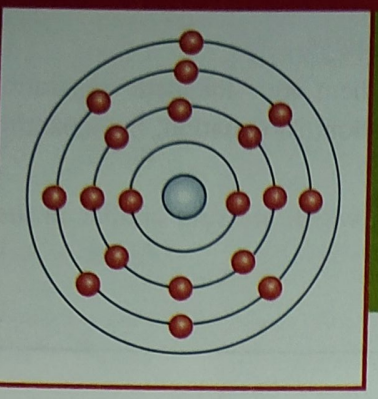

# Atomic Structure

# 4

**Theme :** An atom is the building block of all types of matter. In fact everything on this earth is made up of atoms. It is the atom of an element that takes part in chemical reactions. Therefore, in science, it becomes important to know about the atom and its structure.

**In this chapter you will learn :**

- *Fundamental subatomic particles present in an atom : electrons, protons and neutrons.*
- *Nucleus and extra nuclear parts of an atom.*
- *Atomic number and mass number.*
- *The combining capacity of elements.*

**LEARNING OUTCOMES**

e children will be able to :

describe that an atom consists of electrons, protons and neutrons.

define atomic number and mass number.

discuss valency of elements and radicals with respect to the number of hydrogen atoms combining with one atom of the element.

## MS : BUILDING BLOCKS OF MATTER

You are aware that anything which occupies e and has mass is matter. But do you know, mallest particle of matter is the **atom**. Atoms xtremely minute particles. They cannot be seen through the naked eye. However, there are experimental proofs about the existence of atoms, and they can even be seen through very powerful electron microscopes.

In ancient times, Indian and Greek philosophers were puzzled about the nature of matter. Gradually the idea developed that all matter must be made of some basic elements.

In ancient times water, earth, fire, air and sky were thought to be the five fundamental elements. But we know now that an element is a pure substance made up of only one kind of atoms and has a definite set of properties.

## MAHARISHI KANAD'S VIEWS ON ATOM

Kanad was a great Indian philosopher (600 BC). According to him, "*matter consisted of indestructible particles called* ***paramanus*** (*param* means ultimate and *anu* means particle) (now called *atoms*)". A *paramanu* does not exist in free state, rather it combines with other *paramanus* to form a bigger particle called the *anu* (now known as a *molecule*). There are different types of *paramanus*. Each one of them exhibits specific properties.

The Greek philosopher **Democritus** (460 BC – 370 BC) called the *paramanu* as 'atom', which comes from the Greek word *atomos*, meaning *indivisible.*

## DALTON'S ATOMIC THEORY

In 1808, **John Dalton**, an English scientist, described the *atom* as the smallest particle exhibiting all the properties of a particular element.

The main features of Dalton's atomic theory are :

1. Matter consists of very small and indivisible particles called atoms.
2. Atoms can neither be created nor be destroyed.
3. The atoms of an element are identical in all respects *i.e.*, size, mass, density, chemical properties, but they differ from the atoms of other elements.
4. Atoms of an element combine in small numbers to form molecules of that element.
5. Atoms of an element combine with the atoms of another element in a simple whole number ratio to form molecules of compounds.
6. Atoms are the smallest unit of matter that take part in chemical reactions during which only rearrangement of atoms takes place.

**Note :** *The latest research works about atoms have proved that most of the features of Dalton's atomic theory are incorrect. But Dalton was right that atoms take part in chemical reactions.*

## SUB-ATOMIC (FUNDAMENTAL) PARTICLES OF ATOMS AND EARLY MODELS OF MATTER

Studies and discoveries in the late nineteenth and the early twentieth centuries showed that atoms are divisible *i.e.* they are composed of still smaller particles. The three main particles present in an atom are *electrons, protons* and *neutrons.* These particles are also called *fundamental* particles or *sub-atomic* particles.

