Unit 5 Materials and cycles on Earth
5.1 The structure of the atom

Lesson objectives

- ❏ Describe the structure of an atom
- ❏ List the particles found in an atom
- ❏ Describe properties about the particles found in atom

Key words

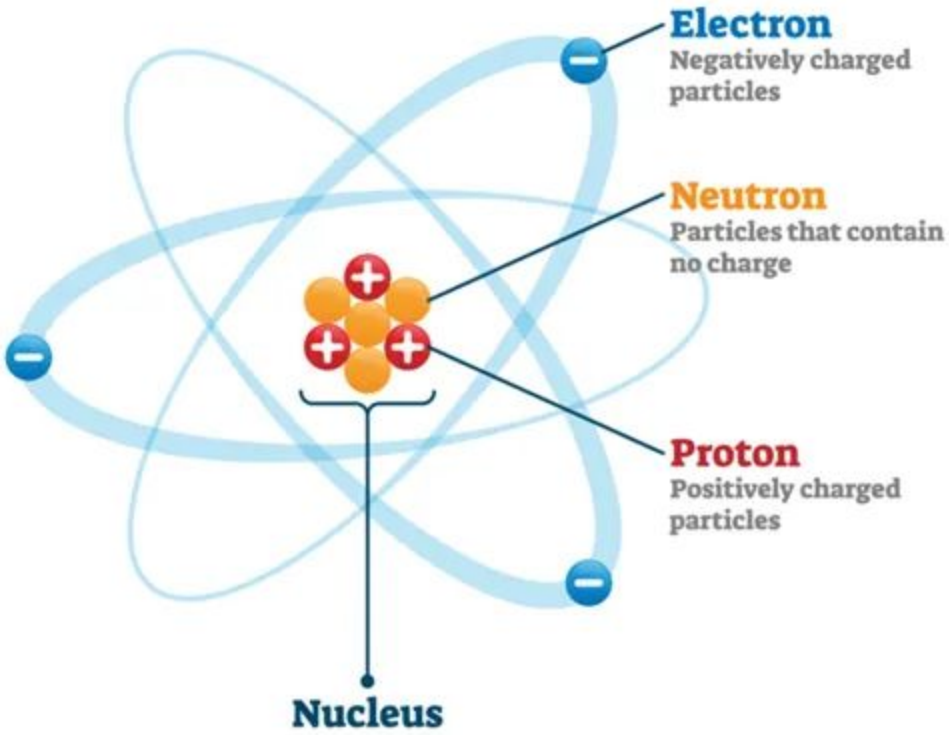
Atoms, protons, neutrons, electrons, nucleus, charge, electrostatic, sub-atomic

Atoms are made up of subatomic (“smaller than an atom") particles; these are **protons**, **neutrons** and **electrons**.

The protons and neutrons make up the **nucleus**, which is at the centre of the atom.

The electrons are found in **orbitals** (or **shells**) around the outside of the nucleus.

In the box on the right, draw a helium atom (2 protons, 2 neutrons and 2 electrons) and label the subatomic particles.


Electron
Negatively charged particles
Neutron
Particles that contain no charge
Proton
Positively charged particles
Nucleus

The different subatomic particles have different electrical charges.

Protons are **positively charged** (+1); **electrons** are **negatively charged** (-1); and **neutrons** have **no charge** (0).

Protons and electrons have exactly **opposite charges** to each other. Opposite charges **attract**, and this is how the electrons are held in their shells outside of the nucleus.

Neutrons have no charge, and they help keep the nucleus stable by preventing the positively charged protons repelling each other.

What is the overall charge of the helium atom that we drew on the previous page?

There is a lot of empty space between parts of an atom.

Electrostatic attraction between the positive charge (protons) and the negative charge (electrons) holds the individual atoms together.

It is also important to look at the size of the subatomic particles.

Protons and neutrons each have a mass of 1.67×10^{-24} g (you don't have to remember this). This is such a tiny number that a new unit of mass is used: the atomic mass unit (amu).

Protons and **neutrons** both have a mass of **1 amu**.

Electrons are 1840 times smaller than protons and neutrons (1/1840 or 0.000549 amu).

