J05 Chemistry Fundamentals
Atoms

English with 2 Little Pigs

www.with2littlepigs.com

Epic Spaceman

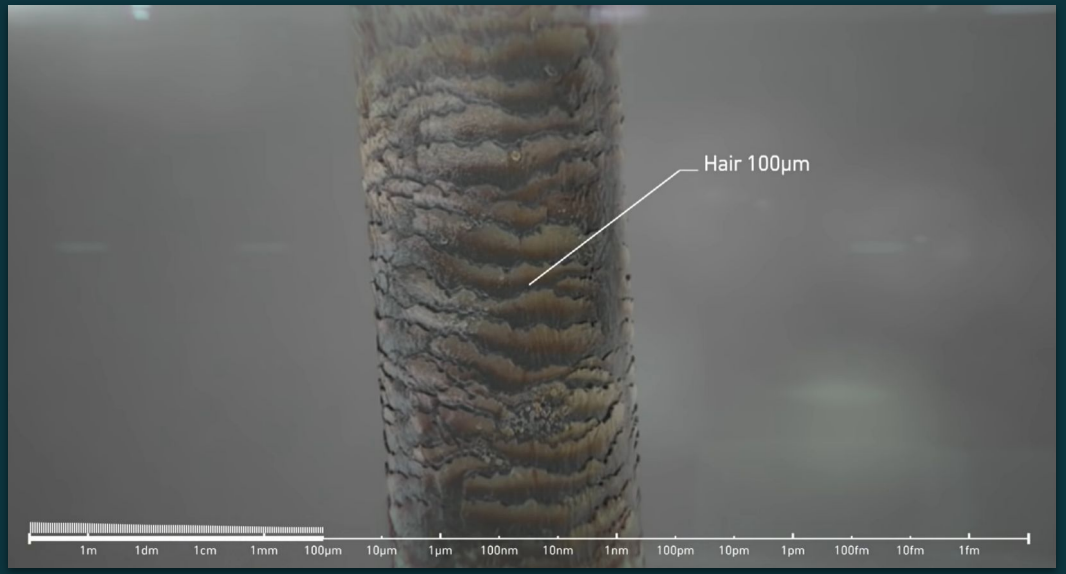
Contents

Units & Dimensions

Metres, millimetres, microns, nanometres, picometres and femtometres

Units & Dimensions

In the next video we will look at smaller and smaller things, from a lady's head down to the size of a proton. But what do all the symbols mean?



1 m is 1 metre
1 dm is 1 decimetre or 0.1m
1 cm is 1 centimetre or 0.01m
1 mm is 1 millimetre or 0.001m

1 thousand mm in 1 m.

1 µm is 1 micron. 1 million µm in 1 m.

1 nm is 1 nanometre. 1 billion nm in 1 m

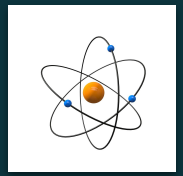
1 pm is 1 picometre. 1 trillion pm in 1 m

1 fm is 1 femtometre. 1,000 trillion fm in 1 m.

Units & Dimensions

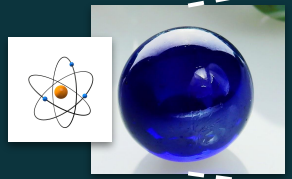
1 billion times bigger

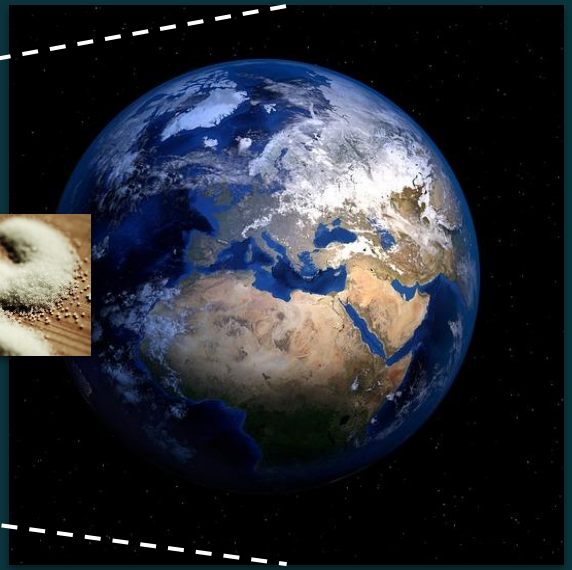
Imagine a 13mm glass marble the size of Earth 13,000km wide.



Each atom would be the size of a grain of salt.

Units & Dimensions





There are around 150,000 billion billion atoms in a marble

Earth would be made of 150,000 billion billion grains of salt.

