Changing models of the atom

Specification references:

- 4.1.3 The development of the model of the atom
- WS 1.1, 1.2, 1.3, 1.6

Aims

You will be learning how the model of the atom changed as new discoveries were made.

Learning outcomes

After completing this worksheet, you should be able to:

- represent different models of the atom as they were developed
- explain how theories and models change in light of new discoveries and scientific understanding
- explain how technological advances can allow scientists to formulate new theories based on observations that were previously not possible to obtain.

Setting the scene

Scientific models and theories are tentative and are often refined when new discoveries are made. It is important to remember that all theories are based on the creativity of scientists who make observations about the natural world and suggest useful ways to explain the results they collect. So, although a scientific model might be very close to reality, they always rely on elements and ideas that cannot be observed directly but that are often inferred from the patterns in our data. If a new model is better at explaining a particular phenomenon and making predictions on how something behaves, it is often accepted by the scientific community and it replaces older theories.

Task

Read the description of how the model of the atom changed over time and draw a diagram to represent each model in the box next to each explanation.

Before the discovery of the electron

Some philosophers in ancient Greece believed that the atom was the smallest building block of everything. They thought it could not be divided into smaller parts.

The plum pudding model

When Thompson discovered the electron he also developed the plum pudding model of the atom in 1897. His model described the atom as a sphere of positive charge with negative electrons embedded inside it, like the raisins in a plum pudding.

Rutherford's experiment (1912)

In his famous experiment, Ernest Rutherford shot high-speed alpha particles through a thin layer of gold. Some alpha particles went straight through, some were slightly deflected (bent in their path), but some bounced back at very large angles. This seemed to show that most of the mass of the atom was concentrated in a very small nucleus that carries a positive charge. In Rutherford's model the electrons orbit around the nucleus at different distances.

Energy levels

Rutherford's model was adapted by Niels Bohr in 1913 by showing that the electrons in an atom could only orbit its nucleus at specific very distances (radii). This new model agreed with experimental measurements, so it was accepted as more accurate than Rutherford's explanation.

The proton

More experiments conducted in 1919 showed that the charge of a nucleus could be divided into a whole number of smaller charges called protons. Every proton had the same positive charge, so the nucleus was now seen as a concentration of protons at the core of an atom with electrons orbiting at discrete distances from the nucleus.

The neutron

Finally, Chadwick proved the existence of the nucleus in 1932. The mass of the nucleus was too large to be made only of protons, so scientists believed that another neutral particle was responsible for this additional mass. This particle was called the neutron and it is inside the nucleus of atoms with the protons.

Questions

1 a Why were so many models of the atom abandoned in favour of new models?

.....

..... (*2 marks*)

b Explain how the discovery of alpha radiation and other technological advances allowed a new model of the atom to be developed by Rutherford.

.....

.....

.....

..... (*4 marks*)

c How is Chadwick's model of the atom different from Rutherford's model? Explain your answer.

.....

.....

.....

.....

..... (*5 marks*)

d What are the similarities between Rutherford's model of the atom and Bohr's model? Explain your answer.

.....

.....

..... (*3 marks*)

2 **a** Why is it important to continue to develop better models to describe physical processes?

.....

..... (*2 marks*)

b What should a new model/theory do better than previous theories/models?

.....

..... (*2 marks*)

c Scientific models and theories change with new discoveries and understanding. What does this suggest about the nature of science?

.....

..... (*2 marks*)