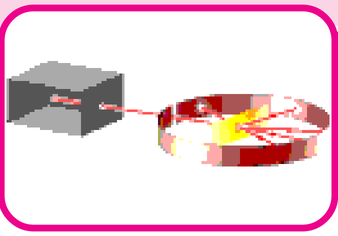
Chapter 6

WHAT IS INSIDE THE ATOM?



In previous chapters we have learnt that all matter is made of atoms. The first modern atomic theory was proposed by John Dalton. According to Dalton, atoms were indivisible. That means that they could not be divided into further smaller parts. Atoms of an element are all identical to each other and different from the atoms of other elements. This naturally led scientists to ask the following questions :

- Why are the atoms of different elements different?
- Is there anything inside atoms that make them to be same or different?
- Are atoms indivisible?

Atoms are too small to be seen with naked eye. Scientists relied on indirect evidence to prove the existence of atoms. Since they could not see the atoms, they could find its properties on the basis of experiments. Very soon they realized that atoms could gain or lose charges. During electrolysis experiments, Michael Faraday discovered that atoms were accquiring negative charge during process of electrolysis.

Michael Faraday's discovery raised few questions about the indivisibility of atoms.

How could a neutral atom become electrically charged? It is a contradiction to Dalton's theory that the atom was indivisible. This led to an idea that there must exist some tiny particles in atom which are responsible for atom to behave sometimes as a charged particle. As atom is considered as electrically neutral, it probably had some positive constituents and equal number of negative constituents to maintain its electrical neutrality. This gave scope to think about sub-atomic particles.

Sub-atomic Particles

In science, theories change when scientists discover new facts or clues. Sometimes, an idea or model must be changed as new information is gathered. Dalton proposed that atoms could not be divided. Experimental evidence began to show that atoms were divisible and are made up of small particle(s). Since these particles are smaller than the atom and are present inside an atom, they are called sub - atomic particles.

Since atoms are neutral they should have at least two types of sub-atomic particles, one is positively charged and another is negatively charged. In fact, three different subatomic particles have been discovered, the third one is a praticle with out any charge. Let us see how ideas about atoms have changed over the time with the discovery of sub-atomic particles.

Electrons, Protons and Neutrons

You read about Faraday's electrolysis experiments earlier. Other experiments on gases were carried out in the latter part of 19th century. Scientists studied the effects of applying electric current to gases at low pressure by using discharge tubes. Other scientists did similar experiments in vacuum tubes. In 1897, a British physicist Joseph John Thomson demonstrated on the basis of these experiments that negatively charged particles are present in the atoms.

Intially, Thomson thought that the negative particles would be different for each element. But after carrying out experiments with many different materials, he found that the negatively charged particles from all the materials were always indentical. He concluded that same type of negatively charged particles are present in the atoms of all the elements. These particles had a very small mass and are now called **electrons**.

Electrons were the first sub-atomic particles discovered and studied. An electron is represented as 'e^-'. The mass of an electron is considered to be negligible and its charge is considered as to be one unit negative.

Think and Discuss

An atom is electrically neutral. But the electrons present in it are negatively charged particles. If only negative charges were present, the atom would not be neutral.

Then, why do we find atoms as neutral?

The atom must also contain some positively charged particles so that the overall charge on it becomes neutral. This sub-atomic particle would have a charge that balances the charge of the electrons. This sub-atomic particle was named as **proton** in 1920. Its mass was approximately 2000 times to that of the electron. It is represented as 'p+' and its charge is taken as one unit positive.

In 1932, James Chadwick discovered yet another sub-atomic particle it had no charge and had a mass nearly equal to that of a proton. It was eventually named as **neutron**. In general, a neutron is represented as **'n'.**

From the above discussion we can conclude that atoms are made of small particles called protons, neutrons, and electrons. Each of these particles is described in terms of measurable properties, like mass and charge. The proton and electron have equal, but opposite, electrical charges. A neutron does not have an electrical charge. The mass of the electron is about 2000 times less than that of a proton or neutron

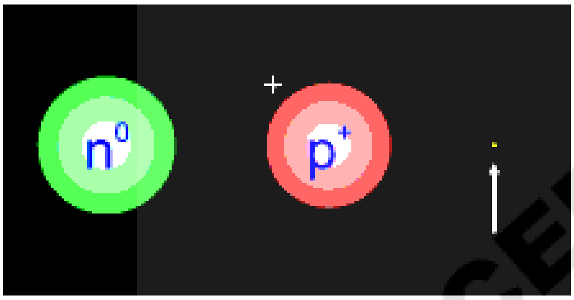


Fig-1 neutron proton, and electron

- If an atom consist of sub-atomic particles like protons, neutrons and electrons, how are they arranged in the atom?