150,000,000,000,000,000,000,000

metre millimetre micron nanometre picometre femtometre

Atoms

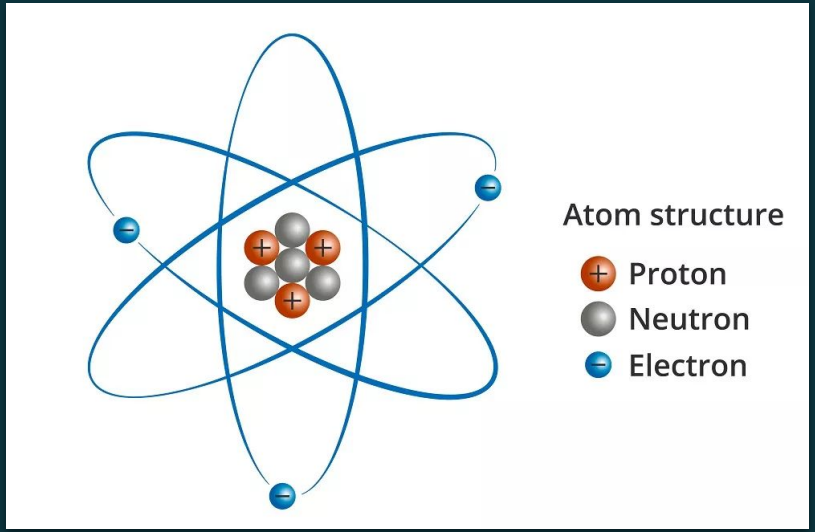
Protons, neutrons and electrons

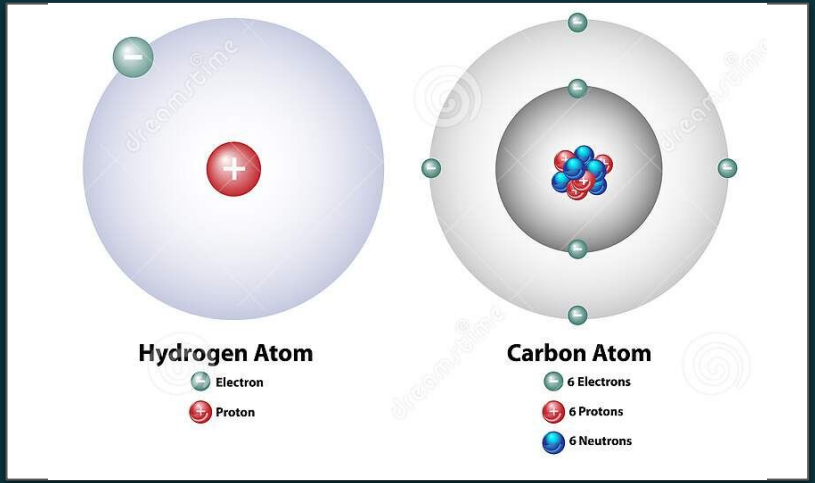
Atoms

An atom is a particle that consists of a nucleus of protons and neutrons surrounded by a cloud of electrons.

The atom is the basic particle of the chemical elements, and the chemical elements are distinguished from each other by the number of protons that are in their atoms.

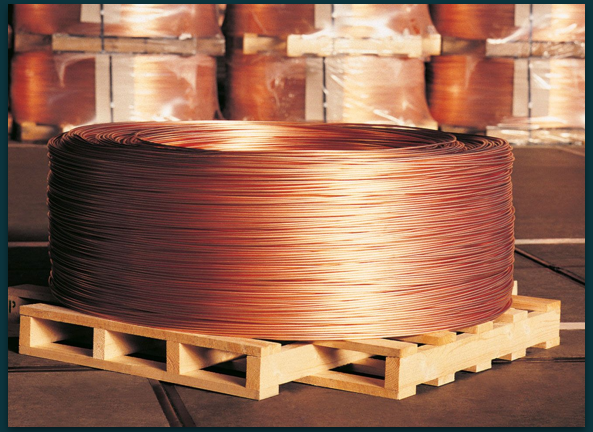
For example, hydrogen has 1 proton, helium has 2, any atom that contains 6 protons is carbon and any atom that contains 29 protons is copper.





Atoms

This is pure carbon.
Each atom of carbon has a nucleus which contains exactly 6 protons



This is pure copper.
Each atom of copper has a nucleus which contains exactly 29 protons

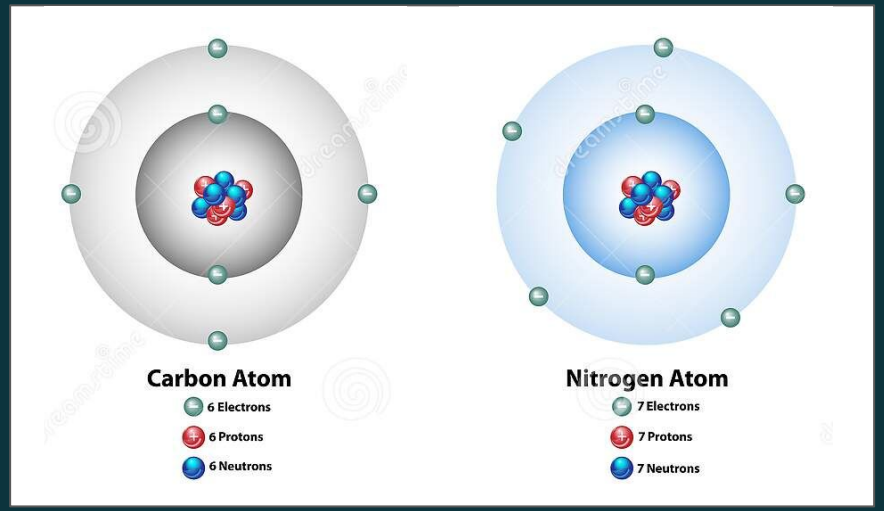
This is pure gold.
Each atom of gold has a nucleus which contains exactly 79 protons

