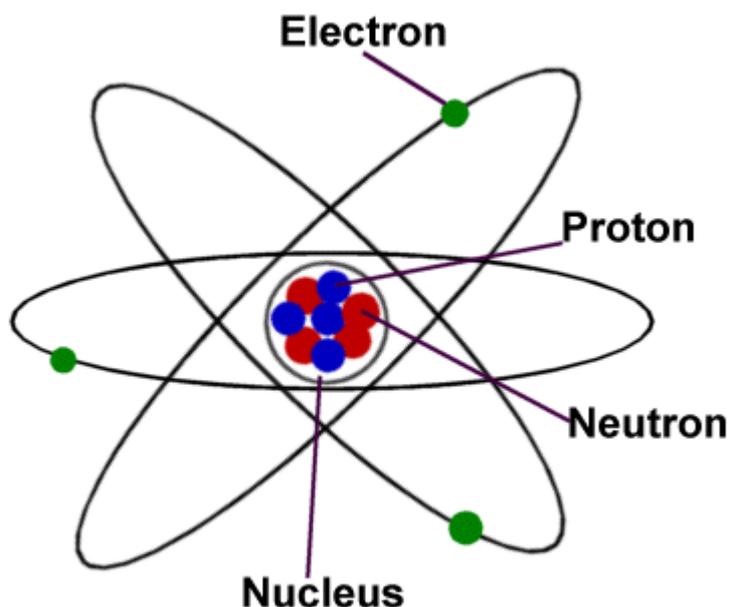


# Atom

## What is an Atom?

Matter is made up of microscopic particles called atoms. An atom is a particle that is the most basic unit of matter. Any substance, whether solid, liquid or gas, is made up of millions of these tiny particles.



## The origin of the word 'Atom'

The word atom comes from the Greek word 'atomos' meaning indivisible.

The theory that matter is made up of these tiny particles was put forth by ancient Indian and Greek scientists. However, this theory could not be proven, because of the lack of technology. These miniscule particles are so tiny that they can only be observed with a very powerful instrument called a 'scanning tunneling microscope.'

## Structure of the Atom

It has a nucleus in the middle. This part is made up of positively charged protons and neutrally charged neutrons. Around the nucleus are negatively charged electrons, which rotate around the nucleus in fixed orbits.

## What is an Atomic Number?

The number of protons in an atom is known as the atomic number. Therefore if an atom has the atomic number 8, it means that there are 8 protons in the nucleus and that the atom is of the element Oxygen. You can also safely say that all oxygen atoms will have 8 protons.

## What is a Molecule?

When two or more atoms combine they give rise to a molecule. A molecule can be made up of many atoms of the same element, as in the case of 2 oxygen atoms combining to form O<sub>2</sub>, or a combination of atoms of different elements; where 2 hydrogen atoms combine with one oxygen atom to form H<sub>2</sub>O (water). There are 112 elements known to man.

## What are atoms made of?

An atom is made of three parts – protons, neutrons and electrons.

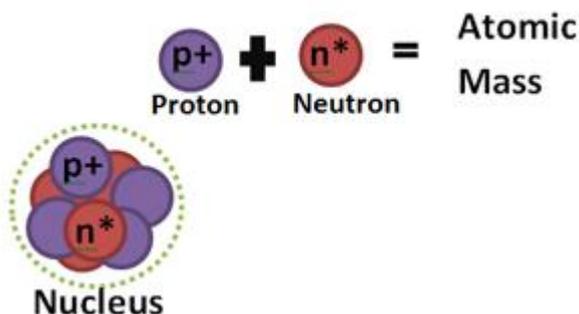
Each of these parts has an associated charge. The protons carry a positive charge, electrons have a negative charge and neutrons possess no charge. Protons and neutrons make up the nucleus of the atom and electrons orbit the nucleus at different energy levels.

## What is atomic number?

Atomic number of an atom is defined by the number of protons in the nucleus of an atom.

## What is atomic mass?

Atomic mass of an atom is equivalent to the number of protons and neutrons in the atom.



## **Parts of an atom**

### **What is a proton?**

A proton is a positively charged particle found within the atom's nucleus. Rutherford discovered them in his experiments with cathode ray tubes.

The number of protons in an atom define what the element is. This is what is referred to as the atomic number of that element. The number of protons also determine the chemical behaviour of that element.

### **What is a neutron?**

A neutron is the neutral part of the atom's nucleus, with no electric charge, and a mass slightly larger than that of a proton. It was discovered by the English physicist, James Chadwick.

Neutrons and protons combined make up the mass of the atom. We can find the number of neutrons if we know the atomic mass and the atomic number of an element, using this simple equation.

$$\text{Atomic Mass} - \text{Atomic Number} = \text{Number of Neutrons}$$

Atoms of the same element may have different number of neutrons. Adding neutrons changes the radioactivity of the element, without changing the charge of the atom. This is important in nuclear physics.