Let us find,

The Structure of an Atom

Activity-1

Sketch the structure of atom as you imagine.

You learnt about electron, proton and neutron. Suppose you had to arrange them in an atom, how do you do it?

Many arrangements are possible. Think that atom looks like a room. You can arrange the particles in alternating rows. Can you draw and show how it will look?

Imagine and draw another arrangement of subatomic particles inside a spherical shape keeping in view the nature of subatomic particles.

- In how many ways can you arrange these subatomic particles in a spherical shape?

Discuss with your friends and try to prepare a model to show various ways of arranging the subatomic particles in the atom.

To understand the structure of an atom, scientist developed different atomic models.

Thomson's Model of the Atom

This atomic model was proposed by J.J. Thomson in 1898. This model was commonly called the **plum pudding model,** referring to the way the fruit pieces are distributed throughout a plum pudding. According to this model:

- An atom is considered to be a sphere of uniform positive charge and electrons are embedded into it, as shown in figure 2(a).

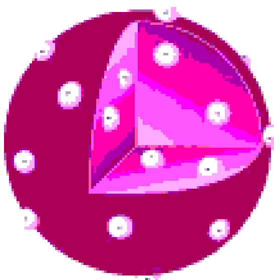


Fig-2(a) **Fig-2**(b)

- The total mass of the atom is considered to be uniformly distributed through out the atom.
- The negative and the positive charges are supposed to balance out and the atom as a whole is electrically neutral.

A more familiar example that represents Thomson's atomic model is watermelon (figure-2(b)). The positive charge is spread throughout the atom like the red part of watermelon. The black seeds distributed through out the red part represents electrons. Thomson's model was modified by one of his students. What is the reason for its modification? The reason was that some of the experiments carried out by Rutherford, a student of Thomson, gave results. Which were not infavour of Thomson's model.

Do You Know?

Besides winning the Nobel Prize in Physics himself, seven of Thomson's research students and even his own son, George, won Nobel Prizes in Physics. One of **Thomson's** students was Ernest Rutherford.

Rutherford's alpha particles scattering experiment

Ernest Rutherford was a scientist born in New Zealand. In 1909, he did some experiments using gold foil and alpha particles. Alpha particles consist of two protons and two neutrons bound together. Since they do not have any electrons, they are positively charged with two units of charge. Let us see the experimental set up and understand Rutherford's experiment.

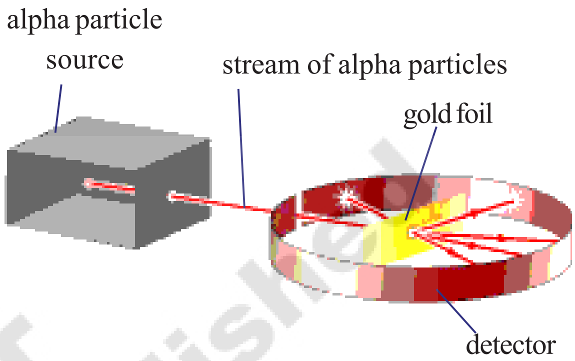


Fig-3

There is a source of the fast moving alpha particles which have a considerable amount of energy. The stream of alpha particles is directed towards a very thin gold foil.

The alpha particle emitter or source and the gold foil which was placed inside a detector are arranged in such a way that the dector would show a flash of light when an alpha particle struck it. (see fig-3) The entire arrangement was kept in a vaccume chamber.

Think of Thomson's model of the atom. When the alpha particle hit the foil, Rutherford expected that they all would be deflected only a little bit by the positive charge spread evenly throughout the gold atoms. He did not expect to see large deflections.

Rutherford's Observations

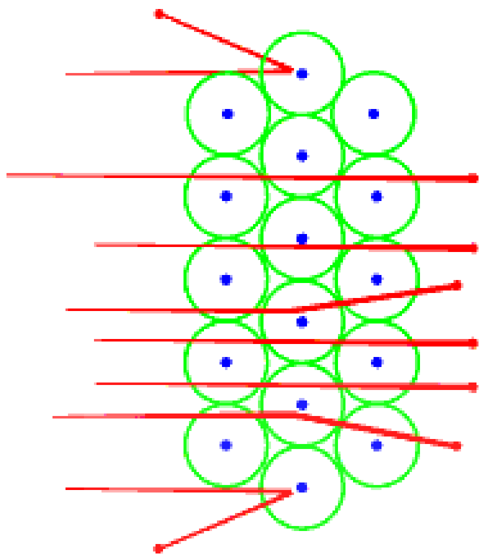


Fig-4

Scattering of alpha particles

But it was found that most of the alpha particles passed straight through the atoms without any deflection Only very few praticles were deflected through large angles and a very, very small number of praticals were reflected right back as shown in figure 4.

