Historical Models of Atoms

Strand Matter

Topic Investigating historical models of atomic structure

Primary SOL PS.3 The student will investigate and understand the modern and historical models of atomic structure. Key concepts include
a) the contributions of Dalton, Thomson, Rutherford, and Bohr in understanding the atom.

Related SOL PS.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
k) research methods are used to investigate practical problems and questions.

Background Information

The modern model of the atom was built on contributions of many scientists in the past. The first person to theorize about the atom was Democritus in 400 B.C. (B.C.E.). He thought that the smallest unit of matter was the atom. It wasn't until the early 1800s A.D. (C.E.) when John Dalton proposed a concept involving a Billiard Ball model that demonstrated atoms as solid indivisible particles. Nearly a century later, J. J. Thomson introduced his Plum Pudding model of the atom. In Thomson's model, negatively-charged particles are imbedded in a positive sphere. In 1911, Ernst Rutherford performed an experiment in which he bombarded a piece of gold foil with alpha particles. Some particles passed through the foil, but some positively-charged particles were deflected. That led to Rutherford's model in which atoms are mostly empty space with a small positively-charged nucleus. A few years later, Niels Bohr developed the planetary model of the atom. Bohr theorized that electrons travel around the nucleus of an atom in certain circular paths or orbits, similar to the way planets orbited the sun. The most widely accepted modern model of an atom, the Electron Cloud (Quantum Mechanics) model, was developed by a group of scientists in the 1920s. In this model, electrons do not follow orbits around the nucleus but move freely in different clouds around the nucleus.

Materials

- Computer with Internet access
- Paper

Vocabulary

atom, Electron Cloud model, Ernst Rutherford, J. J. Thomson, John Dalton, Niels Bohr,

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

1. Have students research the major historical models of atomic structure. Ask the students to create a chart to organize the information they need to collect for each of the atomic models. Have them answer the following questions and draw a picture of each model below:

John Dalton
- When did John Dalton propose his atomic model?
- What is Dalton's model called?
- How would you describe Dalton's model of the atom?

J. J. Thomson
- When did Thomson propose his atomic model?
- What is Thomson's model called?
- How would you describe Thomson's model of the atom?

Ernest Rutherford
- When did Rutherford propose his atomic model?
- How would you describe the Rutherford model?
- What were the events of the Rutherford experiment that led to the creation of his atomic model?

Niels Bohr
- When did Bohr propose his atomic model?
- What is Bohr's model called? (Multiple answers are possible.)
- How would you describe Bohr's model of an atom?

Electron Cloud
- Who contributed to the Electron Cloud model of an atom?
- What is another name for the Electron Cloud model? (Multiple answers are possible—but Quantum Mechanics model should be mentioned.)
- How would you describe the Electron Cloud model?

2. Have students share their findings and drawings with the class to ensure that all students have similar results.
3. Hold a class discussion to allow students to compare and contrast the various models.

Assessment

- **Questions**
  - How were scientists able to develop a theory of the atom when atoms were not visible?
  - What are the main differences between the Thomson and Rutherford models?
  - How are the Rutherford and Bohr models similar?
- **Journal/Writing Prompt**
  - Write a paragraph comparing and contrasting the Bohr and Electron Cloud models. Include at least two similarities and two differences.

Extensions and Connections (for all students)

- Have students create timelines showing the various historical models of atoms.
- Have students research the contributions and models created by Democritus, Hantaro Nagaoka, James Chadwick, A. L. Parson, and Joseph Lucas.

Strategies for Differentiation

- Have each student create a foldable display of the five historical models of the atom discussed in the lesson. Have them arrange their models in order from oldest on the left to most recent on the right.
- Have students create podcasts/videos of interviews with "scientists" describing their historic atomic models. Divide the class into five groups, and have one student in each group role-play as the scientist while the others act as reporters collecting information about the scientist's model. The Electron Cloud model should include a panel of three contributing scientists and two reporters. Once all interviews are recorded, replay the videos/podcasts for all students to view and collect information on the various models.
- Conduct a memory/matching game, using index cards. Groups should be assigned the development of sets of cards based on different scientists or models. The name of a scientist should appear on a single card in each set. The other cards in the set will list corresponding information about that scientist's model. The objective of the game is to match scientists with the corresponding information about their models.
- Have students create posters that include the name and representation of each model.
- Have students conduct Internet research on the Particle-Wave Duality model and prepare short presentations on their findings to present to the class.