as **valence electrons**

STRUCTURE OF AN ATOM

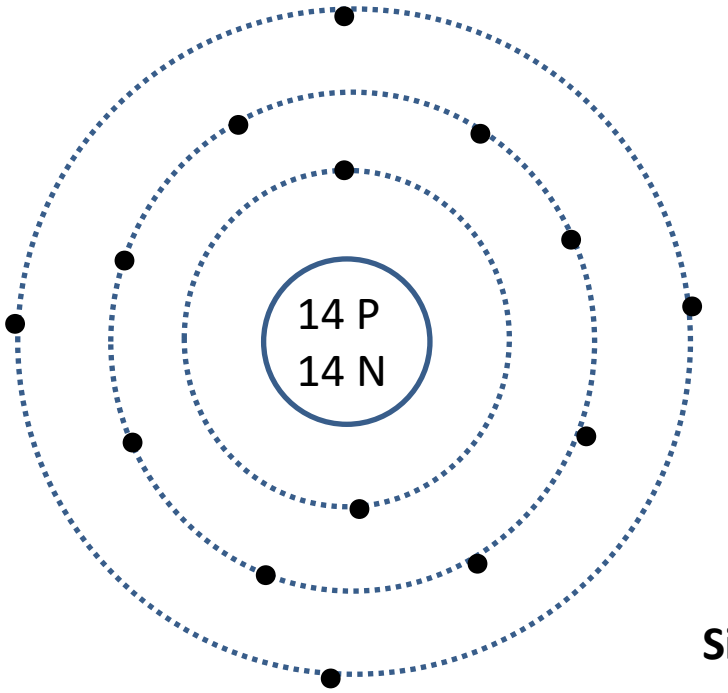
In this module we have to study semiconductor materials that is silicon and germanium

Silicon (Si)
Germanium(Ge)

So let us study about the atomic structure of these materials

STRUCTURE OF SILICON ATOM

- Atomic number (Z) of silicon atom is 14
- 14 = 2,8,4



No of shells = 3

3rd shell is outermost shell (valence shell)

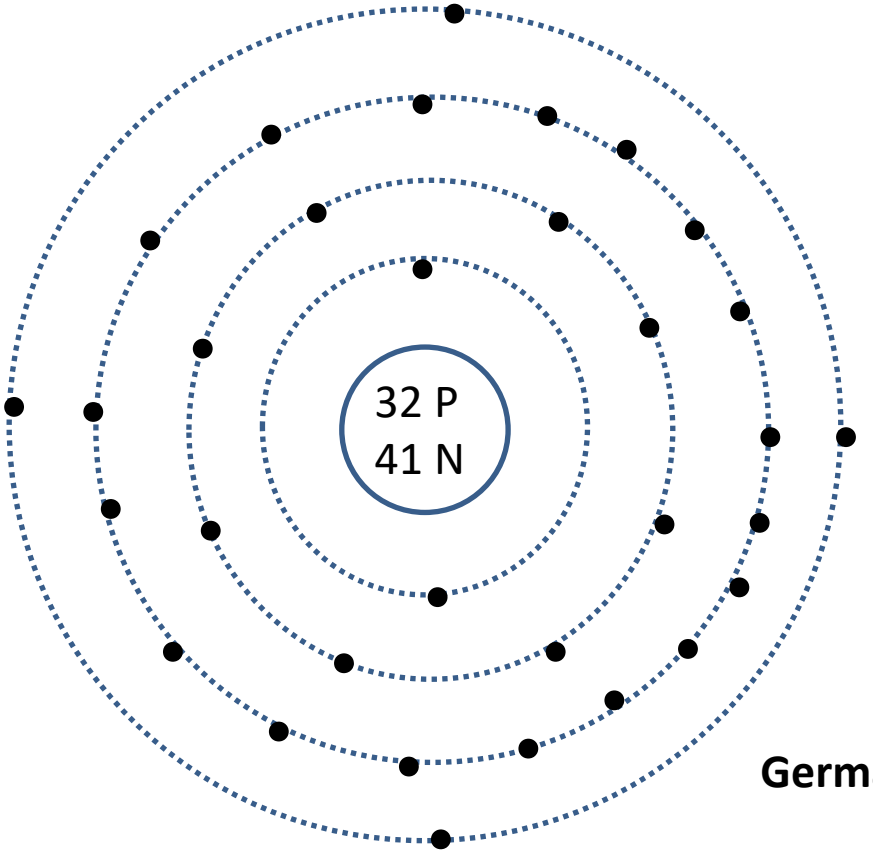
Valence shell consists of 4 electrons.