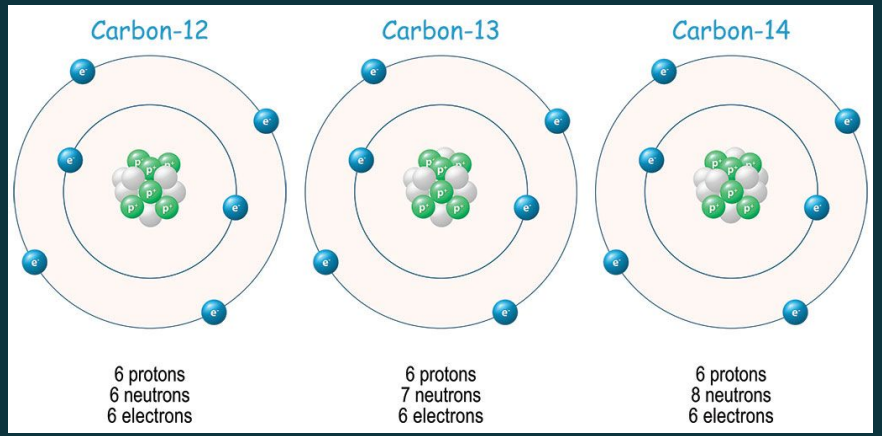
Atoms

The number of protons in the nucleus makes one element different to another. Add a proton and we have a whole new element.

Add 1 proton to a carbon nucleus and it becomes nitrogen. Carbon has 6 protons, nitrogen has 7.

However, the number of neutrons can vary and it doesn't change the element's properties. Elements with different numbers of neutrons are called isotopes.





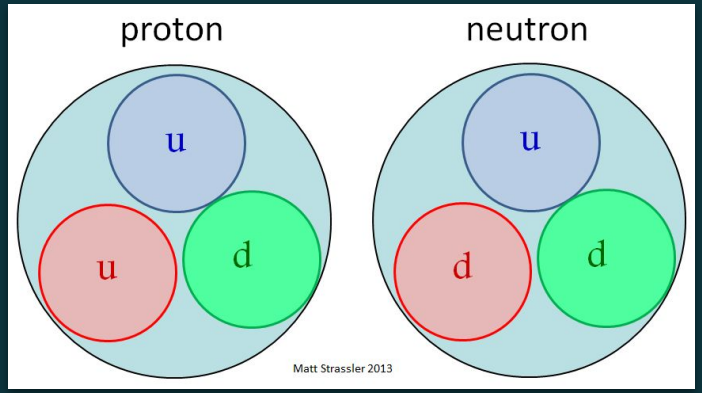
Atoms

A **proton** is made up of 2 “up” quarks and 1 “down” quark. Therefore overall it has a positive charge.

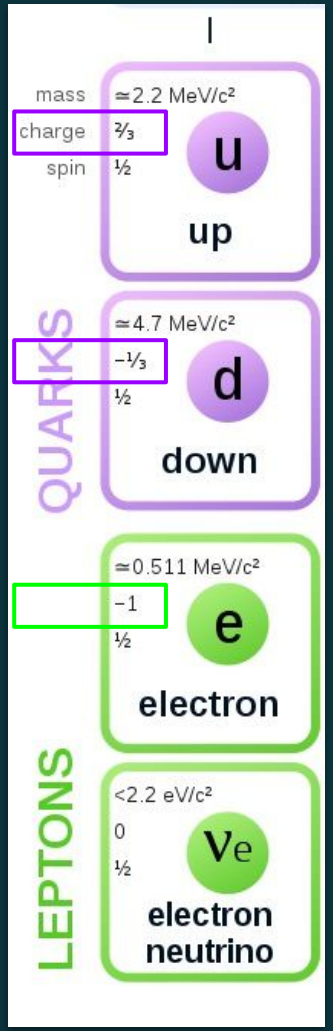
⅔ +⅔ - ⅓ = 1

A **neutron** is made up from 1 “up” quark and 2 “down” quarks. Therefore is has zero charge.

