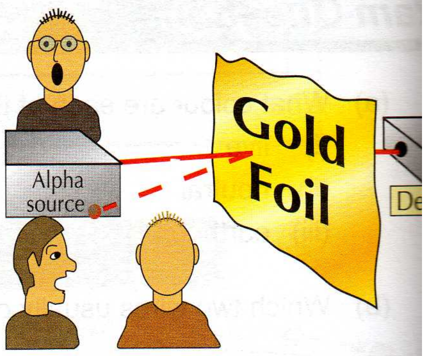
Atomic Structure

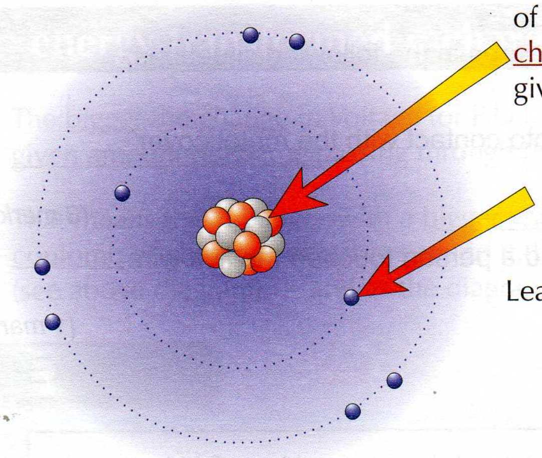
Ernest Rutherford didn't just pick the nuclear model of the atom out of thin air. It all started with a Greek fella called Democritus in the 5th Century BC. He thought that all matter, whatever it was, w made up of identical lumps called "atomos". And that's about as far as the theory got until the 180

Rutherford scattering and the demise of the plum pudding

1) In 1804 John Dalton agreed with Democritus that matter was made up of tiny spheres ("atoms") couldn't be broken up, but he reckoned that each element was made up of a different type of "a
2) Nearly 100 years later, J J Thomson discovered that electrons could be removed from atoms. So Dalton's theory wasn't quite right (atoms could be broken up). Thomson suggested that atoms v spheres of positive charge with tiny negative electrons stuck in them like plums in a plum puddi
3) That "plum pudding" theory didn't last very long though. In 1909 Ernest Rutherford and his merry men tried firing alpha particles at thin gold foil. Most of them just went straight through, but the odd one came straight back at them, which was frankly a bit of a shocker for Ernie and his pals.
4) Being a pretty clued-up guy, Rutherford realised this meant that most of the mass of the atom was concentrated at the centre in a tiny nucleus, with a positive charge.
5) And that most of an atom is just empty space, which is also a bit of a shocker when you think about it.



Rutherford came up with the nuclear model of the atom



The nucleus is tiny but it makes up most of the mass of the atom. It contains protons (which are positively charged) and neutrons (which are neutral) — which gives it an overall positive charge.

The rest of the atom is mostly empty space. The negative electrons whizz round the outside of the nucleus really fast. They give the atom its overall size

Learn the relative charges and masses of each particle:

PARTICLE	MASS	CHARGE
Proton	1	+1
Neutron	1	0
Electron	1/2000	-1

Now would be a good time to read up on isotopes (see page 48).

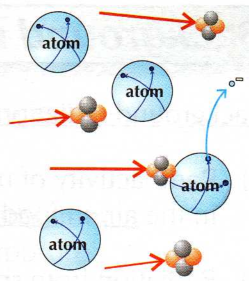
The nuclear model is just one way of thinking about the atom

It works really well for explaining a lot of Chemistry, but it's certainly not the whole story. Other bi of science are explained using different models of the atom. The beauty of it though is that no one model is more right than the others.

Radioactive Decay Processes

When nuclei decay by alpha or beta emission, they change from one element to a different one.

Alpha particles are helium nuclei



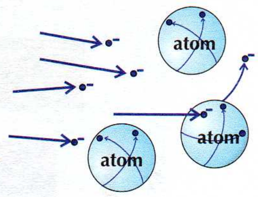
1) They are relatively big and heavy and slow moving.
2) They therefore don't penetrate very far into materials but are stopped quickly.
3) Because of their size they are strongly ionising, which just means they bash into a lot of atoms and knock electrons off them before they slow down, which creates lots of ions — hence the term "ionising".

Alpha emission:

A typical alpha emission:

An α-particle is simply a helium nucleus, mass 4 and charge of +2, made up of 2 protons and 2 neutrons.

Beta particles are electrons



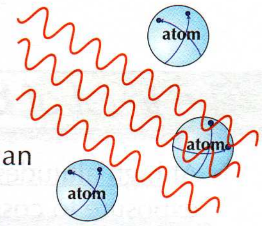
1) These are in between alpha and gamma in terms of their properties.
2) They move quite fast and they are quite small (they're electrons).
3) They penetrate moderately before colliding and are moderately ionising too.
4) For every β-particle emitted, a neutron turns to a proton in the nucleus.

Beta emission:

A typical beta emission:

A β-particle is simply an electron, with virtually no mass and a charge of −1.

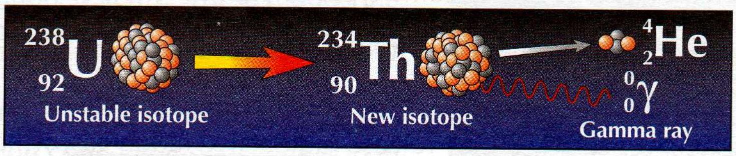
Gamma rays are very short wavelength EM waves



1) They are the opposite of alpha particles in a way.
2) They penetrate a long way into materials without being stopped.
3) This means they are weakly ionising because they tend to pass through rather than colliding with atoms. Eventually they hit something and do damage.

Gamma emission:

A typical combined α and γ emission:



A γ-ray is a photon with no mass and no charge.

After an alpha or beta emission the nucleus sometimes has extra energy to get rid of. It does this by emitting a gamma ray. Gamma emission never changes the proton or mass numbers of the nucleus.

Alpha and beta emissions are particles, gamma emissions are rays

Learn all the details about the three different types of radiation — alpha, beta and gamma. When a nucleus decays by alpha emission, its atomic number goes down by two and its mass number goes down by four. Beta emission increases the atomic number by one (the mass number doesn't change).