These 4 electrons are also called as valence electrons

Silicon atom Z = 14

STRUCTURE OF GERMANIUM ATOM

- Atomic number (Z) of Germanium atom is 32
- 32 = 2,8,18,4



No of shells = 4

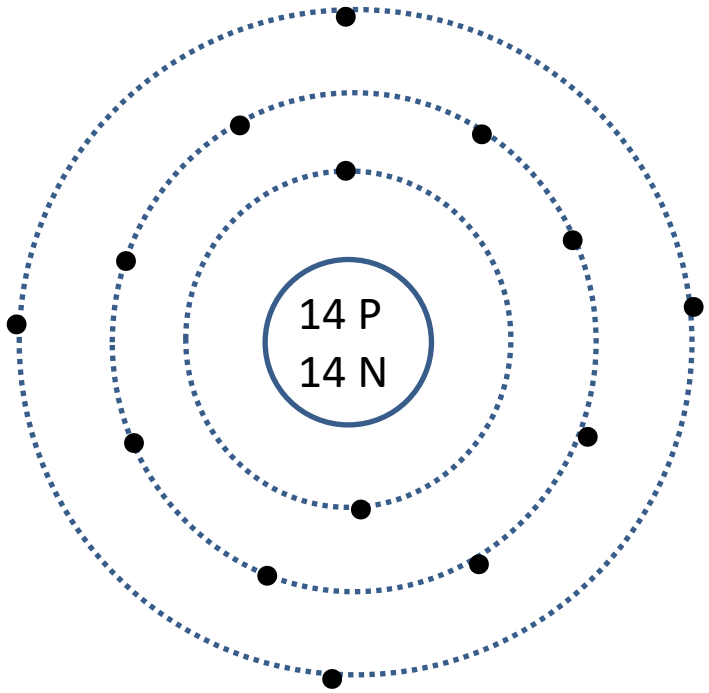
4th shell is outermost shell (valence shell)

Valence shell contains 4 electrons.

These 4 electrons are also called as valence electrons

Germanium atom Z = 32

BOUND ELECTRONS



Electrons in the inner shells other than valence shell or outermost shell are called as **bound electrons.**

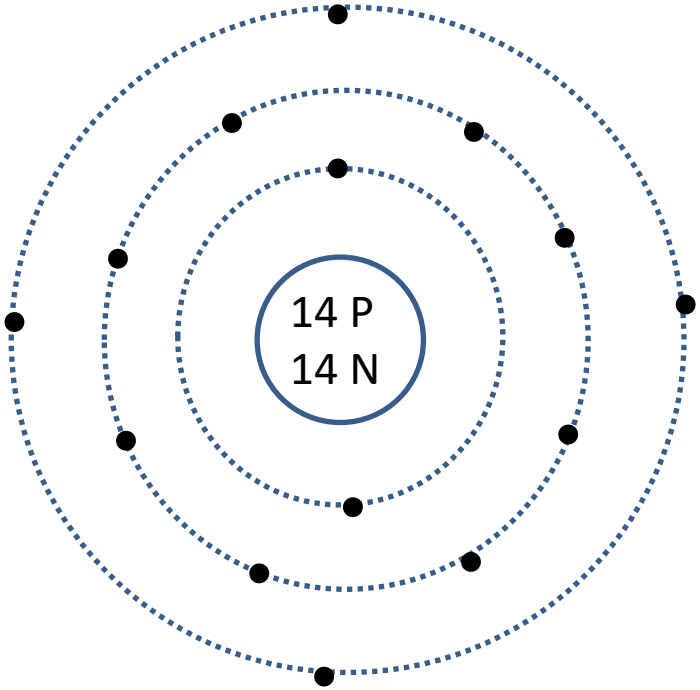
Because they are bounded tightly to the nucleus.

Inner shell electrons are closer to the nucleus.

And nucleus being positively charged attracts the negatively charged electrons with great force.

So these inner shells electrons are not allowed to leave the atom at normal condition.

Valence electrons and free electrons



As we have already discussed that outermost shell is called as valence shell.