-⅓ -⅓ + ⅔ = 0

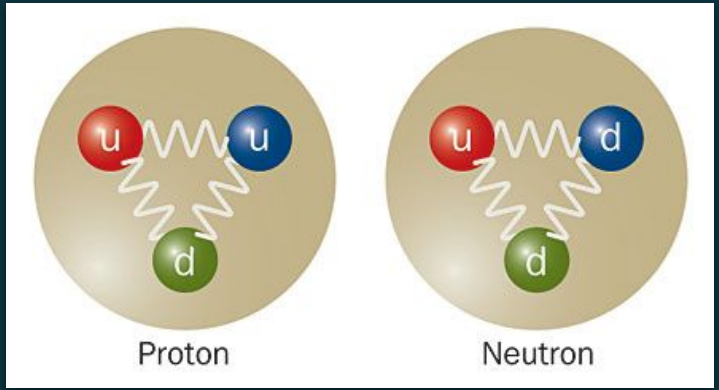


The electrons each have a negative charge of -1

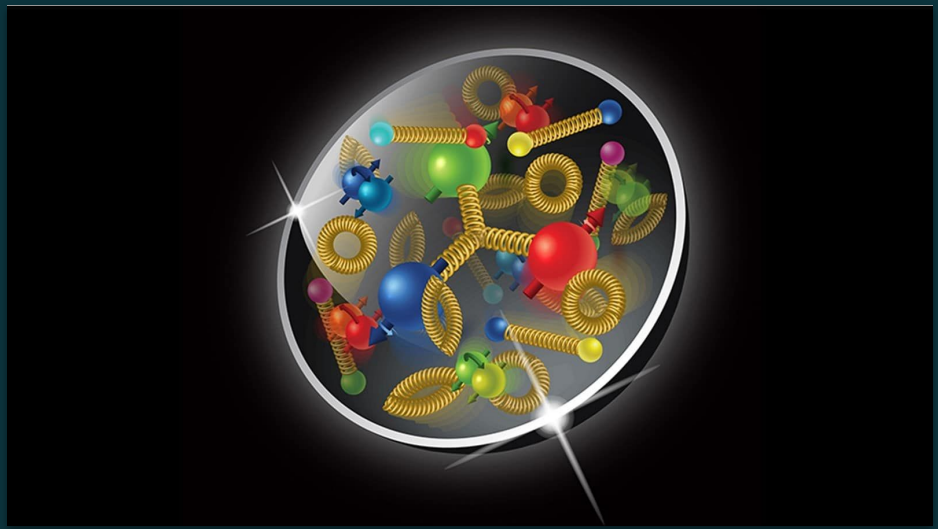


Atoms

The quarks inside the protons and neutrons are held together by gluons.



So now if you take a look at the cover image from the last class you can see which are quarks, which are gluons and possibly guess at the other fermions and bosons.

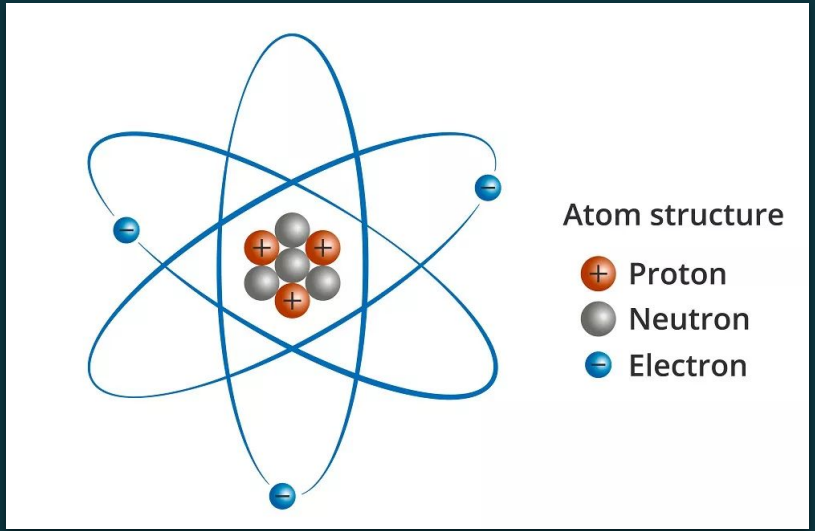


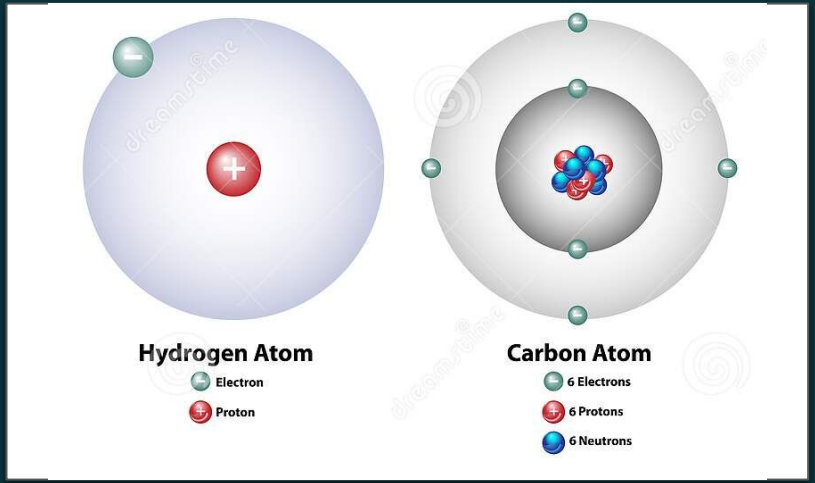
Atoms

Stable atoms will contain exactly the same number of electrons as protons.

Protons have a charge of +1 and electrons have a charge of -1. In order to be perfectly in balance there needs to be the same number of each.

Sometimes atoms will have 1 or more electrons than protons or 1 fewer … that leads to a chemical reaction.