Do You Know?

On average, for every 12000 alpha particles that were fired at the gold foil during Rutherford's famous experiment, only one was reflected backward.

Let us try to understand the results of Rutherford's experments.

Suppose you throw a small stone at a solid wall in a horizontal direction. It will not go through. But if you throw stones through a fence of considerably big gaps, lots of them would pass through the gaps.

Thomson's model was assumed that the positive charge was uniformly distributed throughout the atom and it was expected that all the alpha particles would be deflected. Since the alpha particles are very big, the deflection was expected through small angles. But the Rutherford found that most of the particles passed through the gold foil like stones thrown to a fence of big gaps as mentioned in the above example. This led Rutherford to think about new atomic model.

Rutherford concluded from the alpha particles scattering experiment that :

(i) Most of the space inside the atom is empty because most of the alpha particles passed through the gold foil were deflected to a large extent as shown in figure 4.

(ii) A very small fraction of alpha-particles that were deflected right back indicated that they had met a very large positive charge and mass which repelled the charge on the alpha particle. So, all the positive charge must be concentrated in a very small space within the atom.

On the basis of his experiment, Rutherford put forward the **nuclear model of an atom,** which had the following features:

i) All the positively charged material in an atom formed a small dense centre, called the **nucleus** of the atom. The electrons were not a part of nucleus.

ii) He also proposed that the negatively charged electrons revolve around the nucleus in well-defined orbits. Rutherford's model is sometimes referred to as the planetary model because the motion of the electrons around the nucleus resembles the motion of the planets around the Sun.

iii) The size of the nucleus is very small as compared to the size of the atom.

Try to sketch Rutherford's model of the atom.

Think and discuss

Compare Rutherford and Thomson's models of the atom on the following basis:

- Where the positive charge is placed?
- How the electrons are placed?
- Are they stable inside the atom? Or moving?

Limitations of Rutherford's atomic model

- Do you see any problems with Rutherford's model of the atom?

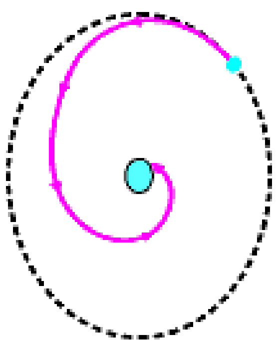


Fig-5

Think of an atom like hydrogen with one electron and one proton. The electron is attracted by the proton in the nucleus. Even in circular motion around the nucleus, the electron constantly should lose energy, because any particle in circular motion acquires acceleration.

An accelerated charged particle moving in a circular path would always radiate energy continuously. Thus the revolving electron would lose energy continuously and directed towards the positively charged nucleus as shown in fig-5 and eventually crash into the nucleus.

If this is true, the atoms should be highly unstable and the matter would not exist in the form that we see it now. But we know that atoms are stable.

So we need to ask: Why is atom stable?

- Can you suggest any other arrangement of subatomic particiles in the atom which prevents the revolving electron to fall into the nucleus?

In 1913, a Danish scientist Neils Bohr gave a model to explain structure of atom that overcome Rutherford's limitations.

Bohr's Model of the Atom

In order to overcome the limitations of Rutherford model, in 1913, Niels Bohr put forward a thought that electrons can be found only in certain *energy levels*, or regions, around the nucleus. Electrons must gain energy to move to a higher energy level or they must lose energy to move to a lower level.

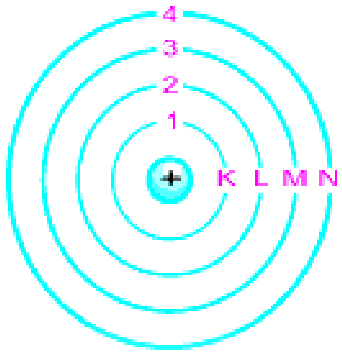


Fig-6 Energy levels of an atom.