### **What is an electron?**

An electron is a negatively charged part of the atom found outside the nucleus in orbits and are attached to the protons in the atom with electromagnetic force. Closer the electron to the nucleus, the stronger the electromagnetic force between them.

Electrons can escape from their orbit in response to an external energy being applied. It can also change its state to a higher energy level by absorbing a photon with sufficient energy to boost it to a new quantum state. It can also drop down to lower energy state emitting the excessive energy as a photon.

Atoms are neutral if the number of protons and electrons are equal. Atoms that have an excess or deficit of electrons are called ions. Electrons have no internal structure, though protons and neutrons on the other hand are made of quarks.

## **Rutherford model of an atom**

After the model of an atom, by Thomson, was unable to explain the positively charged particles in an atom, Ernest Rutherford proved the presence of positively charged particles in the nucleus of an atom. Atomic model of Ernest Rutherford is also known as nuclear atom or planetary model of the atom. This description of atomic structure was proposed in 1911 by renowned physicist Ernest Rutherford.

This theory proved that the nucleus of an atom contains positively charged particles.

His theory claimed that the atom is not one solid substance.

His atomic theory stated that atom is a tiny and dense particle. A positively charged core is called nucleus, in which all the mass is concentrated. Around the nucleus, electrons circulated at some distance.

## **Bohr's model of an atom**

Bohr's model of an atom was proposed by Neil Bohr in 1915. He specified that electrons move in fixed orbits/shells, which have fixed energy levels.

## **What is valency?**

Valency is a measure of the reactivity of an atom. It is defined by the capacity of the atom to lose or gain valence electrons in the valence shell.

Every atom wants to have 8 electrons in the valence shell and this is known as the octet rule.

## **What are isotopes?**

Isotopes are atoms with the same number of protons but that have a different number of neutrons. Since the atomic number is equal to the number of protons and neutrons, isotopes have the same atomic number, but different mass numbers.

Carbon 14, used in carbon dating to find out the age of really old archeological and biological remains, is an isotope of carbon.

Tritium, an isotope of hydrogen, is used to make glow in the dark faces on clocks and wrist watches.

## **What are isobars?**

Isobars are defined as atoms of different elements that have the same atomic mass number, but different atomic number.

Carbon 14 and Nitrogen have the same mass number, which is 14, hence they are isobars.

## What is Ion?

An ion is defined as an atom or molecule which has gained or lost one or more of its valence electrons, giving it a net positive or negative electrical charge. In other words, there is an imbalance in the number of protons (positively charged particles) and electrons (negatively charged particles) in a chemical species.

The term "ion" was introduced by English chemist and physicist Michael Faraday in 1834 to describe the chemical species that travels from one electrode to another in aqueous solution. The word ion comes from the Greek word *ion* or *ienai*, which means "to go".

Examples of Ions

alpha particle  $\text{He}^{2+}$ , hydroxide  $\text{OH}^-$

## Cations and Anions

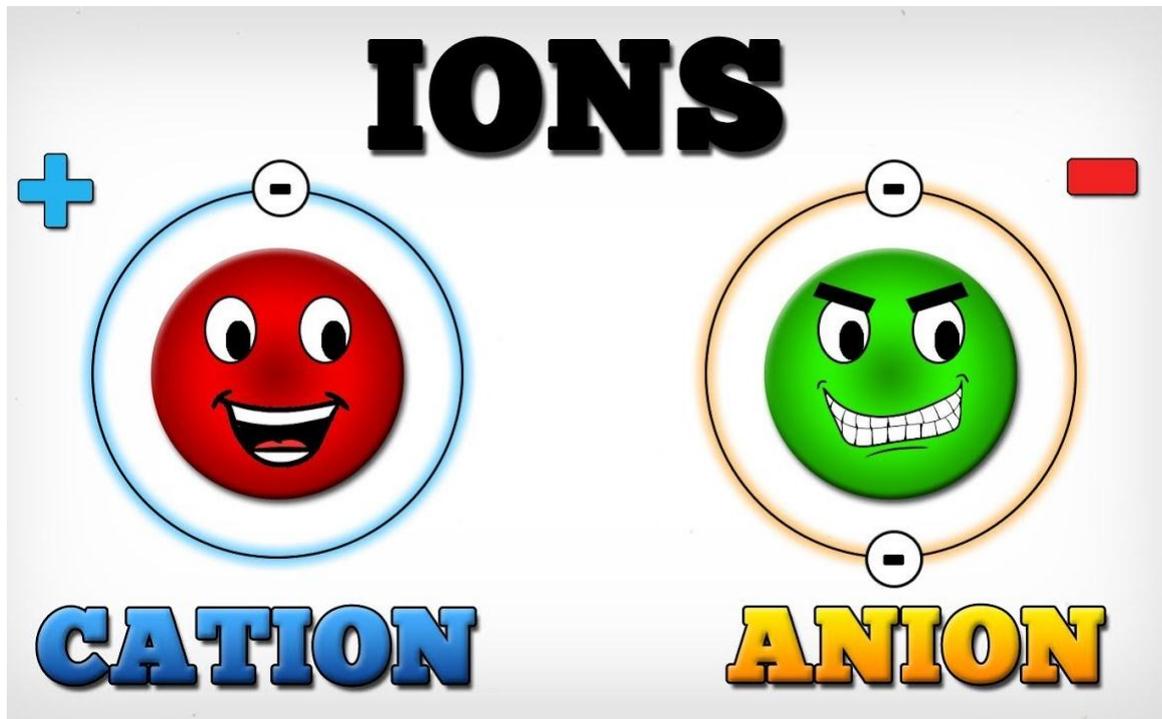
Ions can be grouped into two broad categories: cations and anions.