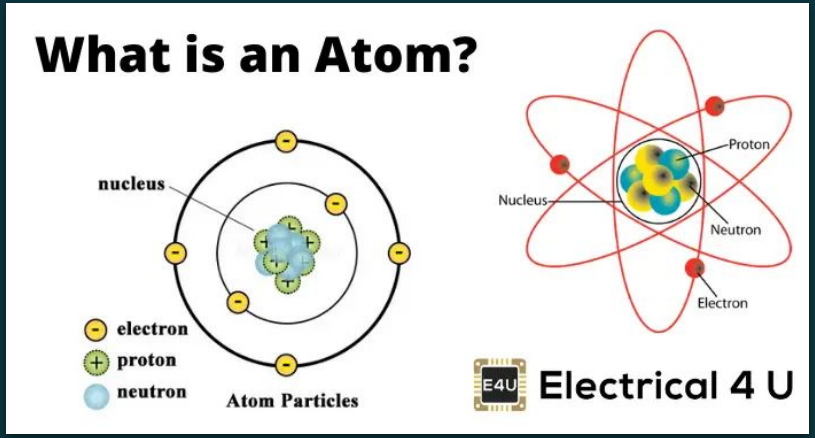


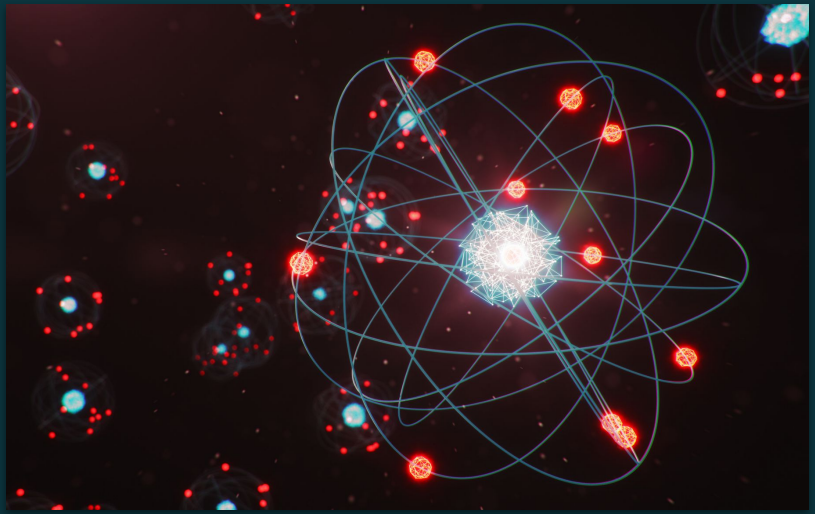


Atoms

These images of electrons orbiting a nucleus are just a representation of an atom. The truth is that atoms do not look anything like this.

The electrons do not orbit, they don’t go around the nucleus in a circle or an ellipse, they are not like planets orbiting a sun. This is just how we draw it.





Journey to the Atom

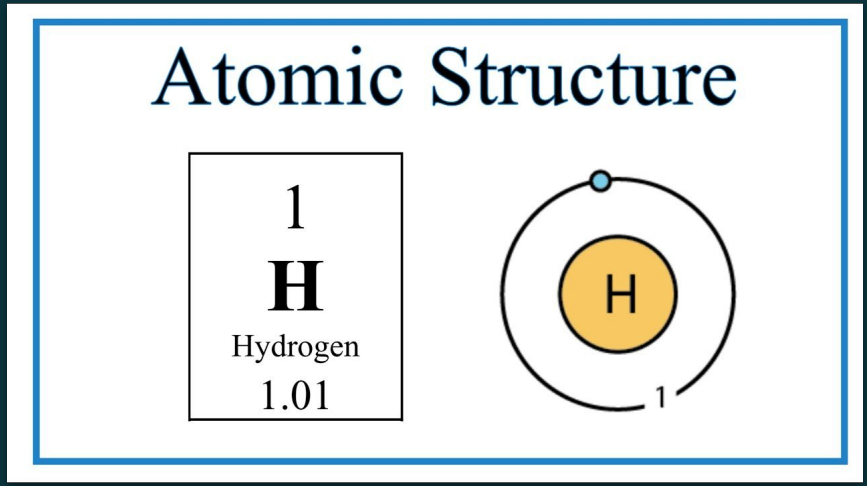
Electron Shells

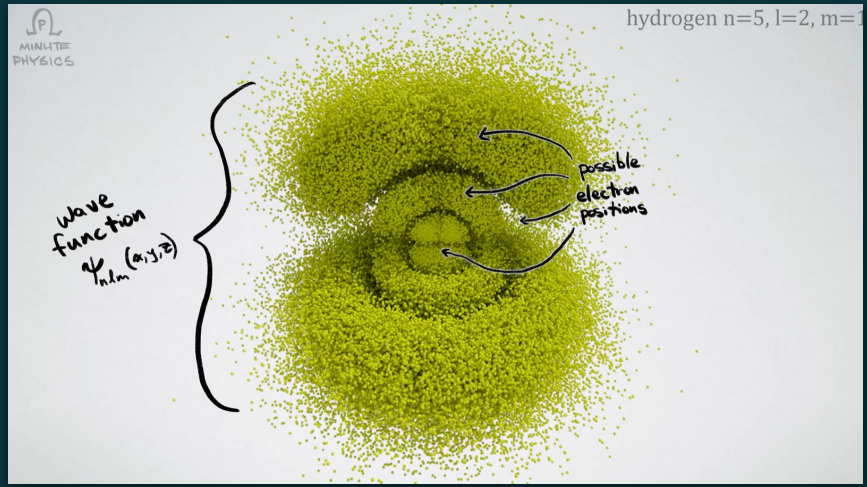
Electrons

We represent electrons as particles that orbit a nucleus purely for simplicity.

In actual fact the electron does not orbit anything, the electron can be in one of many places at any time in a cloud surrounding the nucleus.

Atoms with more protons have more electrons and more layers of clouds around it.



