Classroom VIDEO

Teacher's Notes

THE HISTORY OF THE ATOM

Years: 6-9

Duration: 22 mins

Program Summary

This program explores the history of the atomic theory. Before Chemistry, there was Alchemy. For thousands of years, people tried converting other elements and compounds into gold.

This was because gold was valuable, and its value principally came from the fact that it was scarce.

And so, the quest for gold began. Meanwhile, there were those in the quest for knowledge.

Empedocles had a rather vague idea that all things consist of Earth, Fire, Air and Water. According to his theory, fire and water combined to make steam, earth and water combined to form mud, and fire and earth combined to make lava.

Leucippus theorized that we are made up of small, hard particles. These were called Atoms, which mean indivisible. He argued that atoms were like the tiles in a mosaic. There are only a set number of types of little tiles, but the combination of these tiles creates all sorts of different pictures.

He thought that atoms were made of the same material but had different sizes, and this gives us the different subtleties in different substances.

Centuries later, Aristotle, the greatest scientist of Antiquity came along.

Aristotle argued that if the spheres were packed tight to make a solid, there would still be unfilled spaces in between. He argued that these unfilled spaces would be a vacuum, and dismissed the theory because of his belief that nature abhors a vacuum. One of Aristotle's weaknesses was that he thought that you could use logic and reasoning alone to study nature. He didn't really like doing experiments.

For 1600 years, the best minds of the Arabic world and the European world tried to change lead into gold without investigating what they were trying to do. All the while, they held that matter consisted of air, water, fire and earth.

There were two main reasons for this. The first was their 'paradigm'. A paradigm is the way we frame our thoughts and ideas, a way of looking at things. Basically, the ancients did not check their ideas with experiments. Instead, they took the word of people who hadn't done any experiments either.

Questioning idea was discouraged. In fact, having questions altogether was discouraged.

Although the alchemists were doing experiments, their framework, their paradigm, was that lead could be turned into gold, without really understanding if this was possible at all.

The other main reason was that alchemy was clouded in secrecy, no-one shared their results, or even their methods.

In the Renaissance people started to ask questions and check with experiments. This was a new way of thinking. Slowly, people began trying to make things from the glorious past; checking which ancient ideas worked and which didn't.

With the arrival of the printing press, knowledge began to belong to the people. People who were willing to share the information they had now could do so, through the amazing new technology of printed books.

In the 1600s, using vacuum pumps and known quantities of gasses, Robert Boyle figured out that gasses were particles that moved, exerting pressure like these marbles in a box.

Isaac Newton showed this principle mathematically. If the particles are balls with mass and speed, then when they hit the walls and bounce back, they exert pressure.

Boyle and Newton showed that tiny particles must exist. They could see that purified substances consisted of the same particles, which Boyle called elements.

In the 1700s, the French scientist Lavoisier showed that nothing could combust without one particular element, Oxygen. He also showed that metals increase in mass when heat is applied because they absorb oxygen.

Scientists gradually worked out what were elements and what were compounds. By the middle of the 19th century, the Periodic Table was gradually filled in.

In 1808, after doing experiments with Nitrogen and Oxygen, John Dalton published the following ideas in his book, 'A New System of Chemical Philosophy';

1) The Chemical elements are composed of very minute particles of matter called Atoms, which preserve their individuality in all chemical changes.

2) All the atoms of the same element are identical in all respects, particularly in *weight*. Differing elements have atoms differing in weight. Each element is characterised by the weight of its atom.
3) Chemical combination occurs by the union of the atoms of the elements in simple numerical ratios.
Dalton's book was important in that it established the atomic theory for subsequent experiments. Through this process, people learnt that the reason why lead could not be turned into gold was that both were elements, and one element could not be chemically converted into another element. So the alchemists' question was finally answered.
By 1900, there were 2 models of the atom. One was the plum pudding, with electrons floating in a positive charged region. The other model was the electron moving in orbit of a positive nucleus.
By then, most scientists accepted the Atomic Theory of matter. It was the beginning of investigating what makes up atoms.

