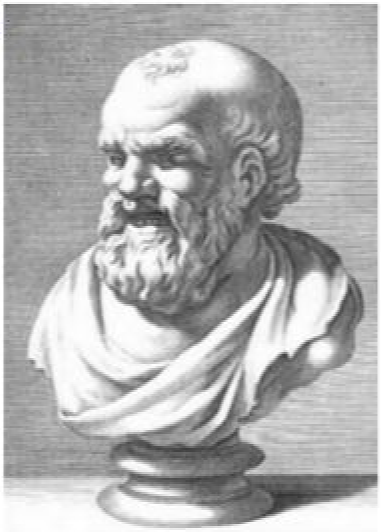
Democritus



The things we know about atoms today were discovered by many scientists over a long period of time. In fact, the first person to hypothesize that atoms exist was Democritus. Democritus was a Greek philosopher who lived in the fourth century BC (around 440 BC). He suggested that everything in the universe was made of tiny, indivisible units. He called these units "atomos". Atomos means "indivisible" or "unable to be cut or divided." He thought that if you cut objects in half repeatedly, you'd eventually end up with a tiny particle that can't be divided anymore.

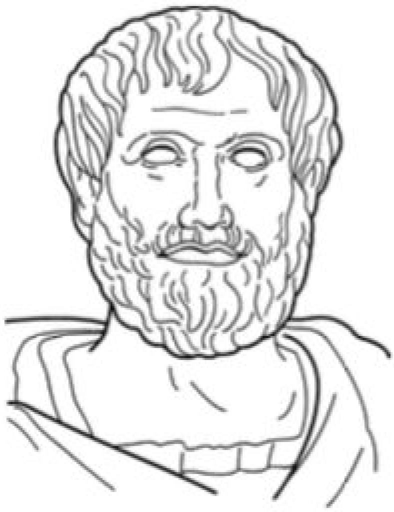
Democritus was the first to propose that the universe is made up of tiny, indivisible units called atoms Democritus made many observations of how matter changes. He thought that the movements of atoms caused the changes he observed. However, Democritus did not have any evidence to show that his theory was correct

Democritus' idea of the atom has been called "the best guess in antiquity." That's because it was correct in many ways, yet it was based on pure speculation. It really was just a guess. Here's what Democritus thought about the atoms:

- All matter consists of atoms, which cannot be further subdivided into smaller particles.
- Atoms are extremely small—too small to see.
- Atoms are solid particles that are indestructible.
- Atoms are separated from one another by emptiness, or "void."
- Atoms were made of a single material and were specific shapes and sizes.
    - The different shapes and sizes gave each atom different properties (Sweet atoms were smooth. Atoms that made sour things were jagged)

His model just looked like a ball or sphere.

Aristotle



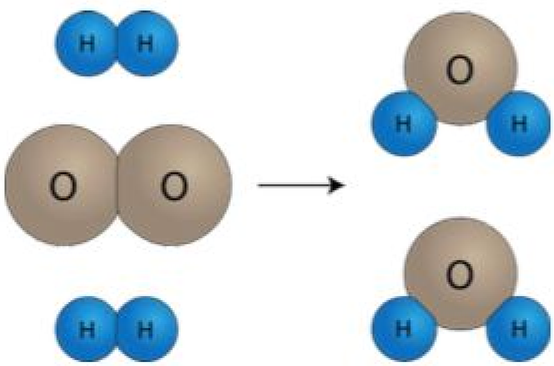
Aristotle did not believe in the atomic theory that Democritus came up with. He believed that you could NEVER end up with a particle that could not be cut. He thought that all materials on Earth were not made of atoms, but of the four elements, Earth, Fire, Water, and Air. He believed all substances were made of small amounts of these four elements of matter. Most people were convinced by Aristotle's idea because he was so popular and respected, causing Democritus' idea- which was that all substances on Earth where made of small particles called atoms- to be over looked for about 2,000 years! Aristotle's view was finally proven incorrect and his teachings are not present in the modern view of the atom.

John Dalton

In 1803, an English schoolteacher named John Dalton proposed a different atomic theory. Like Democritus, Dalton proposed that atoms could not be divided into smaller parts. However, unlike Democritus, Dalton performed scientific experiments to find data to support his theory. Dalton's experiments showed that atoms of different elements could combine in certain ways to form compounds. This is known as the "law of definite proportions."