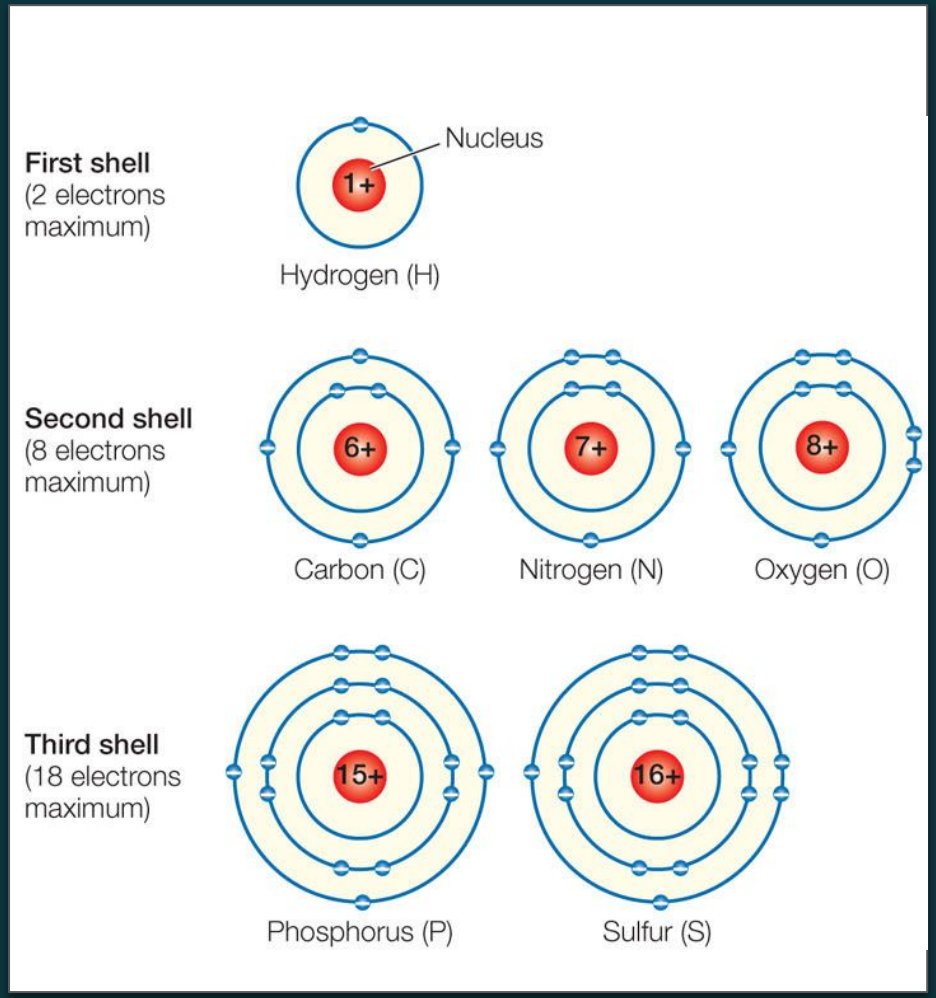


What does an Atom look like?

Electrons

Electrons reside in what we call “shells” surrounding the nucleus. Each shell can hold a maximum number of electrons.

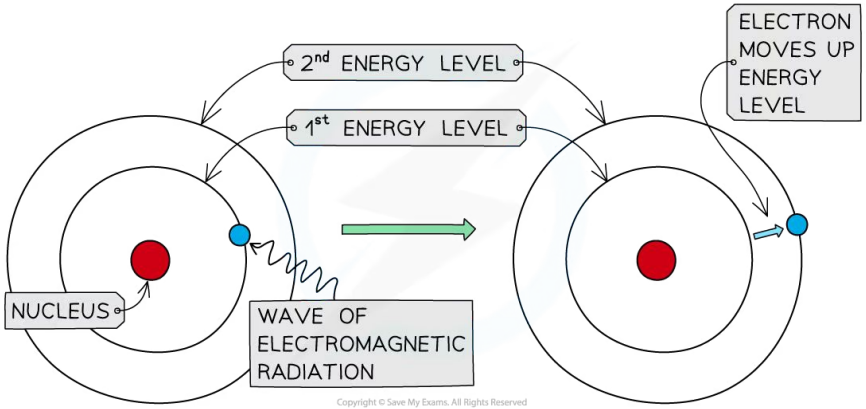
The inner shell (K) can only hold 2 electrons, the next shell (L) can hold 8, the third (M) shell can hold a maximum of 18 electrons, the fourth shell (N) holds 32, the fifth holds 50 and the sixth can hold as many as 72 electrons.



Electrons

These shells have different energy levels. If you apply heat energy, which is electromagnetic radiation, to an atom some of the electrons will jump from a lower energy layer (shell) to a higher one for a split second.

As it returns to its original layer it gives off that energy as a electromagnetic radiation at a particular frequency, one we often see as light.



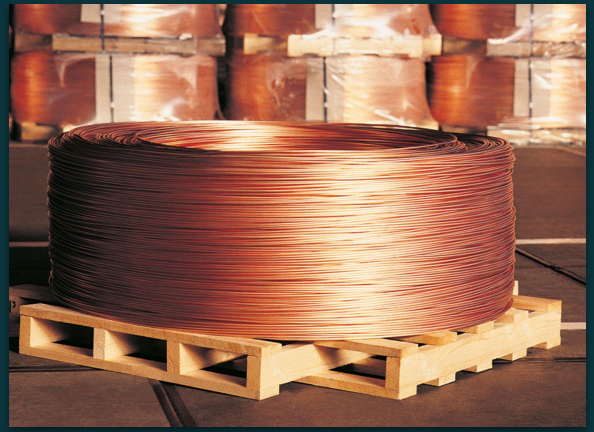
Electricity

Electricity

Let’s take a look at what electricity is and how a battery, for example, can light a light bulb by using copper wire.