Think of books arranged in a bookshelf. They can be placed on a higher shelf or lower shelf but never between shelves.

Restricting the path of electron inside the atom Neils Bohr made the following postulates about the model of an atom:

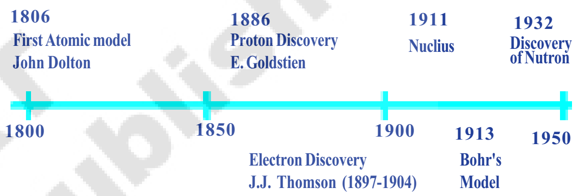
1. Only certain special, discrete orbits of electrons are allowed inside the atom. These orbits or shells are called energy levels.
2. While revolving in these discrete orbits the electrons do not radiate energy and this helps that the electrons do not crash into the nucleus.
3. These orbits or shells are represented by the letters K, L, M, N… or the numbers, n=1, 2, 3, ….. as shown in the figure 6.

- Do you think that Bohr's model is the final model of the atom?

Niels Bohr could succefully explain the properties of a hydrogen atom like the atomic spectra emitted by hydrogen atom employing this model but this model could not predict the spectra of heavier atoms.

You must have noticed that none of the atomic models that we have studied so far, have mentioned about neutrons. This is because neutrons were discovered much later in 1932. Until Rutherford's time the neutron had not been discovered. Neutrons were discovered nearly two decades later. Except hydrogen atom, the atoms of all other elements contain neutrons in their nuclei.

The model of the atom, as we know it today, is the combined result of the work of many scientists. Let us observe below.



We studied that the mass of neutrons and protons is almost equal and 2000 times heavier than the mass of the electron. So the mass of the entire atom is practically due to protons and neutrons alone. Later it was discovered that most of the mass was concentrated inside the nucleus and therefore the neutrons are also present inside the nucleus.

Distribution of electrons in different orbits (Shells)

According to atomic models, electrons move around the nucleus of atom in electron shells. Electrons in different shells have different energies. Each shell is represented by a number, 'n', which is known as a shell number or energy level index.

The shell closest to the nucleus (and has the lowest energy) is called the K-shell (n = 1), the shell farther away (and has higher energy than K-shell) is called the L-shell (n = 2), etc.

- How many electrons can be accommodated in each shell of an atom?
- Can a particular shell has just one electron?
- What is the criteria to decide number of electrons in a shell?

After explaining the structure of atom with different atomic models scientists started describing the distribution of electron in different energy levels or shells of an atom. Bohr and Bury proposed the following rules for electron distribution.

Rule 1: The maximum number of electrons present in a shell is given by the formula $2n^2$, where 'n' is the shell number or energy level index, which takes values 1, 2, 3…. The maximum number of electrons that can be accommodated in each shell is shown in the table 1.

Table - 1

Shell number (n)	The maximum number of electrons in a shell
1 K-shell	$2(1)^2 = 2$
2 L-shell	$2(2)^2 = 8$
3 M-shell	$2(3)^2 = 18$
4 N-shell	$2(4)^2 = 32$

Rule 2: Each energy level or electron shell is further divided into sub shells. The maximum number of electrons that can be accommodated in each sub shell is 8.

Rule 3: Electrons cannot be filled in a given shell unless the inner shells are completely filled i.e., shells are filled in stepwise manner.

Let us take the example of oxygen where Z=8. Since number of electrons is equal to number of protons, it has eight electrons.

Step1. The K shell can accomdates maximum 2 electrons so the first 2 electrons fill the shell of n = 1.

Step 2. The other 6 electrons will fill the higher shell n = 2 or the L shell.

Step 3. Then, the electronic structure for oxygen atom is 2, 6.