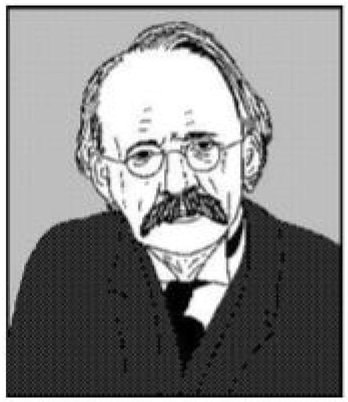
From his research, Dalton developed a theory about atoms. Dalton's atomic theory consists of three basic ideas:

- All substances are made of atoms. Atoms are the smallest particles of matter. They cannot be divided into smaller particles, created, or destroyed.
- All atoms of the same element are alike and have the same mass. Atoms of different elements are different and have different masses.
- Atoms join together to form compounds, and a given compound always consists of the same kinds of atoms in the same ratios or proportions.



Dalton's atomic theory was accepted by many scientists almost immediately. In fact, Dalton's explanation of how atoms combine to form substances is considered the foundation of modern atomic theory.

J.J. THOMSON



In 1897 that a scientist named Joseph John (J. J.) Thomson discovered that was a mistake in Dalton's Atomic theory. He discovered that there are smaller charged particles in the inside of the atom.

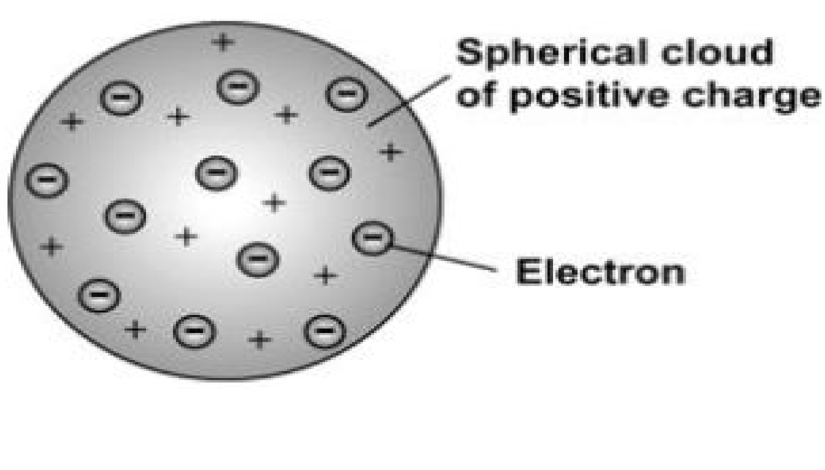
In his research, Thomson passed current through a cathode ray tube. A cathode ray tube is a glass tube from which virtually all of the air has been removed. It contains a piece of metal called an electrode at each end. One electrode is negatively charged and known as a cathode. The other electrode is positively charged and known as an anode. When high-voltage electric current is applied to the end plates, a cathode ray travels from the cathode to the anode.

What is a cathode ray? That's what Thomson wanted to know. There were 2 popular hypothesis at the time: Is it just a ray of energy that travels in waves like a ray of light? Or was a cathode ray a stream of moving particles? Thomson tested both ideas by placing negative and positive plates along the sides of the cathode ray tube to see how the cathode ray would be affected. The cathode ray appeared to be repelled by the negative plate and attracted by the positive plate. This meant that the ray was negatively charged and that is must consist of particles that have mass. He called the particles "corpuscles," but they were later renamed electrons.

In short, Thomson had discovered the existence of particles smaller than atoms. This disproved Dalton's claim that atoms are the smallest particles of matter.

Thomson's experiment showed that atoms contained even smaller particles. He proposed a new model of the atom based on his discovery. According to Thomson's model, electrons were spread randomly throughout an atom. He envisioned the atom as being similar to a plum pudding - mostly positive in charge (the pudding) with negative electrons (the plums) scattered through it. The rest of the atom was a positively charged material. The electrons floated in the positively charged material.

In 1906, he won the Nobel Prize in physics for his research on how gases conduct electricity.



