



What are atoms made of?

KS3 Ages 11-14 🕒 4 min read

For a long time, scientists thought atoms were the smallest possible unit of matter — the word "atom" comes from the Greek for "indivisible." Then we looked more carefully, and found that atoms are made of even smaller things. And those things are made of even smaller things. Welcome to particle physics.

The atom's structure

An atom has a **nucleus** at the centre — a tiny, dense core — surrounded by a cloud of **electrons** at various distances. The nucleus contains two types of particles: **protons** (positively charged) and **neutrons** (no charge). Electrons are negatively charged. The number of protons defines what element the atom is — one proton is hydrogen, six is carbon, 79 is gold.

The nucleus is extraordinarily small compared to the overall atom. If an atom were the size of a football stadium, the nucleus would be about the size of a pea in the centre — and the electrons would be tiny specks somewhere in the stands. An atom is almost entirely empty space.

You are made of atoms. Atoms are almost entirely empty space. So, technically, you are almost entirely empty space — held in shape by electromagnetic forces. The reason you don't fall through your chair isn't that you're solid; it's that the electrons in you and the electrons in the chair repel each other strongly enough to prevent it. Solidity is, in a sense, an illusion. Just the electromagnetic force making its presence known.

What are protons and neutrons made of?

Protons and neutrons aren't fundamental — they're made of smaller particles called **quarks**. A proton contains two "up" quarks and one "down" quark. A neutron has one "up" and two "down." Quarks are held together by the **strong nuclear force**, which is carried by particles called **gluons**. Quarks appear to be truly fundamental — as far as we can tell, they have no internal structure.

The Standard Model

The best current theory of particle physics is called the **Standard Model**. It describes 17 fundamental particles — 6 quarks, 6 leptons (including the electron), and 5 force-carrying particles (including the photon, which carries light). The Standard Model has been tested more rigorously than almost any other theory in science and keeps being confirmed. But it doesn't include gravity, and physicists know it's incomplete — which is one of the biggest unsolved problems in all of physics.