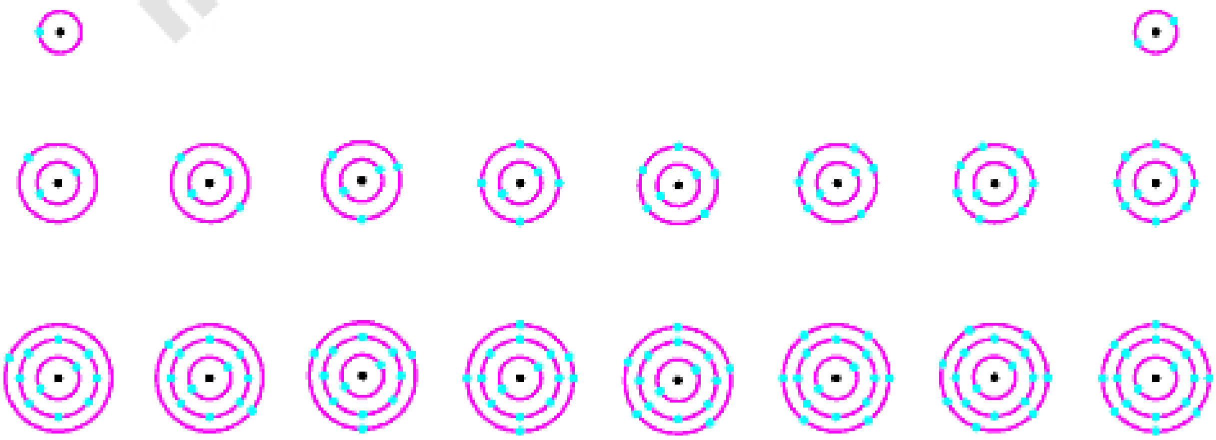


Fig-7 Arrangement of electrons for the first eighteen elements

Arrangement of electrons for the firsteighteen elements is shown schematically in figure 7.

Valency

We have learnt arrangement of the electrons in an atom in different shells/ orbits.

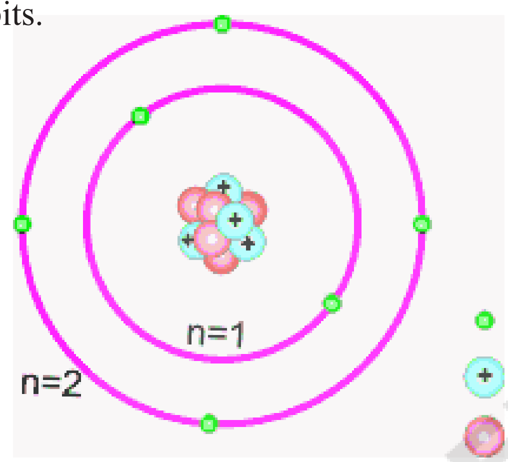


Fig-8

Let us consider a Carbon atom. The atomic number of Carbon atom is 6. Hence it possesses 6 electrons, which surround its nucleus, as shown in the figure 8.

According to Bohr -Bury rule, there should be two electrons in the innermost shell (n=1). Out of 6 electrons of carbon two electrons occupy first shell (n=1). The remaining four electrons occupy the outer most shell n=2. The electrons present in the outermost shell of an atom are known as the valence electrons. Therefore, the number of electrons present in outermost orbit of an atom is called its valency. Valency of an atom explains the combining capacity of the element with other element. In above example the valency of carbon atom is 4.

Let us consider some more examples, if you consider the atoms like hydrogen/ lithium/sodium, they contain one electron in each of their outermost shell, therefore valency of hydrogen, lithium and sodium is one.Can you tell, what is the valency of magnesium and aluminium? It is two and three, respectively, because magnesium has two electrons in its outermost shell and aluminium has three electrons in its outermost shell.

If the number of electrons in the outer shell of an atom is close to its full capacity, then valency is determined in a different way. For example, the fluorine atom contains 7 electrons in the outermost shell, and its valency could be 7. But it is easier for fluorine to gain one electron than to loose seven electrons for obtaining 8 electrons in its outer most shell. Hence, its valency is determined by subtracting seven electrons from eight and which gives you a valency of '1', for fluorine. In a similar manner we can calculate the valency of oxygen.

- What is the valency of oxygen that you can calculate by the method discussed above?

Think and discuss

- Phosphourus and sulphur show multiple valency. See table 2 Why some elements show multiple Valency? Discuss with your friends and Teachers.

Observe the following Table . Valency of the first eighteen elements is given in the last column of Table 2.

Table 2.

Name of element	Symbol	Atomic number	Number of Protons	Number of Neutrons	Number of Electrons	Distribution of electrons				Valency
						K	L	M	N	
Hydrogen	H	1	1	-	1	1	-	-	-	1
Helium	He	2	2	2	2	2	-	-	-	0
Lithium	Li	3	3	4	3	2	1	-	-	1
Berilium	Be	4	4	5	4	2	2	-	-	2
Boran	B	5	5	6	5	2	3	-	-	3
Carbon	C	6	6	6	6	2	4	-	-	4
Nitrogen	N	7	7	7	7	2	5	-	-	3
Oxygen	O	8	8	8	8	2	6	-	-	2
Fluorine	F	9	9	10	9	2	7	-	-	1
Neon	Ne	10	10	10	10	2	8	-	-	0
Sodium	Na	11	11	12	11	2	8	1	-	1
Magnesium	Mg	12	12	12	12	2	8	2	-	2
Aluminium	Al	13	13	14	13	2	8	3	-	3
Silicon	Si	14	14	14	14	2	8	4	-	4
Phosphorus	P	15	15	16	15	2	8	5	-	5,3
Sulphur	S	16	16	16	16	2	8	6	-	2,6
Chlorine	Cl	17	17	18	17	2	8	7	-	1
Argon	Ar	18	18	22	18	2	8	8	-	0

What is the importance of valency?

