The atom and the atomic models

Lesson plan and teacher's notes · Form 1 Chemistry · 1 period of 40 minutes

School	(write school name)	**Teacher**	(write name)
Date	(date)	**Class**	Form 1
Subject	Chemistry	**Enrolment**	Boys ___ Girls ___ Total ___
Time	40 minutes	**Topic**	The atom and the atomic models

Learners say what an atom is, explain atomic structure and atomic model, describe the models of Dalton, Thomson, Rutherford and Bohr in the order they were proposed, and build and label a Bohr model of hydrogen and carbon. Examples come from a seed model built by a group of learners in Luangwa.

Specific outcomes

By the end of the lesson, learners should be able to:

1. Say what an atom is
2. Explain what atomic structure and an atomic model mean
3. Describe the main atomic models in the order they were proposed
4. Describe Bohr's shell model of an atom
5. Build and label a simple Bohr model of an element

Prior knowledge

- Everything around us is made of matter
- The idea of a model as a picture of something we cannot see directly
- Counting and simple labelling of diagrams

Teaching and learning materials

- seeds, beads or small stones in three colours
- chalk and board
- exercise books
- pieces of paper or cardboard for the shells

References

Ministry of Education (CDC) Form 1 Chemistry syllabus and module; 25Schools learners' note: The atom and the atomic models.

Lesson development

Stage and time	Teacher activities	Learner activities
Introduction 5 min	Ask learners what the air, a cooking pot and a school desk have in common. Tell them that all of these are made of atoms and that scientists have used different models to picture the atom.	Suggest answers and copy the lesson title and key words.
Development: what is an atom and atomic models 10 min	Define atom, atomic structure and atomic model. Name the models in order: Dalton, Thomson, Rutherford, Bohr and the quantum model of Schrodinger. Say in one sentence what each scientist suggested.	Copy the definitions and complete a timeline of the five models in their books.
Development: Bohr's shell model 12 min	Draw the carbon atom on the board with 6 protons and 6 neutrons in the nucleus, 2 electrons in the first shell and 4 in the second. Work the hydrogen example step by step.	Draw and label the carbon and hydrogen atoms in their books.
Development: building and comparing models 10 min	In groups, learners build the carbon atom with seeds of three colours. Then ask them to compare Dalton's model with Bohr's shell model.	Build the model, label it, and discuss what each model explains well and what it leaves out.
Conclusion 3 min	Ask each group to name one scientist and say what he suggested. Set the homework.	Answer orally and copy the homework.

Teacher's content notes

Read these before the lesson. They are what you need to know, not what to copy onto the board.

What is an atom

An atom is the smallest particle of an element that takes part in a chemical reaction. Atoms are the building blocks of all matter. The arrangement of the sub-atomic particles inside an atom decides which chemical reactions the substance can undergo and how it behaves. The composition and layout of the sub-atomic particles in an atom is called its atomic structure. Understanding it helps us explain the chemical behaviour of substances.

Atomic models

An atomic model is a theoretical representation that describes the structure and behaviour of atoms. Over time, scientists have proposed several models as new evidence appeared. Dalton pictured the atom as a small solid particle that cannot be divided. Thomson showed that atoms contain smaller particles, the electrons. Rutherford proposed that most of the atom is empty space with a small, dense nucleus at the centre. Bohr then suggested that electrons move around the nucleus in fixed shells with set

energies. The quantum mechanical model, which came from Schrodinger's work, is the most modern

Bohr's shell model

In Bohr's model the protons and neutrons are in the nucleus at the centre, and the electrons move around it in shells. The shells are like layers around the nucleus. The diagram in the note shows a carbon atom, which has 6 protons and 6 neutrons in the nucleus, 2 electrons in the first shell and 4 electrons in the second shell. To show hydrogen, draw a nucleus labelled with 1 proton, draw one shell around the nucleus, and place the 1 electron on that shell.

Building and comparing models

In the laboratory the models can be built with materials such as seeds, beads, candies or styrofoam balls. Use different colours for protons, neutrons and electrons. When you compare Dalton's model with Bohr's shell model, discuss what each model explains well and what it leaves out, and what experiments the idea was based on.