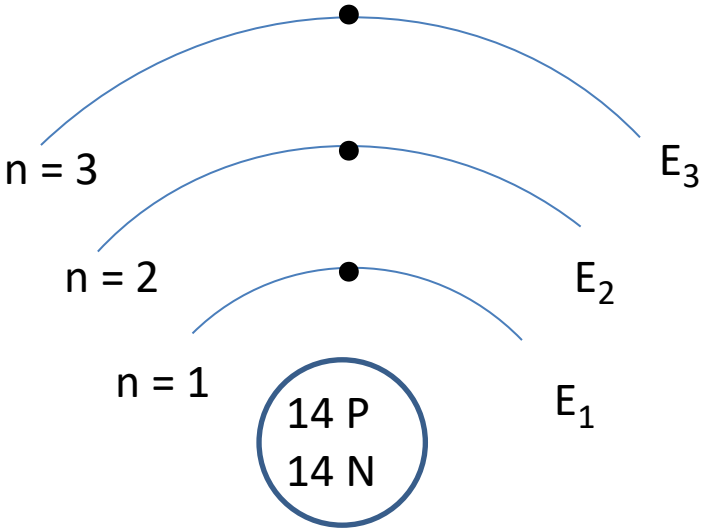
We know that electrons of the atoms take part in the chemical reaction to make compounds.

It is the valence electrons which take part in the chemical reaction.
Valence shell is farthermost from the nucleus .
It means electrons in the valence shell will experience less force of attraction from the nucleus.

Therefore when valence electrons get sufficient energy from the ambient they leave the atom and start wondering randomly from one atom to another.

The electrons which can move in this manner across the structure are called as **free electrons**

ELECTRONS ENERGIES



Energy level diagram of Silicon atom

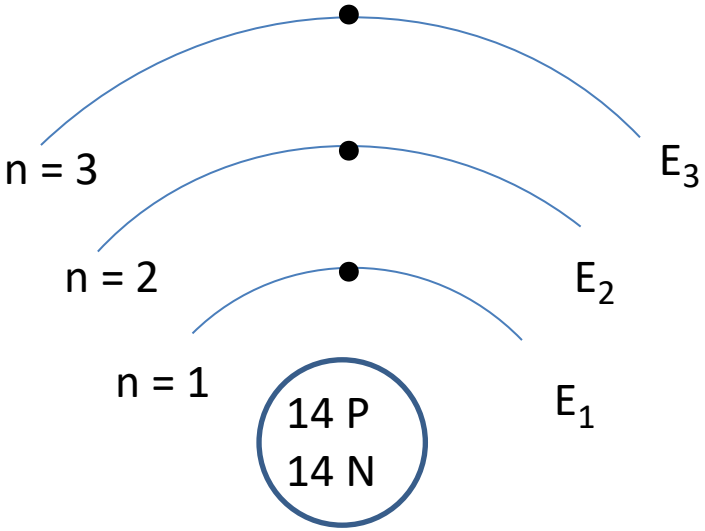
From the energy level diagram it is clear that any isolated atom has only certain number of orbits available.

These available orbits represent energy levels for the electrons.

Modern physics suggests that there is no continuous distribution of energy is possible but only discrete values of electron energies are possible.

It means an electron can not have any energy but only certain permissible energy.

ELECTRONS ENERGIES



Energy level diagram of Silicon atom

Here energy level diagram of isolated Si atom is given.

First energy level (n=1) which is closer to nucleus. An electron orbiting in the first shell is very close to nucleus and is tightly bound to the nucleus will have very small amount of energies.

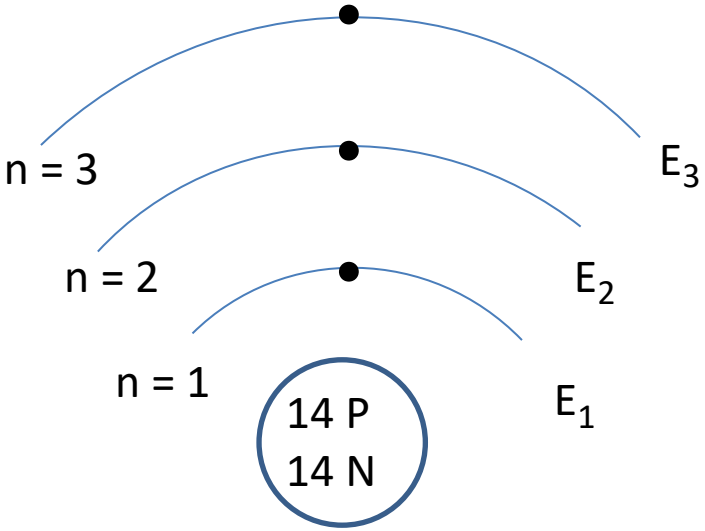
Third energy level (n=3) is the farthest from the nucleus will experience less force of attraction and therefore will have highest energy.

It means greater the distance of an electron from the nucleus the greater is its energy.

So we can say

$E_3 > E_2 > E_1$

ELECTRONS ENERGIES



Energy level diagram of Silicon atom

It means greater the distance of an electron from the nucleus the greater is its energy.

it is the valence electron having maximum energy can easily be taken out of the orbit.

That is why it is the valence electron that take part in chemical reaction.