See electron distribution in helium in figure 7 and table '2'. You will notice that the shell of helium has two electrons in outer most shell and the shell is filled to its full capacity. Neon and Argon have 8 electrons in their outer most shells. All three gases are very stable and have low reactivity. Scientists, studying the distribution of electrons in different shells concluded that the special arrangements of electrons in He, Ne and Ar makes them stable or unwilling to mix with other elements. They do not react with other elements to form compounds. In other words we can say that these gases are chemically inactive and also known as inert or noble gases.

Atoms of all the noble gasses except those of helium have 8 electrons' in their outer most shell. Thus an atom with eight electrons or an octet in their outer most shell, is chemically stable, or does not combine with other atoms. An atom with two electrons in its outer most shell, also is more stable when there is only one shell present in it.

	K	L	M	N
He	2			
Ne	2	8		
Ar	2	8	8	

An outermost-shell which has eight electrons is said to possess an octet. Atoms of an element thus react with other atoms, so as to achieve an octet in their outermost shell. From the above discussion, we can conclude that when an element reacts to form compounds their atoms must be combing in such way that they can attain the stable electron distribution of noble gases or inert gases.

An atom can achieve an octet by two ways, one by transfer of electrons and other by sharing of electrons. Both the processes result in the formation of bonds between atoms.

Let us go back to the question of why do atoms of different elements are different. How can you distinguish between the atoms of one element from the atoms of other element? An element can be recognised by certain characteristics of its atoms.

Atomic number

We know that, the nucleus is at the centre of the atom and contains the protons and neutrons. Elements differ from one another according to the number of protons in their atoms 'nuclei'. This value is called the element's atomic number and is denoted by the letter Z.

Atomic number is the number of protons in the nucleus of an atom

Atomic mass number

- Should we consider the number of neutrons a characteristic of an atom?

The mass of an atom which is a characteristic of an atom depends on the number of neutrons and protons that it's nucleus contains. Number of protons in a nucleus is denoted as Z (atomic number) and number of neutrons of a nucleus is denoted by N.

The number of nucleons, i.e. the total number of protons and neutrons, is called the atomic mass number and is denoted by the letter A.

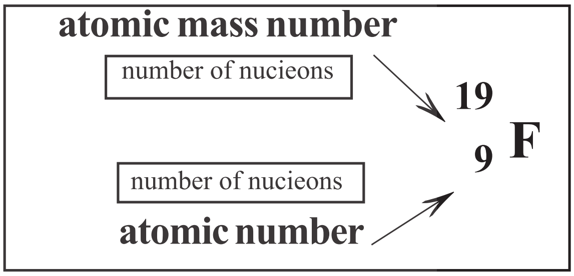
Atomic mass number = atomic number + neutron number

A = Z + N

- ***Mass number is a nearest numerical to the mass of an individual atom.***
- ***Mass number is the number of protons plus the number of neutrons.***

Writing symbols of atoms

In standard notation to represent an atom, the atomic number, mass number and symbol of the element are written as:



F is the symbol of the element fluorine, its atomic number is written at bottom left. It tells us that this atom has 9 protons. The mass number is written at top left. It tells us that this fluorine has 19 nucleons (protons + neutrons).

Therefore the number of neutrons present in fluorine is equal to 19 - 9 = 10 neutrons. (N = A - Z).

Isotopes

It must be clear to you that every element has a unique atomic number, or number of protons.

What about mass number? Does every element has a unique mass number, which is different from the mass number of other elements?

No, the mass number of an element is not unique because there are more than one type of atoms of the same element present in nature in certain cases. Observe the following figure of different Hydrogen atoms? What do you understand?