At school they tell you that electrons flow from the battery, through the copper wire, and into the filament of the light bulb.

Because the filament is so much thinner than the copper wire the electrons rubbed together and this heats up the filament which then glows.

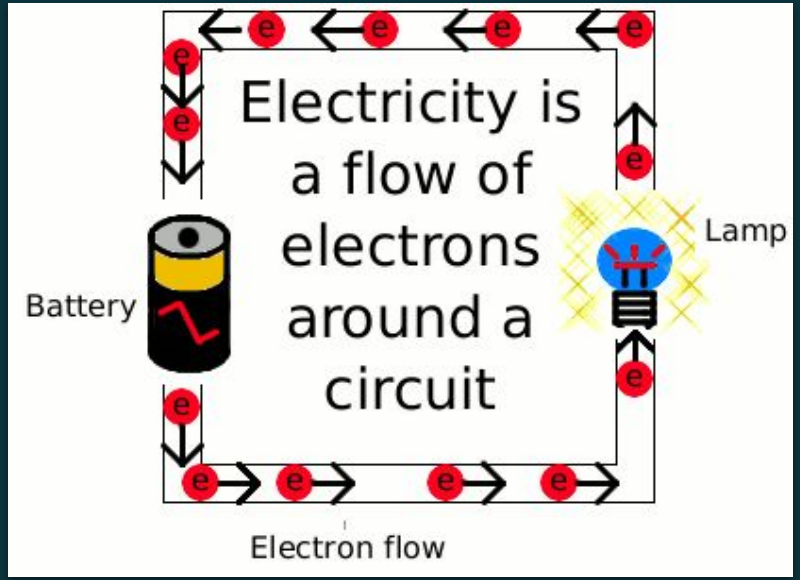


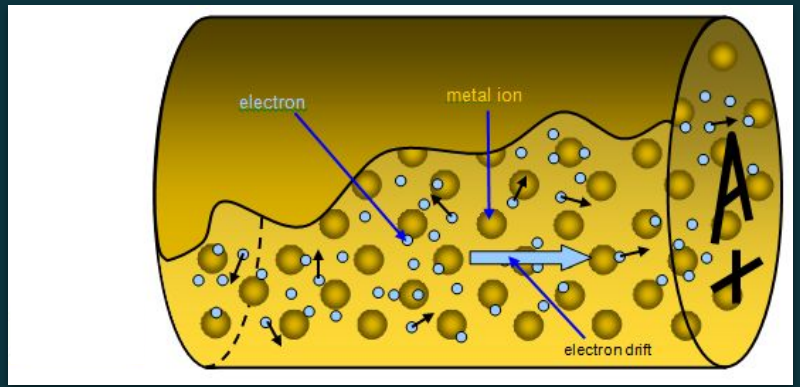
Electricity

This is the typical representation of what happens in an electrical circuit. <u>But it is not true.</u>

Pure copper wire contains atoms of copper with positively charged nuclei and negatively charged electrons.

The electrons do bounce around but barely move forwards or backwards.

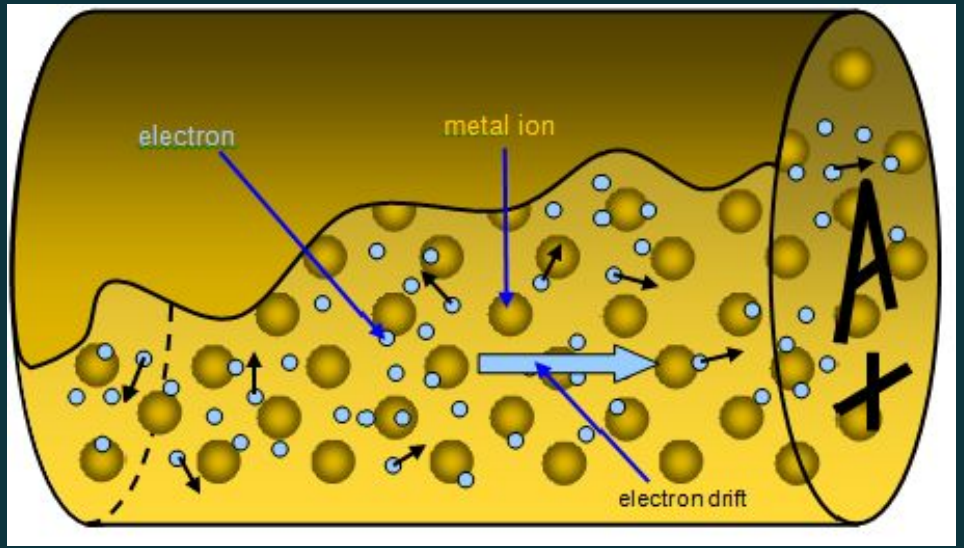




Electricity

Electron drift, or the slow movement of electrons along the wire is extremely slow, around 0.1 mm/s. That is about 6mm every minute, from your heel to your toe in 1 hr.

