

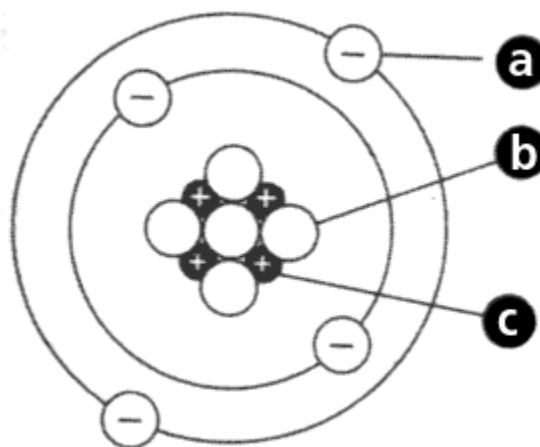
What is the world made of?

What holds it all together?

Elementary Particles

Atoms are made of **subatomic particles**. The three types of subatomic particles are:

- a) **ELECTRONS**
- b) **NEUTRONS**
- c) **PROTONS**



But what are these particles made of?

They are made of (or are) **elementary particles**.

What is an elementary particle?

An elementary particle is a particle that is **not made up of any smaller particles**.

Elementary particles are the building blocks of the universe.

All the other particles and matter in the universe are made up of elementary particles.

ATOMIC MODEL History

For many years scientists thought that the atom was the smallest particle possible.

We explored the development of the ATOMIC MODEL in Science 8 !!!

Scientists have subsequently learned that the atom was made up of even smaller particles.

When we study the atom we learned about the basic particles of the atom including the

electron, proton, and neutron that we labeled on the diagram, above.

Today, scientists have found even smaller particles that make up the proton and the neutron.

History of Atomic Chemistry: Crash Course Chemistry # 37.

<https://youtu.be/thnDxFdkzZs>

10 minute video

A HISTORY OF THE ATOM: THEORIES AND MODELS

How have our ideas about atoms changed over the years? This graphic looks at atomic models and how they developed.

SOLID SPHERE MODEL	PLUM PUDDING MODEL	NUCLEAR MODEL	PLANETARY MODEL	QUANTUM MODEL
JOHN DALTON	J.J. THOMSON	ERNEST RUTHERFORD	NIELS BOHR	ERWIN SCHRÖDINGER
 1803	 1904	 1911	 1913	 1926
Dalton drew upon the Ancient Greek idea of atoms (the word 'atom' comes from the Greek 'atomos' meaning indivisible). His theory stated that atoms are indivisible, those of a given element are identical, and compounds are combinations of different types of atoms.	Thomson discovered electrons (which he called 'corpuscles') in atoms in 1897, for which he won a Nobel Prize. He subsequently produced the 'plum pudding' model of the atom. It shows the atom as composed of electrons scattered throughout a spherical cloud of positive charge.	Rutherford fired positively charged alpha particles at a thin sheet of gold foil. Most passed through with little deflection, but some deflected at large angles. This was only possible if the atom was mostly empty space, with the positive charge concentrated in the centre: the nucleus.	Bohr modified Rutherford's model of the atom by stating that electrons moved around the nucleus in orbits of fixed sizes and energies. Electron energy in this model was quantised; electrons could not occupy values of energy between the fixed energy levels.	Schrödinger stated that electrons do not move in set paths around the nucleus, but in waves. It is impossible to know the exact location of the electrons; instead, we have 'clouds of probability' called orbitals, in which we are more likely to find an electron.
+ RECOGNISED ATOMS OF A PARTICULAR ELEMENT DIFFER FROM OTHER ELEMENTS	+ RECOGNISED ELECTRONS AS COMPONENTS OF ATOMS	+ REALISED POSITIVE CHARGE WAS LOCALISED IN THE NUCLEUS OF AN ATOM	+ PROPOSED STABLE ELECTRON ORBITS; EXPLAINED THE EMISSION SPECTRA OF SOME ELEMENTS	+ SHOWS ELECTRONS DON'T MOVE AROUND THE NUCLEUS IN ORBITS, BUT IN CLOUDS WHERE THEIR POSITION IS UNCERTAIN
- ATOMS AREN'T INDIVISIBLE - THEY'RE COMPOSED FROM SUBATOMIC PARTICLES	- NO NUCLEUS; DIDN'T EXPLAIN LATER EXPERIMENTAL OBSERVATIONS	- DID NOT EXPLAIN WHY ELECTRONS REMAIN IN ORBIT AROUND THE NUCLEUS	- MOVING ELECTRONS SHOULD EMIT ENERGY AND COLLAPSE INTO THE NUCLEUS; MODEL DID NOT WORK WELL FOR HEAVIER ATOMS	+ STILL WIDELY ACCEPTED AS THE MOST ACCURATE MODEL OF THE ATOM

