

What makes up “stuff”?

Look around you. You might see a table, chairs, walls, pictures, and people. What are all of these things made of? You might think the answer is easy. The table is made of wood, but what is wood made of? “I know, I know!.....a tree”. Well, what is a tree made of? The questions never stop. This story is about how human beings have tried to figure out just what makes up “stuff” (matter).

The story is over 2,500 years old. The ancient Greeks were some of the first people to think about this question. The key word here is “think”. The Greek citizens who thought about these questions were upper class citizens. Getting their hands dirty to test an idea was below their rank.

Two of these Greek thinkers, Democritus and Aristotle, had different ideas about what makes up stuff (matter). Democritus and his teacher, Leucippus, believed that all things were made of very tiny pieces called particles. However, a much more famous thinker, Aristotle, disagreed. Aristotle and Empedocles thought everything was made of different amounts of fire, earth, air and water. Because of Aristotle’s reputation, his ideas were favored for almost 2,000 years.

- **We do not use Aristotle’s ideas in science any more, but people liked his ideas for 2,000 years. How do you think reputations can cause scientists to be biased?**

During the Scientific Revolution of the 1600’s, Rene Descartes of France supported Aristotle’s view of the four elements. However, two English scientists, Isaac Newton and Robert Boyle supported the ideas of Democritus – that all matter is made of small particles. Boyle wrote two books on the subject and Newton mentioned the idea in many of his papers.

In 1643, Evangelista Torricelli from Italy added support to the particle idea. He demonstrated that air has mass and can push down on liquids with great force. Then, the Swiss mathematician, Daniel Bernoulli, explained the observations by claiming even air is made out of very tiny particles, just like water or stone. These particles are what give mass to matter. In air, the particles are just more spread out.

In the late 1700’s, a French scientist named Antoine Lavoisier observed that when two chemicals were mixed, the amount at the start always equals the amount at the end. He explained his observation using the particle idea. He said that particles can change form, but cannot ever go away.

- **How is Lavoisier’s approach to studying nature different from Democritus’ strategy?**

In the early 1800’s another English scientist, John Dalton, observed that the amount of water in the air depends on how hot the air is. He explained his observations using the particle idea. Hotter particles move faster, so they can hold up more water.