Ernest Rutherford

The nucleus of the atom was discovered in 1911 by a scientist from New Zealand named Ernest Rutherford. Through his clever research, Rutherford showed that the positive charge of an atom is confined to a tiny massive region at the center of the atom, rather than being spread evenly throughout the "pudding" of the atom as Thomson had suggested.

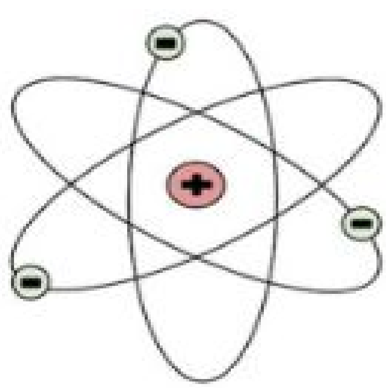
Rutherford set up a gold-foil experiment with some of his students to study the charge within atoms. Rutherford's students aimed a beam of positively charged particles at a very thin sheet of gold-foil. Rutherford predicted that the positive charge in the gold atoms would be too weak to affect the positively charged particles. Therefore, the particles would either pass straight through the foil or be deflected slightly. However, this is not what the experiment showed. Most of the particles passed straight through the foil. Some were deflected slightly. However, some of the particles bounced back at sharp angles.

Observations of gold foil experiment: –

- Most of the alpha particles follow the straight line and hot the gold foil.
- Some particles get deflected.
- A few alpha particles bounced of the foil and back to the left.

Conclusions:

- The atom must have a tightly packed central area that has a positive charge and nearly all the mass of atom is concentrated here.
- Based on his results, Rutherford concluded that an atom's positive charge is concentrated at the center of the atom. This positively charged, dense core of the atom is called the nucleus (plural, nuclei). Data from the experiments showed that the nucleus must be very tiny. If an atom were the size of a football stadium, its nucleus would be only as big as a marble.
- The atom is approximately 100,000 times bigger than the nucleus, so the atom is 99.99% empty space.

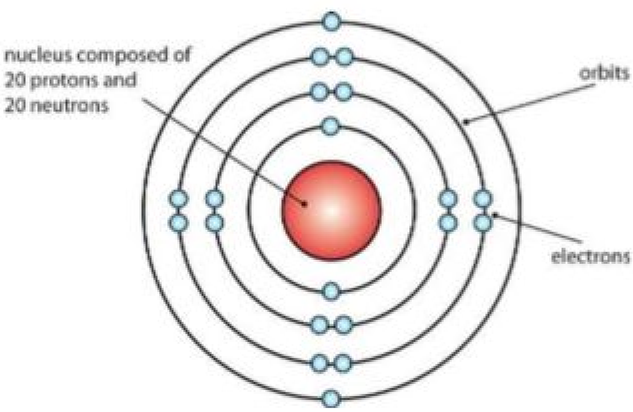


Rutherford's results led to a new model of the atom. In the Rutherford model, negatively charged electrons orbit the positively charged nucleus, as shown below. This is similar to the way that the planets orbit the sun.

Niels Bohr

The next major advance in atomic history occurred in 1913, when the Danish scientist Niels Bohr published a description of a more detailed model of the atom. His model identified more clearly where electrons could be found. Although later scientists would develop more refined atomic models, Bohr's model was basically correct and much of it is still accepted today. It is also a very useful model because it explains the properties of different elements. Bohr received the 1922 Nobel Prize in physics for his contribution to our understanding of the structure of the atom.

Bohr showed that electrons can be found only in specific energy levels, or regions, and they move AROUND around the nucleus. He proposed that the electrons move in pathways that had energy levels. Electrons must gain energy to move to a higher energy level. They must lose energy to move to a lower level. Imagine that the nucleus of an atom is in a deep basement. Electrons can be on any floor, but they cannot be between floors. Energy levels in an atom are like the rungs of a ladder. Just as you can stand only on the rungs and not in between them, electrons can orbit the nucleus only at fixed distances from the nucleus and not in between them. So the energy levels did not have paths between each other, but electrons could jump between the levels by gaining or losing energy.



In Bohr's model, electrons orbited the nucleus like planets orbit the sun.