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More Information on each of these proposed models here:

<https://www.compoundchem.com/2016/10/13/atomicmodels/>

Of course there are MANY more scientists that contributed to what we know about the model of the atom, over the centuries.

Elementary Particles - Quarks, Bosons, Leptons

Types of Elementary particles

There are two main categories of elementary particles:

- **FERMIONS**
- **BOSONS**

Fermions

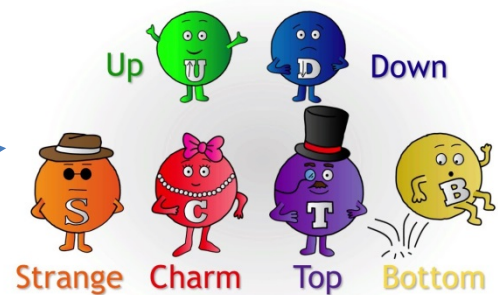
Fermions are the **MATTER** particles.

All matter is made up fermions. Fermions are divided into two types of particles:

- **QUARKS**
- **LEPTONS**

Quarks - the basic building blocks for **protons, and neutrons.**

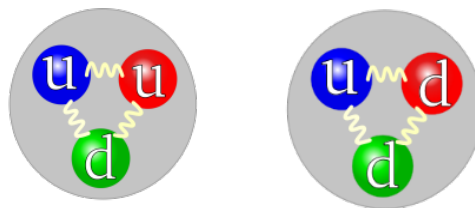
- There are six types of quarks and they have pretty interesting names
- The different types of quarks are called " **flavours** " by physicists.



*Note: A proton is made up of **three** quarks*

Proton: A proton is made up of three quarks including two "up" quarks and one "down" quark.

Neutron: A neutron is made up of three quarks including two "down" quarks and one "up" quark.



Leptons - One type of lepton that you have probably heard of is the **electron.**

Electrons are important building blocks for atoms.

Other types of leptons include the **Muon** and the **tau.**

Bosons

Bosons are **FORCE** -carrying particles. This means that they are made up of tiny bundles of **ENERGY**.

Photon - **LIGHT** is made up of a type of boson called a photon.

Gluons – Gluons are a type of boson that act as the force-carrier between quarks in creating one of the fundamental forces of nature, the **STRONG FORCE**.

	I	II	III	
Quarks	up u	charm c	top t	photon γ
	down d	strange s	bottom b	gluon g
Leptons	electron neutrino ν_e	muon neutrino ν_μ	tau neutrino ν_τ	Z-boson Z
	electron e	muon μ	tau τ	W-boson W

Four Fundamental Forces:

All interactions in the universe (YES THE UNIVERSE) are thought to arise from four different forces

Strong

- The strongest of the forces
- Holds the **NUCLEUS OF AN ATOM** together
- Uses **GLUONS** to hold protons and neutrons together



Weak

- The second strongest force (only weak when compared to the **STRONG** force)
- Responsible for **RADIOACTIVITY** in some elements

Electromagnetism

- Electricity and magnetism are interconnected
- Static electricity, like a balloon sticking to a wall, or magnetism, like magnets attracting or repelling each other are both the result of a *single* force
- Positively charged **PROTONS** attract negatively charged **ELECTRONS**
- Holds the **ATOM** together

Gravity

- The **WEAKEST** of the fundamental forces
- Holds you to the **EARTH**, and the Earth to the sun (etc.)
- Very easy to overpower