



What Is Stuff Made of?

NC Standards PS.8.1

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Activity Description & Estimated Class Time

Students will use one 50-minute class period to view the world of chemistry as the ancients did and analyze materials based on an early theory.

Correlations to NC Science Standards

PS.8.1 Understand the properties of matter and changes that occur when matter interacts in open and closed systems.

Learning Targets

Students will consider what things are made of by asking questions in the same way that people in early cultures did. Questions include:

- What are the smallest bits of things?
- If more than one kind of part makes up a thing, what are those parts?
- What can we consider as evidence for identifying unseen constituent parts?

Students demonstrate this knowledge and understanding by analyzing common materials to determine their composition of earth, air, fire, and water.

Brief Science Background

Long ago, ancient people of many cultures looked at the world and tried to figure out what things were made of. They began with simple questions such as, “If you cut a piece of cheese in half, and divide a resulting piece in half again, and keep doing that, can you keep dividing it until what is left is no longer cheese?” One early idea they had was that some combination of four basic elements - Air, Earth, Fire, and Water - makes up everything. The ancients developed this idea from looking at the world just as scientists today develop theories from evidence and observations. The ancients noticed that a piece of wood that burned produced fire, smoke (air), and ash (earth). From that, they thought that wood must be made of some proportion of fire, air, and earth. They noticed that oil used in lamps is liquid like water, and it makes fire and smoke (like air) when it burns, so it must be made of some combination of water, fire, and air. This idea lasted thousands of years and appeared among many different kinds of people all around the world. Early alchemists were especially interested in what matter is made of because they were working feverishly to find ways to change cheap metals like iron and lead into gold.

Common Student Preconceptions

Children have difficulty distinguishing between elements, compounds, atoms, and molecules for reasons having to do with basic language. For example, elements are described as “pure” substances, meaning “made of only one thing.” For many children, the term “pure” means “without harmful contents,” or “clean, bright, and as-it-should-be.” In addition, children have difficulty with the idea of “substance.” For example, some middle school children see ice and water as different substances. In general, most children understand matter in a macroscopic way, not at a microscopic level. As a result, they tend to view chemical combination as a kind of mixing, with only a hazy idea of microscopic internal chemical bonds. For example, many think that burning is like evaporation, only faster because of the heat. Although they know that oxygen is necessary for combustion, they have little or no sense that it is interacting with the material that is burning.



The Four Elements

Materials

Materials for the whole class

- science notebooks (supplied by teacher)
- SD 1 to project for the whole class (optional)

Procedure

1. Explain the ideas presented in the Science Background section to the class, either verbally, or if you prefer, project and read SD 1 as an option.
2. Present the whole class with examples of natural things to analyze for these four elements that might make them up: a potato, a rock, a coin. Ask them to analyze these things thinking as an ancient person and give their evidence for their analysis.

potato

is wet when cut so it must have water
can burn so has fire
produces steam when hot and cut open so it has air
turns to ash when burned so it has earth

rock

no water in it
can't burn, so no fire in it
falls in air, so no air in it
only made of earth

coin

can't burn, so no fire
melts in heat, so must have some water
makes no smoke or bubbles, so no air
heavy like earth, so it must have earth

3. Challenge pairs of students to think of three natural objects and use the four element approach to describe what they could be made of.

Content Connection

Ask volunteers to present their analysis and accept all answers.

After this discussion, point out that people began to see limitations of the four element system. For example, lead and gold were both made of earth and water, and the model didn't explain the differences. Early alchemists were eager to get rich, so they worked very hard to turn metals such as lead into gold. They never did make gold from lead, but their hard work produced some discoveries about matter. Over a long period of time, as they developed better systems to classify what matter was made of, their work began to look a little more like the science we know as chemistry. Over time, chemists began to make more things that people needed, such as dyes and gunpowder. As we will see, chemists now have models that work well to explain how matter interacts, and people continue to explore what stuff is made of.

SD 1

Ancient people of many cultures looked at the things around them and tried to figure out what those things were made of. They asked questions such as, “If you cut a piece of cheese in half, and divide each resulting piece in half, and keep doing that, can you keep dividing until you are left with something that is no longer cheese?” They thought that things might be made of basic parts that are too small to see. One reason they worked so hard on this was because they wanted to get rich. They thought they might be able to rearrange the tiny basic parts of things to turn a cheap metal like lead into gold. People doing this were called alchemists.

The alchemists had an idea that four basic elements make up everything: Air, Earth, Fire, and Water. Ancient people got this idea from looking at the world around them, just as scientists today explain what they see using evidence collected from observations. The ancient people noticed that burning wood made fire, so it must have fire in it. They noticed that ashes were left over after the fire. The ashes came from the wood and ashes are like earth. They saw that burning wood made smoke, and smoke is like air. From this, they thought that wood must be made of fire, earth, and air. Thinking in this way, they noticed that oil burned in lamps is liquid, so it must have water. Because it burns, it must have fire. It makes smoke, so it must have air. Ideas like this lasted for thousands of years. People in different parts of the world came up with very similar ideas about this, even though they did not talk to each other.