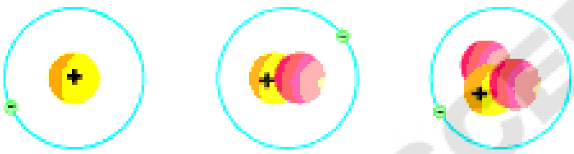


Fig-9

An atom of hydrogen has one neucleon in its nucleus, an atom of deuterium has two neucleons in its nucleus, and tritium has three. Since atoms of hydrogen, deuterium and tritium have only one proton in their nuclei, they only have one electron. But number of neutrons present in hydrogen atom is not same in all cases.

The atoms of the same element which have the same number of protons but have different number of neutrons are called isotopes. Deuterium and tritium are isotopes of hydrogen. The chemical properties of isotopes are similar. But their physical properties are different.

For Example: Carbon has three stable isotopes. Isotopes can also be represented by their element name followed by the mass number. See following notations.

Carbon-12, carbon-13, & carbon-14

$^{12}_{6}C$ $^{13}_{6}C$ $^{14}_{6}C$

Did You Know?

Two elements share the record for the highest number of known isotopes. Both xenon and cesium have 36 isotopes.

How do we determine the atomic mass of an element with isotopes?

In nature, most elements occur as a mixture of two or more isotopes, each isotope has a certain percentage of natural occurrence.

For example, consider the isotopes of Chlorine. It occurs in nature in two isotopic forms, with masses 35 units and 37 units. The isotope with mass 35 is present in 75% and isotope with mass 37 is present in 25% in nature

The atomic mass of an element is taken as an average mass of all the naturally occurring atoms of the sample element.

The average atomic mass of chlorine atom, on the basis of above data, will be

$$\left(35 \times \frac{75}{100} + 37 \times \frac{55}{100}\right)$$

$$= \left(\frac{105}{4} + \frac{37}{4}\right) = \frac{142}{4} = 35.5u$$

Applications of isotopes

Some isotopes are used for solving chemical and medical mysteries. Isotopes are also commonly used in the laboratory to investigate the steps of a chemical reaction.

i) The isotope of uranium is used as a fuel in nuclear reactors.

ii) The isotope of iodine is used in the treatment of goitre.

iii) The is otope of cobalt is used in the treatment of cancer.

Key words

Atom, sub atomic particle, electron, proton, neutron, nucleus, atomic mass, molecular mass, formula unit mass, atomic number (Z), mass number (A) valency, isotopes

What we have learnt

- An atom is the smallest particle of an element that retains the identity of the element.
- John Dalton's atomic theory described elements in terms of atoms, which he believed to be small, indivisible particles that make up all matter. He stated that all the atoms of the same element are identical in mass and size, but atoms of different elements are different.
- The three sub-atomic particles of an atom are: (i) electrons, (ii) protons and (iii) neutrons.
- Electron is a negatively charged particle of the atom
- Proton a positively charged particle that is part of atomic nucleus
- Neutron is an uncharged particle that is part of atomic nucleus
- Credit for the discovery of electron and neutron goes to J.J. Thomson and J. Chadwick respectively.
- Thomson determined that atoms contain negatively charged particles, which are now called electrons. He developed a model of the atom that shows electrons embedded throughout the mass of positively charged material.
- Rutherford's alpha-particle scattering experiment led to the discovery of the atomic nucleus.
- Ernest Rutherford's model of the atom has large empty space, with a small, dense, positively charged nucleus in the centre.

- Neils Bohr modified Rutherford's model of the atom by stating that electrons move in specific energy levels around the nucleus.
- The atomic number of an element is the same as the number of protons in the nucleus of its atom.
- The mass number of an atom is equal to the number of nucleons in its nucleus.
- Valency is the combining capacity of an atom.
- An atom with eight electrons or an octet in their outer most shell is chemically stable, or does not combine with other atoms.
- Isotopes are atoms which have the same number of protons, but a different number of neutrons

Improve your learning

1. What are the three subatomic particles? (AS_1)
2. Compare the characteristics of electrons, protons and neutrons.(AS_1)
3. What are the limitations of J.J. Thomson's model of the atom?(AS_1)
4. What were the three major observations Rutherford made in the gold foil experiment?(AS_1)
5. Sketch Rutherford's atomic model. Why Rutherford's model of the atom is called the planetary model?(AS_5)
6. Put tick (√) against correct choice and cross (×) against wrong choice: (AS_1)

   i) In Rutherford's gold foil experiment, majority of alpha particles passed directly through the gold foil. This observation leads to which conclusion?

      a) The positive region of the atom is very small.
      b) The majority of the atom must consist of empty space.
      c) The alpha particle makes a direct hit on the positive region.
      d) The positive region of the atom is very dense.

   ii) In Rutherford's gold foil experiment, occasionally the alpha particle veered from a straight-line path. This observation leads to which conclusion?

      a) The positive region of the atom is very small.
      b) The majority of the atom must consist of empty space.
      c) The alpha particle makes a direct hit on the positive region.
      d) The positive region of the atom is very dense.