Questions to ask during the lesson

Question	Expected answer
A teacher in Luangwa points to a cooking pot, the air in the room and a school desk and says that all of them are made of atoms. (a) What is an atom. (b) What does atomic structure mean. (c) Why is it useful to understand atomic structure.	(a) The smallest particle of an element that takes part in a chemical reaction. (b) The composition and layout of the sub-atomic particles in an atom. (c) It helps us explain the chemical behaviour of substances.
A learner reads that scientists have proposed several models of the atom over time and wants to explain this to her friend. (a) What is an atomic model. (b) Why have scientists proposed several models. (c) Name the scientists whose models are in the note, in order.	(a) A theoretical representation that describes the structure and behaviour of atoms. (b) New evidence appeared over time. (c) Dalton, Thomson, Rutherford and Bohr, then Schrodinger for the quantum model.
Two learners compare the ideas of Thomson and Rutherford before drawing them on the board. (a) What did Thomson show about atoms. (b) What did Rutherford propose about most of the atom. (c) Where did Rutherford place the dense part.	(a) Atoms contain smaller particles, the electrons. (b) Most of the atom is empty space. (c) At the centre, as a small, dense nucleus.
A group draws Bohr's model of an atom for a poster in their classroom. (a) Where are the protons and neutrons. (b) Where do the electrons move. (c) What are the shells like.	(a) In the nucleus at the centre. (b) Around the nucleus in shells. (c) Like layers around the nucleus.

Worked examples for the board

Example 1: the hydrogen atom on a Bohr diagram

How would you show an atom of hydrogen on a Bohr diagram? Hydrogen has 1 proton in the nucleus. Draw a nucleus labelled with 1 proton. Draw one shell around the nucleus. Place the 1 electron on that shell.

Example 2: the carbon atom

The note shows a carbon atom in Bohr's model. The nucleus at the centre holds 6 protons and 6 neutrons. The electrons move around it in shells: 2 electrons in the first shell and 4 electrons in the second shell. In total carbon has 6 electrons, because 2 + 4 = 6.

Example 3: comparing Dalton and Bohr

Dalton pictured the atom as a small solid particle that cannot be divided. Bohr suggested that electrons move around the nucleus in fixed shells with set energies. Dalton's model is simple but leaves out the smaller particles, and Bohr's model shows the nucleus and the shells.

Board plan

Write the title and key words. Left: the definitions of atom, atomic structure and atomic model. Centre: the table of the models in order. Right: the Bohr diagram of carbon with its numbers of protons, neutrons and electrons.

Scientist	Main idea
Dalton	The atom is a small solid particle that cannot be divided
Thomson	Atoms contain smaller particles, the electrons
Rutherford	Most of the atom is empty space with a small, dense nucleus at the centre
Bohr	Electrons move around the nucleus in fixed shells with set energies
Schrodinger	The quantum mechanical model, the most modern of these ideas

The atomic models in the order they were proposed

Mistakes to expect

Learners often think	Put it right
An atom is a solid ball that cannot be split.	This was Dalton's idea. Later evidence showed that atoms have smaller parts, so models changed.
Electrons are found inside the nucleus.	Protons and neutrons are in the nucleus. Electrons move around it in shells.
Once a model has been replaced, it was useless.	Each model was built on the experimental evidence of its time and has strengths and limits. Later models improved the picture.
A model of an atom shows the atom exactly as it is.	An atomic model is a theoretical picture that describes the structure and behaviour of atoms.

Differentiation

Learners who struggle

Give learners a ready-made table with the five scientists and ask them to fill in the main idea of each. For the Bohr diagram, give them the numbers for carbon and let them place the seeds one shell at a time.

Learners who finish early

Ask learners who finish early to explain why scientists keep changing the atomic model and what the new models were based on. They should also build a hydrogen model and compare it with carbon.

Hearing or visual impairment

For learners with visual impairment, build the model with seeds of different sizes and let them feel the nucleus and each shell. For learners with hearing impairment, write each scientist's name and idea on the board and point to the diagram while you speak.

No projector, no printing

Use seeds, bottle tops or small stones for the model, and draw the shells on the ground or on paper. Everything else can be done with chalk and the board.

If time is short

Teach the definitions and the order of the models, then draw the carbon and hydrogen atoms on the board. Leave building the models with seeds for the next lesson.