The existence of the sub-atomic particles was proved by the fact that an atom is electrically neutral but it can be made to gain a positive or a negative charge. This means that an atom must contain tiny particles, each carrying either a positive or a negative charge. These opposing charges balance each other under ordinary conditions to make an atom electrically neutral.

## DISCOVERY OF ELECTRONS ($e^-$)

Electrons were discovered in 1897 by **J.J. Thomson** when he was studying the properties of cathode rays.

Earlier, William Crooks, another British Scientist, had performed an experiment to study the phenomenon of electric discharge through gases. He observed that when an electric current of high voltage was passed through a ***discharge tube*** (a glass tube sealed at both ends with metal plates) containing a gas at very low pressure (0·01 mm of mercury), rays were emitted from the negative terminal called cathode. He called these rays '*cathode rays*'.

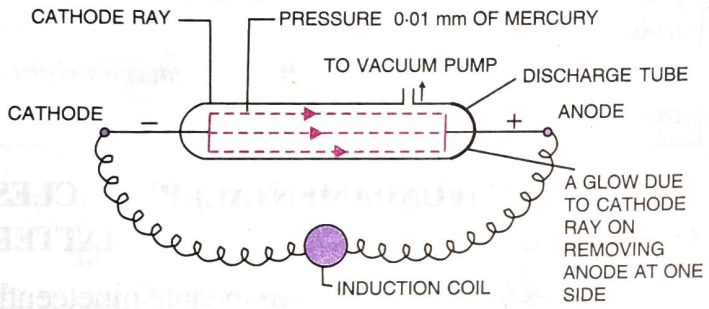


***Fig. 4.1 Discharge tube in which electrons are flowing.***

### J.J. Thomson's work on cathode rays

*J.J. Thomson* studied the characteristics and the constituents of the cathode rays and concluded that : *Cathode rays consist of negatively charged particles (now called electrons),* present in atoms of all the elements.

***J.J. Thomson's Experiment :*** An electric field was applied in the path of cathode rays in the discharge tube. It was observed that cathode rays were deflected towards the positive plate of the electric field. This showed that cathode rays were negatively charged.

When a magnetic field was applied in the path of cathode rays, they were again deflected in a direction in which moving negative charge would be deflected.

This proved that cathode rays contained negatively charged particles called electrons.

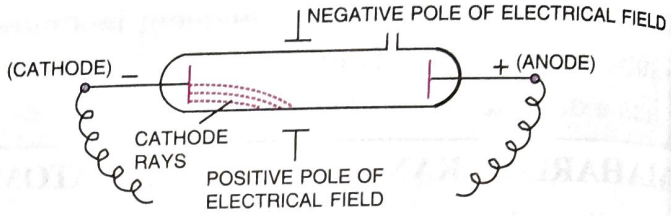


***Fig. 4.2 Diagram showing deflection of cathode rays in an electric field***

### *Properties of electrons*

1. Electrons are an integral part of all atoms.
2. Its properties are independent of the nature of the gas in the discharge tube.
3. An electron has a definite mass and it carries a definite electric charge.
4. The mass of an electron has been found to be 1/1837 of the mass of a hydrogen atom ($9{\cdot}108 \times 10^{-28}$ g)
5. Its charge is one (1) unit negative charge, *i.e.* $1{\cdot}602 \times 10^{-19}$ coulombs.

An ***electron*** is denoted by the symbol ${}_{-1}e^{0}$. The superscript 0 represents its mass and the subscript –1 represents its one unit negative electrical charge.

## DISCOVERY OF PROTONS ($p^+$)

The presence of the negatively charged electrons in an atom suggests that it must contain positively charged particles as well, otherwise an atom would not be electrically neutral. These positively charged particles were discovered by ***E. Goldstein***, a

German scientist, while he was performing an experiment with a discharge tube fitted with a perforated cathode with small holes to allow passage of positive rays (called as canal rays) (Fig 4.3). A ray, which was just the opposite to the cathode ray in all respects, was emitted from the anode. This ray was named the *anode ray*. The anode ray consisted of the positively charged particles (now called **protons**).

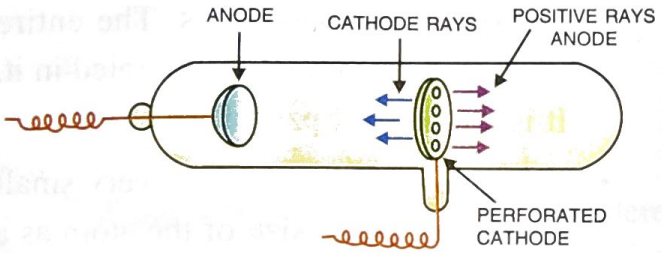


***Fig. 4.3 Rays travelling in opposite directions.***

### *Properties of protons*

1. The mass of a proton was calculated as being equal to the mass of an atom of hydrogen, *i.e.* $1{\cdot}672 \times 10^{-24}$ g.
2. The positive charge on a proton is equal to the negative charge on an electron, *i.e.* $1{\cdot}602 \times 10^{-19}$ coulombs.

Further experiments proved that all elements are composed of electrons and protons. However, no two elements contain the same number of protons in their respective nuclei. *For example*, the atoms of hydrogen, helium, lithium, carbon, nitrogen and oxygen contain 1, 2, 3, 6, 7 and 8 protons respectively. Since an atom is electrically neutral, the number of electrons in an atom is equal to the number of protons in that atom.

Protons are denoted as $_{+1}p^{1}$, where the superscript 1 represents 1 amu (atomic mass unit) mass and the subscript +1 represents one unit positive charge.

## THOMSON'S MODEL OF THE ATOM

***Now the question arose as to how protons and electrons were arranged in an atom.*** The first model for an atom was worked out by **J.J. Thomson**. It is known as the *Plum Pudding Model* (Fig. 4.4).

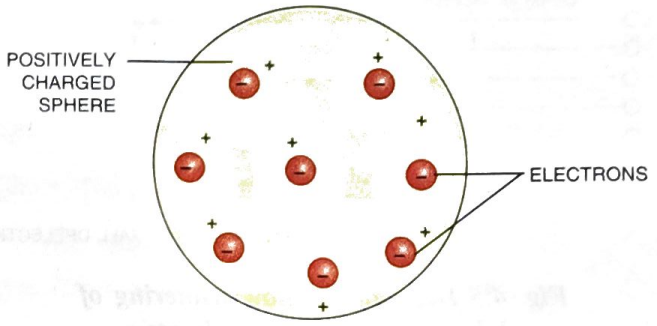


***Fig. 4.4 Thomson's Plum Pudding model of the atom***

According to this model, an atom is a positively charged sphere in which electrons are embedded just like dry fruits are distributed in a pudding.

Therefore it is known as the **Plum Pudding Model**.

Since the total positive charge of the atom was equal to the total negative charge of its electrons, it followed that an atom would become negatively charged if it gained electrons and positively charged if it lost electrons. However, this model failed to explain many experimental observations about atoms. Hence, Thomson's model was not accepted.

## DISCOVERY OF THE NUCLEUS

In 1911, **Lord Rutherford**, a scientist from New Zealand, conducted an experiment in order to find the arrangement of electrons and protons in an atom. His experiment led to the discovery of a small, positively charged *nucleus* in the centre of the atom.

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2020 SEPTEMBER

DAY 259 - 107 WEEK 38

TUESDAY

09 September 2020

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APPOINTMENT / MEETING

Class VIII

Subject - Chemistry

Date - 18.6.20 Chapter - 4 Atomic Theary part - I

(1) Give the main features of Daltons atomic theary.

(2) What are the properties of electron.

(3) How can you represent electron?

(4) What are the properties of proton?

(5) How can you represent proton?

(6) What is Plum Pudding modle?

P.S.
18.6.20