Development of the Model of the Atom Notes

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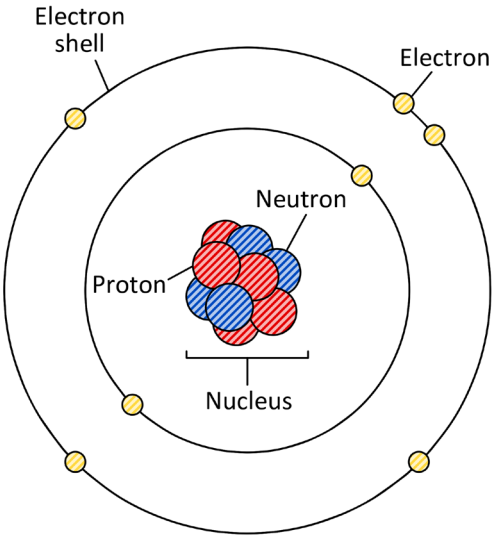
The model of the atom that we have today is the culmination of many years of study, experimentation, logic and plain old guess work. The current model of the atom is known as **the nuclear model** of the atom. The figure below shows the nuclear model of the atom. In the figure we can see electrons orbiting a central nucleus.

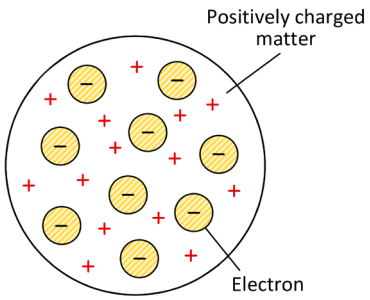


But how did we get this model and what were the old models of atoms like? At GCSE we can be asked about the development of the model of the atom and in particular about the Plum Pudding model and Gold Leaf experiment. This could come up as anything from 1-mark multiple choice questions to a 6-mark long answer.
For ease we can break the development of the atom into stages.

Stage 1: The Greeks – 460-370 BC (we do not have to know any of the dates)
Democritus was a Greek philosopher who was the first person to use the term atom. He thought that if you cut something in half with a knife and then cut the half in half and kept repeating this over and over, that eventually you would get a piece so small that you could not cut it. This is what he thought were the building blocks that everything in the universe was made from. He used the Greek word "Atomos" which mean indivisible (can't be cut into smaller bits) to describe these blocks – where we get the word atom from. This theory was the accepted model for over 2000 years!

Stage 2: John Dalton - 1803AD
John Dalton was the first to really adapt the theory of Democritus into a modern atomic model. Dalton put forward that each substance was made of a different atom. Which was a step in the right direction.

Stage 3: J. J Thomson – late 1800's AD
Nearly 100 years later, J. J Thomson carried out experiments and discovered the electron. This led him to suggest the plum pudding model of the atom. In this model, the atom is a ball of positive charge with negative electrons embedded in it - like currants in a Christmas pudding. In this model, positive and negative charges are distributed in the atom in no order. The figure shows the plum pudding model of the atom.



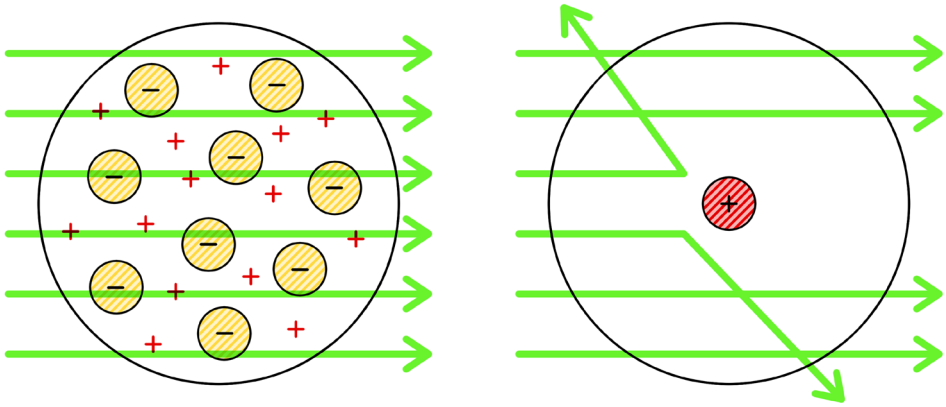
Stage 4: Ernest Rutherford – 1909 AD

Important exam note: the majority of questions on the development of the atom (not including multiple choice questions) in some way ask about Rutherford's experiment. Rutherford later went on to prove that protons exist.

In 1909 Ernest Rutherford designed an experiment to test the plum pudding model. In the experiment, positively charged alpha particles were fired at a very thin gold foil.

Description of the Gold leaf experiment.

1. Alpha particles were fired at a very thin sheet of gold leaf.
2. Most particles passed straight through unaffected.
3. Some particles were deflected and even fewer were reflected back.



Expected result Actual result

What could Rutherford conclude from this?

1. He concluded that the atom was mostly made of empty space. As most of the Alpha particles passed through unaffected.
2. The atom had a nucleus, an area where all of the positive charge was located.
3. The mass of the atom is concentrated at the centre (in the nucleus). Because the alpha particles bounced back, it proved they hit something incredibly heavy and dense.
4. The electrons orbited the nucleus.

But Rutherford didn't understand the order of electrons orbiting or why they weren't just pulled into the nucleus, as they were oppositely charged. This is where Bohr jumps in…

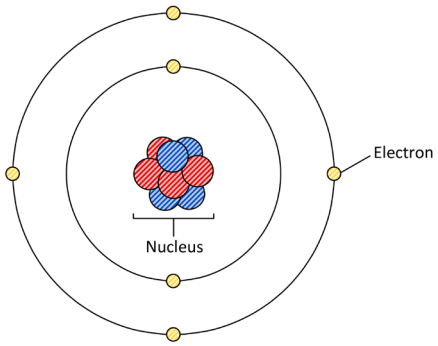
Stage 5: Niels Bohr – 1913 AD

Niels Bohr adapted Ernest Rutherford's nuclear model. Bohr conducted experiments that led him to suggest that electrons orbit the nucleus in shells.

The shells are at certain distances from the nucleus. His theory agreed with observations from experiments.

This is where we get the electron shells and the rules (2, 8, 8) from.

The figure shows an image of an atom of carbon.



The figure above shows nuclear model of the atom put forward by Bohr showing electrons in shells.

Stage 6: James Chadwick – 1932 AD

In 1932 James Chadwick found evidence for the existence of particles in the nucleus with mass but no charge. These particles are called neutrons.

This was the final piece of the puzzle that led to another development of the nuclear model, which is still used today.