Timing Information (set VCR to 00:00)

Min	Topic
00:02	Start
01:56	Ancient Babylon - Gold
02:30	Ancient Greece 5th cent. BC
02:44	Empedocles and Leucippus
04:19	Aristotle 384-322 BC
05:30	Epicurus 342-270 BC
07:36	Leucretius circa 95 BC
09:09	Dark Age alchemy
13:35	Paris 1641 AD Pierre Gassendi
14:51	1661 AD Boyle & Newton
15:56	1774 AD Joseph Priestly
16:48	Antoine Lavoisier
18:42	1803 John Dalton
21:19	End credits

Suggested Activities

A. Create a scaled time-line of the history of the atom. Include the following information:
i. Year or era
ii. Name of the person/people proposing a theory
iii. Brief explanation of the theory proposed.

B. Research the contributions made by the following scientists into the structure of the atom:
i. Thompson
ii. Rutherford
iii. Bohr
The research may be presented to the class in the form of an oral presentation, poster, or a re-enactment/role play.

C. Students could create a 3-dimensional model of the atom (either Dalton's, Thompson's, Rutherford's or Bohr's model) and explain its structure to the class. This could be an extension to **activity B**.

D. Experiment: Students could demonstrate the problems associated with Joseph Priestly's work by measuring the mass of the metal magnesium before and after burning it in a crucible.

E. Students could demonstrate Dalton's theory about chemical reactions between elements by using molecular model kits to build different compounds given the ratios of the elements making up the compound. Students could draw the shapes of the compounds constructed and label the elements involved.

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Student Worksheet

1. What was the branch of science called prior to chemistry?

ANCIENT BABYLON

2. What did the Ancient Babylonians discover when you mix certain metals together? Give ONE example of this discovery.
3. Why was this discovery of particular interest to the Ancient Babylonians?

ANCIENT GREECE 5th CENTURY BC

4. What 4 things did Empedocies believe everything was made up of?
5. Give ONE example of Empedocies idea.
6. Leucippus did not agree with Empedocies idea. What did he propose instead?
7. How did Leucippus describe atoms?

ARISTOTLE (384-322 BC)

8. Why did Aristotle not agree with the "Atomists view of the world"?
9. What did Aristotle not like doing?

EPICURRUS (342-270 BC)

10. What was Epicurrus known as?
11. Why was Epicurrus's 'theory of matter' not widely accepted by his critics?
12. What did his critics believe?

LUCRETIUS (circa 95 BC)

13. Whose work inspired Lucretius to describe the nature of matter?
14. What did Lucretius propose, and what was his problem with this theory?

DARK AGE ALCHEMY

15. 1600 years were spent trying to turn lead into gold. What were some of the major problems with the ancient's lack of progress during those years?
16. What happened during the Renaissance that encouraged progress in the study of matter?

PIERRE GASSENDI (Paris 1641 AD)

17. Whose work did Pierre Gassendi study and with whose ideas did he disagree?
18. What was Gassendi's philosophy about atoms and how did this help the intellectuals?

ROBERT BOYLE & ISAAC NEWTON (1661 AD)

19. What did Boyle and Newton use in their studies of matter?
20. What did they discover?

JOSPEH PRIESTLY (1774 AD)

21. What did Priestly experiment on?
22. What did he think 'phlogiston' was?
23. What was the problem with Priestly's ideas on phlogiston?

ANTOINE LAVOISIER

24. What did Lavoisier believe this 'de-phlogisticated' air that Priestly talked about really was?
25. What did his work show?
26. Lavoisier conducted combustion experiments using tin. What did he discover? Provide an example of this process.
27. What understanding did Lavoisier's work lead to?

JOHN DALTON (1803 AD)

28. What two elements did Dalton study?
29. What did he believe both elements were made up of?
30. What did he believe about all the atoms within a particular element?
31. How did he believe chemical reactions took place between the elements?
32. Why was Dalton's work important?
33. What was the reason for why lead could not be turned into gold?

MODELS OF THE ATOM

34. Describe the 'plum pudding' model of the atom. Draw a diagram representing this model.
35. Describe and draw a diagram of the other model of the atom?