7. Which one of the following is a correct electronic configuration of sodium?(AS_1)

   (a) 2,8 (b) 8,2,1 (c) 2,1,8 (d) 2,8,1.

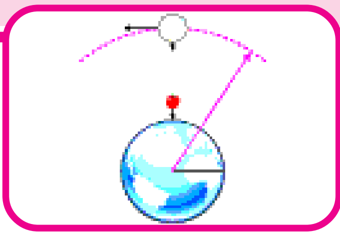
8. Give the main postulates of Bohr's model of an atom. (AS_1)
9. Compare all the proposed models of an atom given in this chapter.(AS_1)
10. Define valency by taking examples of nitrogen and boron.(AS_1)
11. State the valencies of the following elements : Magnesium and Sodium (AS_1)
12. If Z = 5, what would be the valency of the element? (AS_2)
13. Write the atomic number and the symbol of an element which has mass number 32 and the number of neutrons 16 in the nucleus.(AS_1)
14. Cl- has completely filled K&L shells. Explain. (AS_1)
15. What is the main difference between isotopes of the same element?(AS_1)
16. For the following statements, write T for True and F for False.(AS_1)
    a. J.J. Thomson proposed that the nucleus of an atom contains only nucleons.
    b. A neutron is formed by an electron and a proton combining together. Therefore, it is neutral.
    c. The mass of an electron is 1/2000 times that of proton.
17. Fill in the missing information in the following table.(AS_4)

Name	Symbol	Atomic Number Z	Mass Number A	Number of Neutrons	Number of Electrons
Oxygen	$^{16}O_8$	8	16	8	8
	7		7		
^{34}S					
Beryllium			9		
	12	24			
	12	25			

18. How do you appreciate the efforts made by scientists to explain the structure of atom by developing various atomic models?(AS_6)
19. Geeta got a doubt, "Why atomic nucleus contains proton and neutrons inside it? Why can't electrons and neutrons?" Can you help to clarify her doubt? Explain.(AS_1)
20. Collect information about various experiments conducted and theories proposed by scientists starting from John Dalton to Niels Bohr and prepare a story with a title "History of atom".(AS_4)

Chapter 7

GRAVITATION



We have learnt about uniform accelerated motion in the chapter 'motion'. In this chapter let us study about uniform circular motion which is an example of non-unifom accelerated motion.

We always observe that an object dropped from certain height falls towards the earth. We know that all planets move around the sun. We also know that the moon moves around the earth. In all these cases there must be some force acting on these objects to make them move around another object, instead of moving in a straight line.

- What is that force?
- Is the motion of the earth around the sun uniform motion?
- Is the motion of the moon around the earth uniform motion?

Newton explained the motion of moon by using the concept of uniform circular motion and then he developed the idea of gravitation between any two masses.

In this chapter you will learn about gravitation and centre of gravity.

Uniform circular motion

Activity-1

Observing the motion of an object moving in a circular path

Take an electric motor and fix a disc to the shaft of the electric motor. Place a small wooden block on the disc at the edge as shown in figure 1 (a). Switch on the motor. Find the time required to complete ten revolutions by the block and repeat the same two to three times. Begin counting of revolutions after few seconds of start of motor.

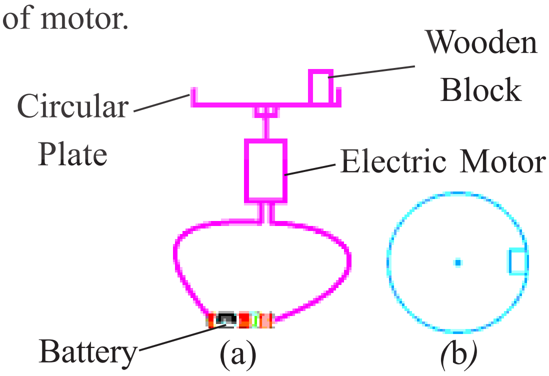


Fig-1 (a) motion of wooden block on a circular plate (b) top view of wooden block

- Is the time of revolution constant?
- Is the speed of the block constant?