So what carries the energy?

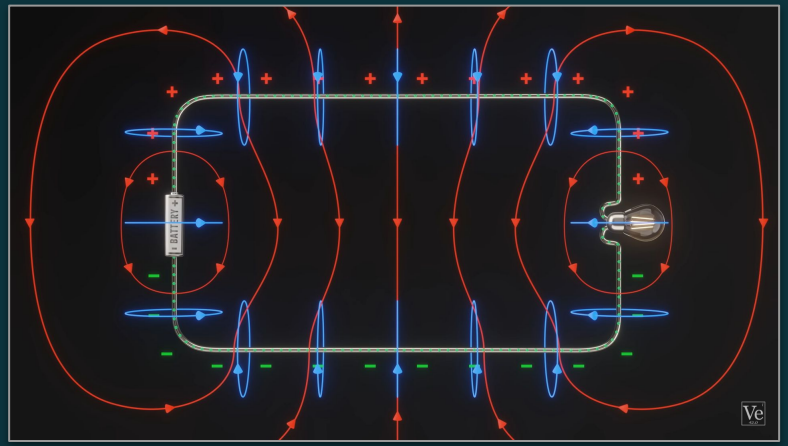


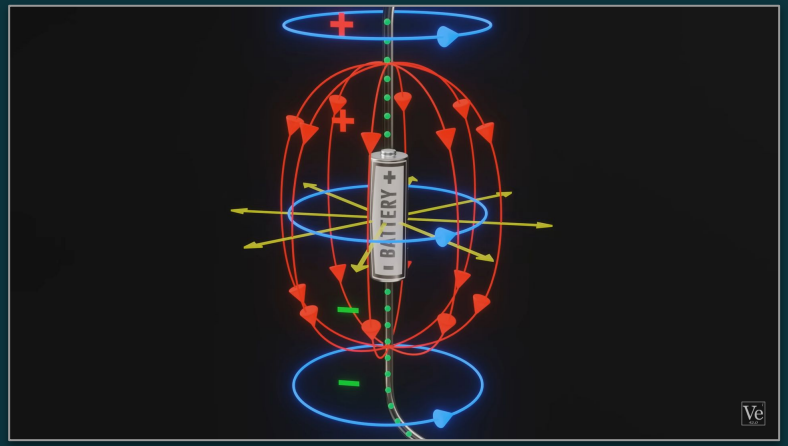
Electricity

This is your electrical circuit. We have a battery and light bulb connected by wires.

We have a negative charge on one side and a positive on the other. We also have a magnetic field. Where ever you have an electrical field you have a magnetic field.

It is electromagnetic and the energy does not flow along the wires but out of the battery through the magnetic field.



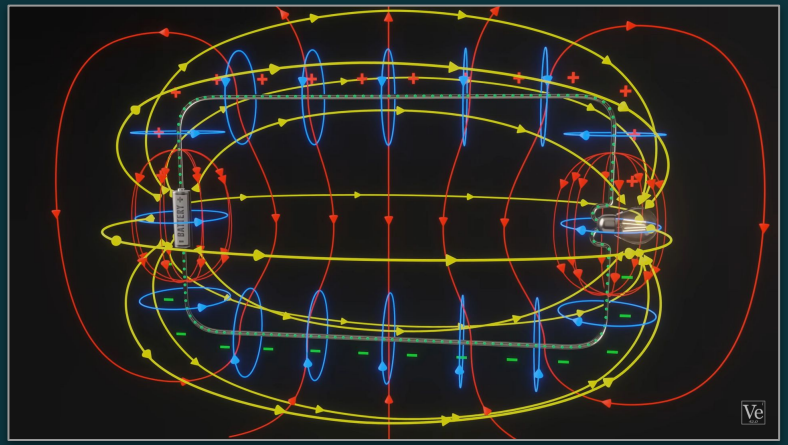


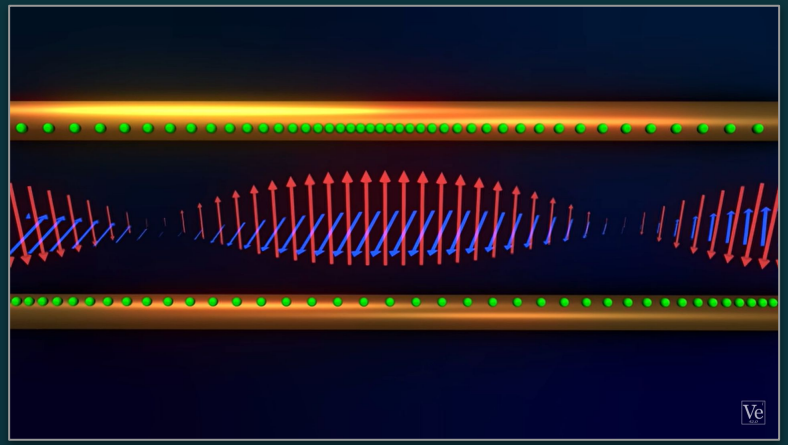
Electricity

The energy flows through the magnetic field from the battery to the bulb … as shown by the yellow lines.

It does not matter how long the wires are, it only matters how far the battery is from the bulb.

The energy is not passed on by flowing electrons, it is transferred through the magnetic field.





How Electrical Energy Flows [6:00 -9:00 mins]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The End