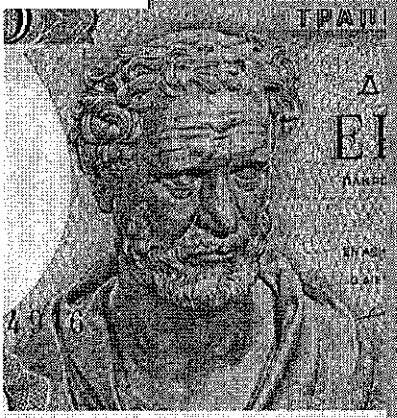
What Is Everything Made of?

Many people love the taste of salt. Since ancient times, people have added salt to their food to enhance flavor. But what is salt? What is salt made of? To that end, what is anything made of? Early thinkers pondered these questions.

Four-Element View of the World

Before the invention of microscopes, we had a limited view of the world. People could not conceptualize things that were too small to see, but they noticed that some things changed. Fire burned wood into ash. Water would boil away. Plants grew from earth. People breathed air. These observations led early scientists to classify what they saw into four building blocks: fire, water, earth, and air. They called these building blocks "elements." Others challenged this four-element notion, imagining even smaller pieces. This idea led to the theory that all matter was made of tiny particles.

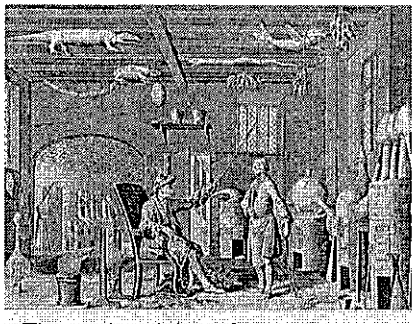


Greek philosopher Democritus suggested matter was made of atoms.

Changing Perspectives of the Atom

The Greek philosopher Democritus named the tiny particles everything was made of "atoms." Although Democritus had no way to test his theory, he was correct. Today, we know atoms are the building blocks of matter.

Because scientists did not have instruments to see atoms, Democritus' ideas were forgotten for many centuries. Instead, people tried to understand matter through the four elements. Experimenters (called alchemists) tried to make gold from lead. Doctors believed they could treat disease by balancing the four elements in the body.



The early origins of chemistry related to alchemy.

Over time, society's definition of elements changed. By the Renaissance, alchemists had isolated chemicals from matter. They realized they could not break down some substances, such as lead and copper. Scientists called these substances elements. Scientists combined elements to make new substances, which they called compounds. Thus, the

science of chemistry was born.

Chemists searched for the rules of how elements combined to make compounds. Why would some elements react explosively? Why would some elements not react at all?

The Development of the Atomic Model

To answer these questions, scientists returned to the atomic model. John Dalton, a 19th-century English chemist, proposed that all elements were made of atoms. His breakthrough idea was that each element was made of a unique type of atom. For example, an atom of lead was different from an atom of gold.

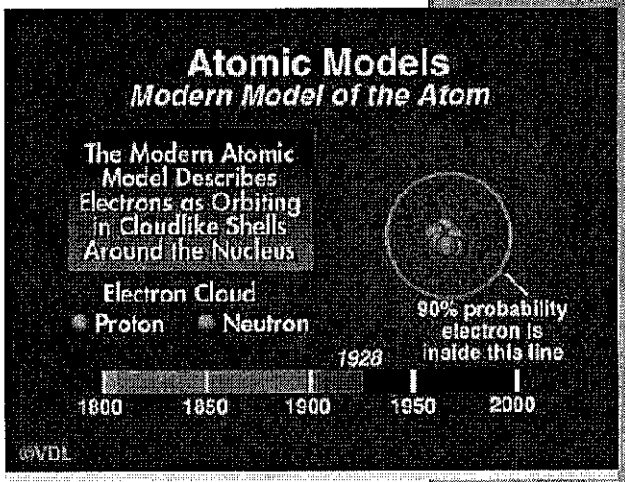
Dalton correctly suggested that each element's atoms are identical. He based his theory on the way elements combined into compounds. Dalton could not look inside an atom and did not fully understand atomic structure. Despite this, his ideas inspired more than a century's worth of research and scientific thought into the properties of atoms.

Marie Curie won two Nobel Prizes for her research into radioactivity.

Many technological advances occurred in the late 19th and early 20th centuries. These advances allowed scientists to peer inside an atom. Ernest Rutherford was researching radioactivity. Wilhelm Röntgen discovered radioactivity. Marie Curie was the first person to isolate radioactive elements. Radioactivity changed understanding of science at the time because it proved that atoms could be broken apart. It also had an impact on society through technologies varying from X-rays to nuclear power plants.

Ernest Rutherford's method was to fire a beam of positively charged alpha particle radiation at gold foil. A detector on the other side of the gold emitted a flash of light when struck by an alpha particle. At this time, scientists pictured atoms with evenly spaced positive and negative charges. Rutherford's team found that some particles deflected much more than expected. The best explanation was that gold atoms had a positively charged nucleus that deflected the alpha particles. Rutherford's work changed scientific thought by indicating that atoms had parts.

Scientists conducted additional investigations throughout the 20th century; Niels Bohr improved upon the atomic model. Bohr's model included a central nucleus of protons and electrons. He also proposed that electrons orbited the nucleus. Scientists realize the world on an atomic scale is a very strange place; physical laws are quite different on the atomic scale. Subatomic particle movement and location cannot be described accurately. Particles pop in and out of existence. To explain these observations, scientists developed quantum mechanics. Quantum mechanics is the foundation of modern physics and chemistry.



With quantum mechanics, we can understand how many modern devices work. We can explain how radios, televisions, microchips, and nuclear bombs function. We can also understand more about nature, including how stars get their energy. Scientists also understand that salt is a compound made of the elements sodium and chlorine; however, they have yet to explain why salt makes pretzels taste so good.

Comprehension Questions

1. How did scientific research impact our understanding of the atom?
2. Throughout history, scientists have had different ideas about the structure of the atom. How are these ideas related? Give an example.

Annotating

"Article Title"

! = WOW = This is amazing! Hard to believe

? = What = This is hard to understand

X = DQ = This would make a great discussion question

Connections = TS → Text to Self
= TT → Text to Text
= TW → Text to World

Do this for each main section