He was awarded the Nobel Peace Prize in 1922 for Physics

Erwin Schrodinger

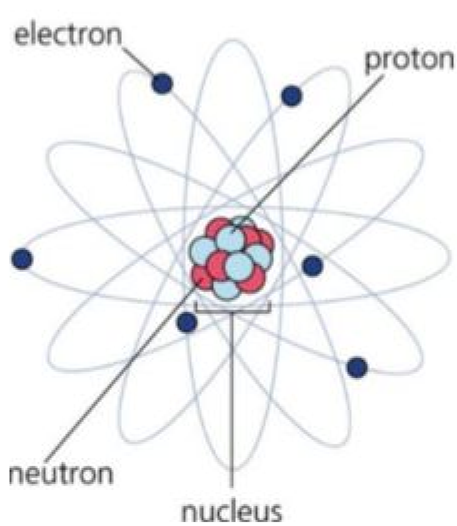
In the mid-1920s, an Austrian scientist named Erwin Schrödinger thought that the problem with Bohr's model was restricting the electrons to specific orbits. He wondered if electrons might behave like light, which scientists already knew had properties of both particles and waves. Schrödinger speculated that electrons might also travel in waves.

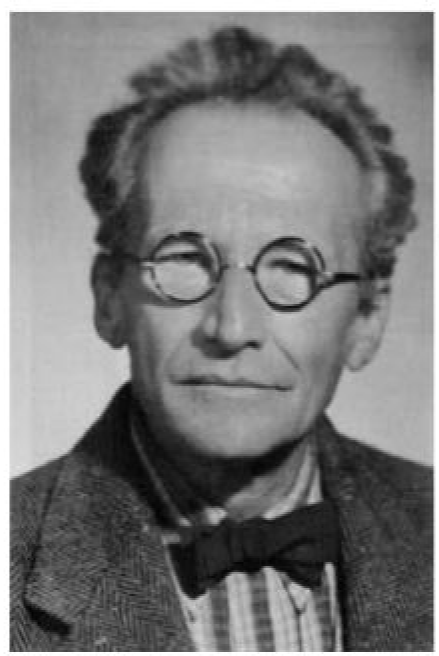
You can't specify the exact location of an electron because electrons are constantly moving. However, Schrödinger showed that you can at least determine where an electron is most likely to be.

Schrödinger said that electrons don't have a fixed position in an atom. He developed an equation that could be used to calculate the chances of an electron being in any given place around the nucleus. Based on his calculations, he identified regions around the nucleus where electrons are most likely to be. He called these regions orbitals. Orbitals may be shaped like spheres, dumbbells, or rings. In each case, the nucleus of the atom is at the center of the orbital.

Schrödinger's work on orbitals is the basis of the modern model of the atom, which scientists call the quantum mechanical model. The modern model is also commonly called the electron cloud model. That's because each orbital around the nucleus of the atom resembles a fuzzy cloud around the nucleus. The densest area of the cloud is where the electrons have the greatest chances of being.

Schrödinger won the Nobel Peace Prize in 1933 for his work on the Atomic Theory.





Werner Heisenberg

In 1926 German scientist named Werner Heisenberg proposed what's known as the Heisenberg Uncertainty Principle. According to the Heisenberg Uncertainty Principle, it is impossible to measure certain properties, like speed and position at the same time without introducing uncertainty into the measurement. Of course, if you can't make accurate measurements, you can't make accurate prediction either.

According to Werner Heisenberg, when it comes to small objects, scientists will never be able to make accurate measurements and accurate predictions, no matter how good their machinery is.

Heisenberg studied the pattern of an atom's electrons. He calculated the behavior of electrons, and subatomic particles that make up an atom. Instead of focusing mainly on scientific terms, this idea brought mathematics more into understanding the patterns of an atom's electrons. This discovery helped clarify the modern view of the atom because scientists can compare atoms by their movements of electrons, and can now figure out how many electrons each atom contains. Surrounding an atom's nucleus is an electron cloud, which is a name given to the electrons that are widely spreading and moving around.

In conclusion, Werner Heisenberg contributed to the atomic theory by including quantum mechanics, the branch of mechanics, based on quantum theory, used for interpreting the behavior of elementary particles and atoms.

Heisenberg won the Nobel Peace Prize in 1932 for his work in Quantum Mechanics.