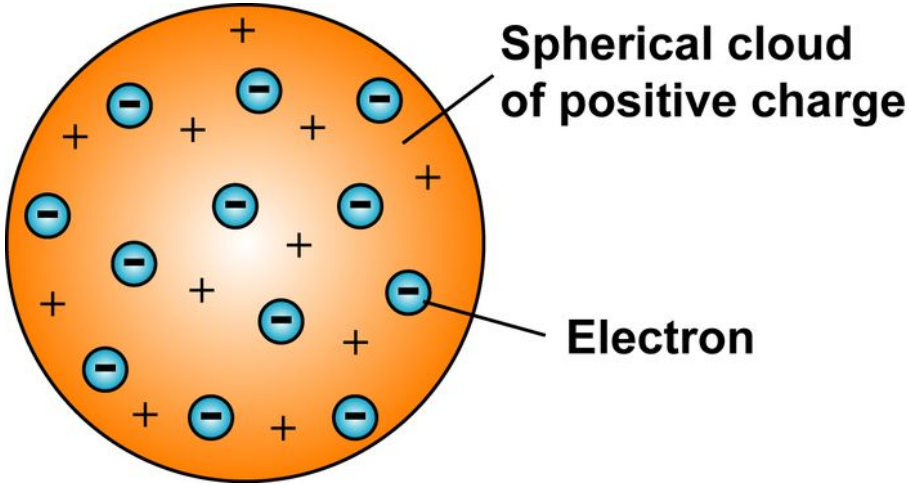
Complete a table to summarise the information you need to know about the subatomic particles.

Particle	**Location (inside or around the outside of the nucleus?)**	**Charge (+1, 0, -1?)**	**Relative mass (mass in amu)**
Proton			
Neutron			
Electron			

Many people have tried to come up with a model to show what the atom looks like.

1890s: J.J. Thomson discovered electrons and later came up with the **“Plum pudding model”**

- **Electrons** were scattered throughout the structure
- Particles arranged randomly throughout the model, like fruit in a cake or pudding



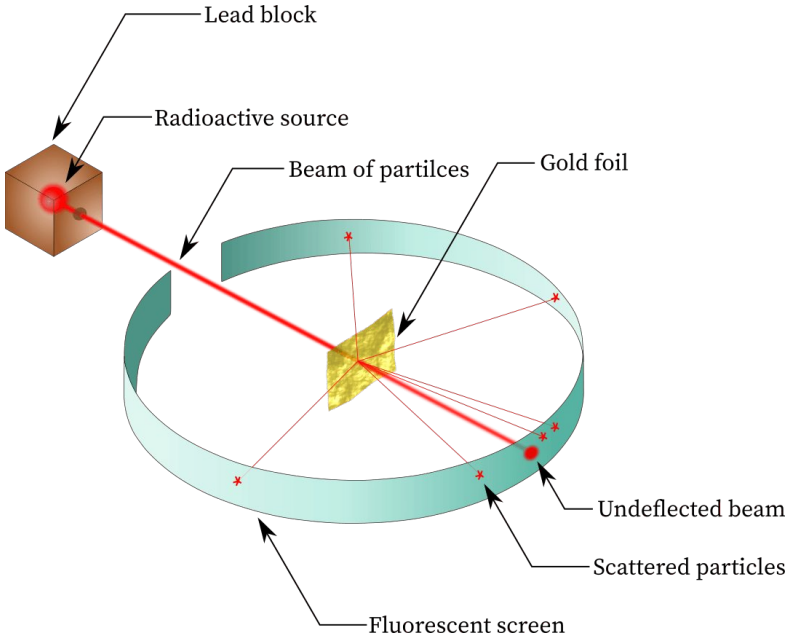
1911: Ernest Rutherford discovered the proton and the nucleus