Cations are ions that carry a net positive charge because the number of protons in the species is greater than the number of electrons. The formula for a cation is indicated by a superscript following the formula that indicates the number of the charge and a "+" sign. A number, if present, precedes the plus sign. If only a "+" is present, it means the charge is +1. For example,  $\text{Ca}^{2+}$  indicates a cation with a +2 charge.

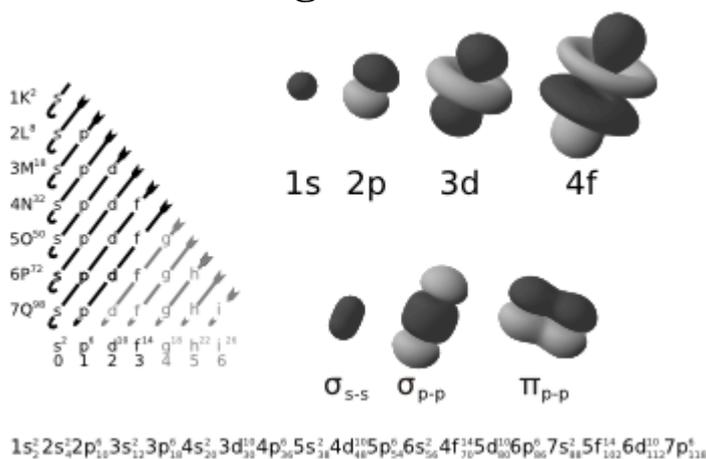
Anions are ions that carry a net negative charge. In anions, there are more electrons than protons. The number of neutrons is not a factor in whether an atom, functional group, or molecule is an anion. Like cations, the charge on an anion is indicated using a superscript after a chemical formula. For example,  $\text{Cl}^-$  is the symbol for the chlorine anion, which carries a single negative charge (-1). If a number is used in the superscript, it precedes the minus sign. For example, the sulfate anion is written as  $\text{SO}_4^{2-}$ .

One way to remember the definitions of cations and anions is to think of the letter "t" in the word cation as looking like a plus symbol. The letter "n" in anion is the starting letter in the word "negative" or is a letter in the word "anion".

Because they carry opposite electrical charges, cations and anions are attracted to each other. Cations repel other cations; anions repel other anions. Because of the attractions and repulsion between ions, they are reactive chemical species. Cations and anions readily form compounds with each other, particularly salts. Because ions are electrically charged, they are affected by magnetic fields.



### Electron configuration



The diagram on the left shows the orbitals in order of increasing energy. The diagram on the top right shows the four types of orbitals: 1s, 2p, 3d, and 4f.

An **electron configuration** is the arrangement of electrons within an atom. The electron configuration describes where the electrons are inside orbitals. The structure of the Periodic table of elements is partly based on electron configuration.

There are four kinds of electron configurations: s, p, d, and f orbitals. S orbitals are roughly sphere-shaped, p orbitals are shaped like a dumbbell, d orbitals are usually shaped like a four-leaf clover, and f orbitals form a mathematically complex shape. An atom can have more than one orbital: in fact, all except hydrogen do. Similarly, atoms can have more than one of each kind of orbital.

The electron configurations fill up with electrons in an unchanging order.

এই অধ্যায়টি যেহেতু সপ্তম শ্রেণিতে একবার পড়ানো হয়েছে তাই আরেকটু বিস্তারিত দেয়া হয়েছে বোঝার সুবিধার্থে। এছাড়া যে অধ্যায়গুলো পড়ানো শেষ হয়েছে সেই অধ্যায়গুলোর সব প্রশ্নের উত্তর পড়বে। ছাত্র ছাত্রীদের পড়া সম্পূর্ণ করার পর অবশ্যই সর্শিক্ষষ্ট শিবিকার নিকট ফোনের মাধ্যমে পড়া জমা দেয়ার জন্য বলা হচ্ছে। কোন প্রশ্ন বুঝতে সমস্যা হলে শিবিকার কাছ থেকে বুঝে নিবে। এ বিষয়ে সম্মানিত অভিভাবকগণের সার্বিক সহযোগিতা আশা করছি।  
সবাই নিরাপদে থাকুন।