

1 Matter and radiation

1.1 Inside the Atom

Atoms can only be imaged with electron microscopes. Although we cannot see inside atoms we know from **Rutherford's alpha-scattering investigations** that every atom contains

- A positively charged **nucleus** composed of protons and neutrons.
- **Electrons** surrounding the nucleus.

A **nucleon** is a proton or a neutron in the nucleus.

Electrons are negatively charged, they are held in the atom by the electrostatic force of attraction between them and the nucleus.

- The nucleus contains most of the mass of the atom.
- Its diameter is of the order of 0.00001 times the diameter of the atom.

	Charge/C	Relative charge	Mass/kg	Relative mass
proton	$+1.6 \times 10^{-19}$	1	1.6×10^{-27}	1
neutron	0	1	1.6×10^{-27}	1
electron	-1.6×10^{-19}	1	9.1×10^{-31}	0.0005

where relative charges and masses are relative to that of the proton.

Notice that

- The electron has a much smaller mass than the proton or neutrons.
- The proton and neutron have almost equal mass.
- The electron has equal and opposite charge to the proton, the neutron is uncharged.

An **uncharged atom** has equal number of protons and electrons. An uncharged atom gains or loses electrons to become an **ion**.

Isotopes

Every atom of a given element has the same number of protons.

- The **proton number** of an element is also called the **atomic number Z** .
- The **nucleon number** of the atom A is the total number of protons and neutrons in an atom.

The nucleon number A is sometimes called the **mass number** because it is approximately the mass of the atom in relative units, as the mass of a proton or neutron is approximately 1.

Isotopes are atoms with the same number of protons and different number of neutrons.

Each type of nucleus is called a **nuclide**, and is labelled using the **isotope notation**.

A_ZX

where X is the chemical symbol of the element. The number of neutrons is given by $A - Z$.

Specific Charge

The **specific charge** of a charge particle is defined as its charge divided by mass

$$\text{specific charge} = \frac{\text{charge}}{\text{mass}}$$

The electron has the largest specific charge of any particle.