ScienceNews

Activity Guide for Students: Dig Into Atomic Models

Directions:
In this activity, you will learn about classic models of the atom and how views of atomic structure changed over time as scientists did more experiments and made new discoveries. You will also learn about the standard model of particle physics and brainstorm ways that it might be visualized in two or three dimensions.

Based on decades of research, the standard model is a well-established theory in particle physics that describes elementary particles and how they behave with each other.

The elementary particles do not contain any smaller components. The electron is an example of an elementary particle. But protons and neutrons, the subatomic particles that make up the nuclei of atoms, are not elementary particles. Scientists used to think they were — until physicists discovered that protons and neutrons are made up of even smaller particles called quarks.

There are 17 fundamental particles in the standard model, a fact that would surprise physicists who lived in the early part of the 20th century. For them, all matter was made up of protons and electrons.

This activity takes place over three class periods and includes homework.

The setup
Before the first class, read the online *Science News* article "How matter's hidden complexity unleashed the power of nuclear physics" and answer these three questions. Be prepared to share your answers in class. A version of the story, "Cracking the atom," appears in the April 10, 2021 issue of *Science News*.

1. What is an atom and why do we care about its structure?

2. Why has the model of the atom changed over time?

3. What are some practical implications of knowing the structure of the atom?

First class

Your teacher will divide the class into groups, and each group will be assigned a classic model. The models are named Dalton, Thomson, Rutherford, Bohr and Schrödinger — the last names of five physicists.

In class, your group will research your assigned model and begin preparing a 5- to 7-minute presentation that you will give to the class.

For homework, you or your group will build a physical model of the assigned model. (Your teacher will tell you whether model building should be done individually or by the group.) Models will be part of the group presentation.

Think carefully about the components of the model and how you want to represent each of them. Use materials from home or the classroom. Have fun and be creative. Just make sure you can carry the model to school.

Use the following questions to develop your presentation and build your classic model.

1. What other names have been used to describe the model assigned to you, and why did the model receive the names it did?

2. When was your assigned model developed?

3. Although each classic model is named after the scientist who proposed it, these scientists either worked with or were influenced by other scientists. Name some of the influencers.

4. What discovery or new evidence led to the development of this model?

5. How is the model that you were assigned different from previous models?

6. Are there places your assigned model is still used. and where have you seen it before?

Second class

At the start of class, your group will finalize its presentation and do any last work on the model. If the members of your group each made a model, you will have to agree on which model to use in the presentation. It might be that your group decides to show more than one model if the models focus on different, but equally important points.

Before presenting, agree on who in the group will say what.

Third class
During this session, your teacher will discuss the standard model of particle physics. Then, the class will brainstorm ways that the standard model could be shown in two or three dimensions.

This is a complex subject. If you would like to read more about the standard model before class, you can read CERN: The Standard Model and DOE Explains...the Standard Model of Particle Physics.

The following questions will be covered in class.

1. What is the standard model of particle physics? What are some key things to know about the standard model?

2. How is antimatter different from matter? Give an example of each.

3. Who developed the standard model of particle physics?

4. When was the standard model developed?

5. Are there any other common names for the standard model?

6. What discoveries or ideas contributed to the standard model?

7. How is the standard model different from the classic models you have studied?

8. What are some weaknesses of the standard model?

9. What visual depictions of the standard model have you seen, and what do you think of them?

10. If you were doing a 2-D or 3-D visualization of the standard model, would you include all of the known elementary particles? Why or why not?

11. Describe how you would depict the standard model.

12. How would you convey the interactions among the various elementary particles?