He carried out a gold foil experiment

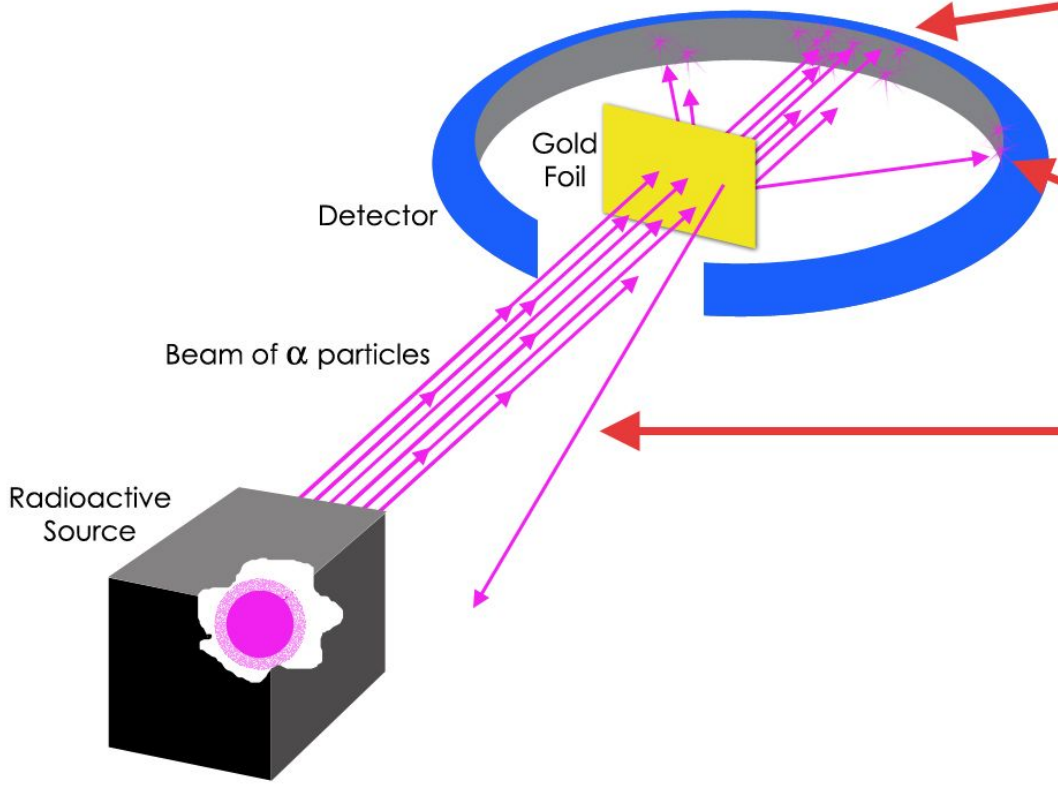
He fired fast moving particles (smaller than an atom) at a very thin sheet of **gold foil**.

Most of the particles did pass straight through the gold foil **without changing direction**.

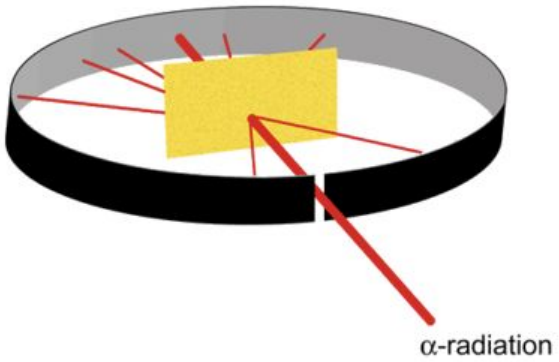
However, some of the particles were **slightly deflected**, and a few of the particles were **deflected straight back**!



Rutherford's Gold Foil Experiment



Observation	Interpretation
Most α particles travel through the foil undeflected	The atom is mostly empty space
Some α particles are deflected by small angles	The nucleus is positively charged, as is the α particle
Occasionally, an α particle travels back from the foil	The nucleus carries most of the atom's mass

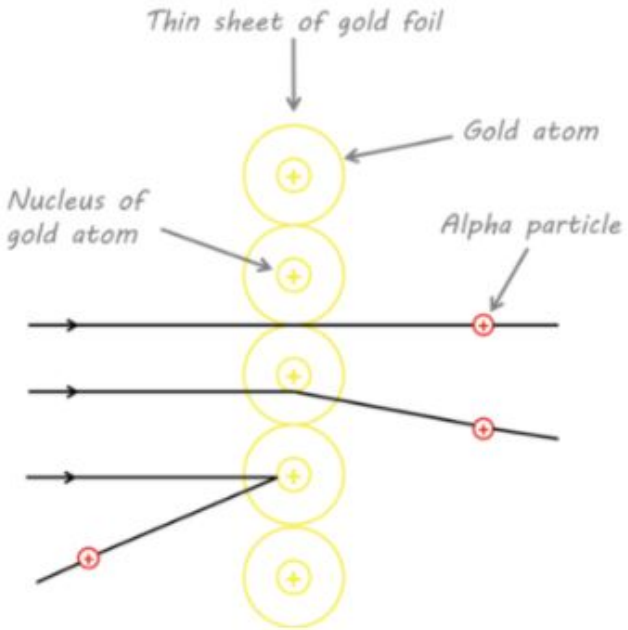


This led him to conclude that a small, dense mass exists at the centre of every atom. He called this the **nucleus**.

Gold atoms must be mostly empty space, with their dense particles packed into a dense nucleus at the centre.

The nucleus must also be positively charged in order to repel the positively charged alpha particles.
Rutherford called the positively charged particles in the nucleus **protons**.

Why were most of the particles not deflected at all?



Later, James Chadwick also worked with Rutherford and Thompson and proved that neutrons exist.