

The Structure of Matter

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7th Grade Integrated Science

Standard 1: Students will understand the structure of matter

Objective 1: Describe the structure of matter in terms of atoms and molecules.

1d: Describe the limitations of using models to represent atoms

1e: Investigate and report how our knowledge of the structure of matter has been developed over time.

ILOs:

1. Use Science Process and thinking Skills

a. Observe objects and events for patterns and record both qualitative and quantitative information.

f. Distinguish between factual statements and inferences.

5. Demonstrate Awareness of Social and Historical Aspects of Science.

c. Understand the cumulative nature of the development of science knowledge.

d. Recognize contributions to science knowledge that have been made by both men and women.

Time Need to Complete Inquiry is two 45-minute class periods on Rutherford. If you do the introductory activity there is an additional 45-minute class period. If you do the follow-up activity on the timeline, then another 45-minute class period will be necessary. (Total of three hours class time).

Inquiry question: What are the properties of the interior of your sphere?
This is a structured inquiry.

Prior Knowledge Needed: Knowledge from the first day's lesson on the timeline of the model of the atom as well as a definition of models and why they evolve over time. (First day's lesson included at the end).

Introduction: Present each group of students with their clay sphere and their investigative tools (toothpicks). They should investigate the sphere to see if anything is inside. If they find something, they should try to determine its size, shape and location. Explain that this is a type and shadow of a true experiment by a famous scientist.

Materials: Clay spheres that have been previously molded by the teacher, spheres measuring approximately 5 cm in diameter, with a marble, die, or penny in the middle, 10 or so toothpicks, and tools for recording their findings. The penny tends to be more challenging. If you have an advanced group they may enjoy the challenge. A struggling group, however, may be frustrated or have a difficult time locating their object.

Procedures:

1. Place the materials in front of the students and introduce the idea.
2. Present the rules
 - a. The tools may only be used as probes
 - b. The clay sphere can not be dismantled in any way
 - c. You can only use the tools you were given
3. Investigate the interior of your sphere by inserting the toothpicks into (or through) the sphere. If you find anything inside, try to determine its size, shape and location.
4. Record your findings.

Data Collection: Students will make a visual representation of their findings showing the results of their probes in their spheres.

Data Analysis: By analyzing the visual clues of the probes in their sphere, students will make inferences about the sphere's interior. This will be accomplished by group discussion. Conclusions need to be drawn as a group. Remind them to stick to the facts as much as possible. They then need to draw a model of the sphere's interior showing the size, shape and location of anything found. They then need to express their thoughts in writing.

Assessment: Each group will present their finding to the class with their large group whiteboard. They need to present the visual representation of their model.

Introductory lesson on the Evolution of the Atomic Theory

-Give each students a small piece of paper (Sticky note works well)

Ask the question – Is this made of matter?

Go back to the definition and conclude.

Ask the students to tear off the smallest piece of paper that they can. Keep telling them to tear it smaller until they have the smallest piece possible.

Discuss.

-Introduce that in 440 BC the Ancient Greek philosopher, Democritus proposed the existence of atoms. The name atoms is derived from the Greek word, "atomos" which means "indivisible" or "uncuttable". At this time in history many philosophers were debating the topic of matter and what it was made of. Democritus' theory was beyond human experience and no one could see it or prove it. This first atomic theory was insightful, but most at the time did not accept it. Discuss what a model is and why they could not develop certainties about matter. Fill in his information on the timeline.

-Show the students a pool ball. Tell them that several hundred year later (1766-1844) Democritus' theory was revived by John Dalton. After experimenting with gases, he came to believe that all matter was composed of atoms. His proposed model was a sphere like this solid billiard ball that couldn't be created, altered, or destroyed. Fill in on the timeline.

-Give each group a blueberry muffin. Tell them to think of this as a model of an atom. Have them pay particular attention to the blueberries. What things are different or important about this model? After they have come to some conclusions, introduce the theory of J.J. Thomson in 1898. Share his story: He experimented with electrical currents past charged metals. Due to the bending towards the positively charged plates, he proposed that atoms had negatively-charged particles. Not knowing the location of these particles, he theorized that they were spread evenly throughout in a spongy-type material. Fill in Thomson's information on the timeline.

Go through the inquiry lesson on the clay spheres.

Follow-up lesson to the inquiry lesson on Rutherford:

-Put up the overhead picture of Rutherford's gold foil experiment and discuss what the results of his experiment were.

Emphasize:

1-Alpha particles were fired at a sheet of gold foil.

2-Most went straight through, but some came back.

(Compare it to firing bullets through a bale of straw with a cannon ball inside. Most of the bullets would go through the straw, but a few would hit the cannon ball and be deflected).

Ask how this information is related to their investigation. What would it mean?

Discuss what conclusions could be drawn from his experiment. Have them record that he concluded that atoms must have a dense, positively-charged nucleus in order to have a deflection of that magnitude. There must be a concentrated mass with a charge. Ask the questions:

-Were his conclusions logical? Why?

-Was there absolute proof? Why? Like you, was he able to determine the size, shape and location of something in the interior of a sphere?

Let them get their sphere from the previous day and have them cut open.

Were your findings completely accurate?

Discuss again the difficulty of developing models with investigations and why the model of the atom is an evolving process.

-Fill in the information on the timeline about Niels Bohr. He had worked under J.J. Thomson and Ernest Rutherford. He had further studied the behavior of electrons. In 1913, he said that electrons revolved around the nucleus in orbits, circular paths. Their energy levels determined their orbits. Fill in timeline.

-1920s. Electron cloud model was developed. This model suggests that electrons surround the nucleus, but they don't travel in specific paths. They travel in regions or thicknesses called clouds. They oscillate around the nucleus. Fill in timeline.

In conclusion –ask– Do you think this model will change? Why or why not? What would be needed to make changes in the model? (Emphasize that results from new experiments will be needed to make changes in the model).

Timeline of the Model of the Atom

Democritus	John Dalton
J.J. Thomson	Ernest Rutherford
Niels Bohr	Current Model