Evaluation

Question or task	A correct answer shows
A learner at a school in Luangwa is asked to draw a Bohr model of hydrogen on the board for the class. (a) How many protons are in the nucleus of hydrogen. (b) How many shells and electrons does the diagram need. (c) Where is the electron placed.	(a) 1 proton. (b) One shell and one electron. (c) On the shell around the nucleus.
Two learners in Lusaka discuss the atomic models. One says Dalton showed that atoms contain electrons, and the other says Thomson did. (a) Say which learner is correct. (b) Describe Dalton's picture of the atom. (c) Describe Rutherford's idea of the nucleus.	(a) The second learner, because Thomson showed that atoms contain electrons. (b) A small solid particle that cannot be divided. (c) Most of the atom is empty space with a small, dense nucleus at the centre.
A group builds a model of a carbon atom using seeds to explain the Bohr model to a younger class. (a) How many protons, neutrons and electrons does carbon have in the note. (b) Where are the protons and neutrons placed. (c) How are the electrons shared between the first and second shell.	(a) 6 protons, 6 neutrons and 6 electrons. (b) Together in the nucleus at the centre. (c) 2 electrons in the first shell and 4 in the second shell.

Homework

A group of learners in a village school builds a model of a hydrogen atom for a science fair, using one seed for the proton and one seed for the electron. (a) Where do they place the proton seed and the electron seed. (b) How many shells do they draw. (c) Name the scientist whose model they are using.

Extra practice with answers

Question	Answer
1. A group at a school in Luangwa builds a model of a carbon atom using green seeds for protons, red seeds for neutrons and blue seeds for electrons. (a) How many seeds of each colour do they need. (b) Where do they place the green and red seeds. (c) How do they place the blue seeds.	(a) 6 green, 6 red and 6 blue. (b) Together in the centre as the nucleus. (c) 2 blue seeds in the first shell and 4 in the second shell.
2. Two learners argue about the atom. One says an atom is a solid ball that cannot be split, as Dalton thought. The other says it has a small nucleus with electrons moving around it in shells. (a) Which learner is describing Bohr's model. (b) Explain why scientists changed from Dalton's model to later	(a) The second learner. (b) New experimental evidence showed that atoms have smaller parts, so the earlier ideas could not explain everything. (c) Build physical models of both, present them and discuss the strengths, weaknesses and experimental basis of each.
3. A learner in Lusaka is asked to draw hydrogen on a Bohr diagram and to say what is different from carbon. (a) How many protons and electrons does hydrogen have in the note. (b) How many shells does the hydrogen diagram need. (c) How many protons does carbon have in the note.	(a) 1 proton and 1 electron. (b) One shell. (c) 6 protons.
4. A class is asked to arrange the models of Dalton, Bohr, Thomson and Rutherford on a timeline before the lesson on atoms. (a) Give the order in which the four models were proposed. (b) Which model came from Schrodinger's work. (c) Which of the models is the most modern.	(a) Dalton, Thomson, Rutherford, Bohr. (b) The quantum mechanical model. (c) The quantum mechanical model.

Answers to the learners' check-yourself questions

1. What is an atom?
   The smallest particle of an element that takes part in a chemical reaction.
2. What is an atomic model?
   A theoretical representation that describes the structure and behaviour of atoms.
3. Name three scientists whose atomic models you have studied.
   Any three of Dalton, Thomson, Rutherford and Bohr (Schrodinger for the quantum model).

4. In Bohr's model, where are the electrons found?
   In shells around the nucleus.
5. Which two particles are found in the nucleus of Bohr's model?
   Protons and neutrons.
6. You are a learner at a school in Luangwa. Your group builds a model of a carbon atom using green seeds for protons, red seeds for neutrons and blue seeds for electrons. Carbon has 6 protons, 6 neutrons and 6 electrons. (a) How many seeds of each colour do you need? (b) Where do you place the green a
   (a) 6 green, 6 red and 6 blue. (b) Together in the centre as the nucleus. (c) 2 blue seeds in the first shell and 4 in the second shell.
7. Two learners argue about the atom. One says an atom is a solid ball that cannot be split, as Dalton thought. The other says it has a small nucleus with electrons moving around it in shells. (a) Which learner is describing Bohr's model? (b) Explain why scientists changed from Dalton's model to later
   (a) The second learner. (b) New experimental evidence showed that atoms have smaller parts, so the earlier ideas could not explain everything. (c) Build physical models of both, present them and discuss the strengths, weaknesses and experimental basis of each.

Teacher's reflection

What went well:

What I will change next time:

Learners who need follow-up: