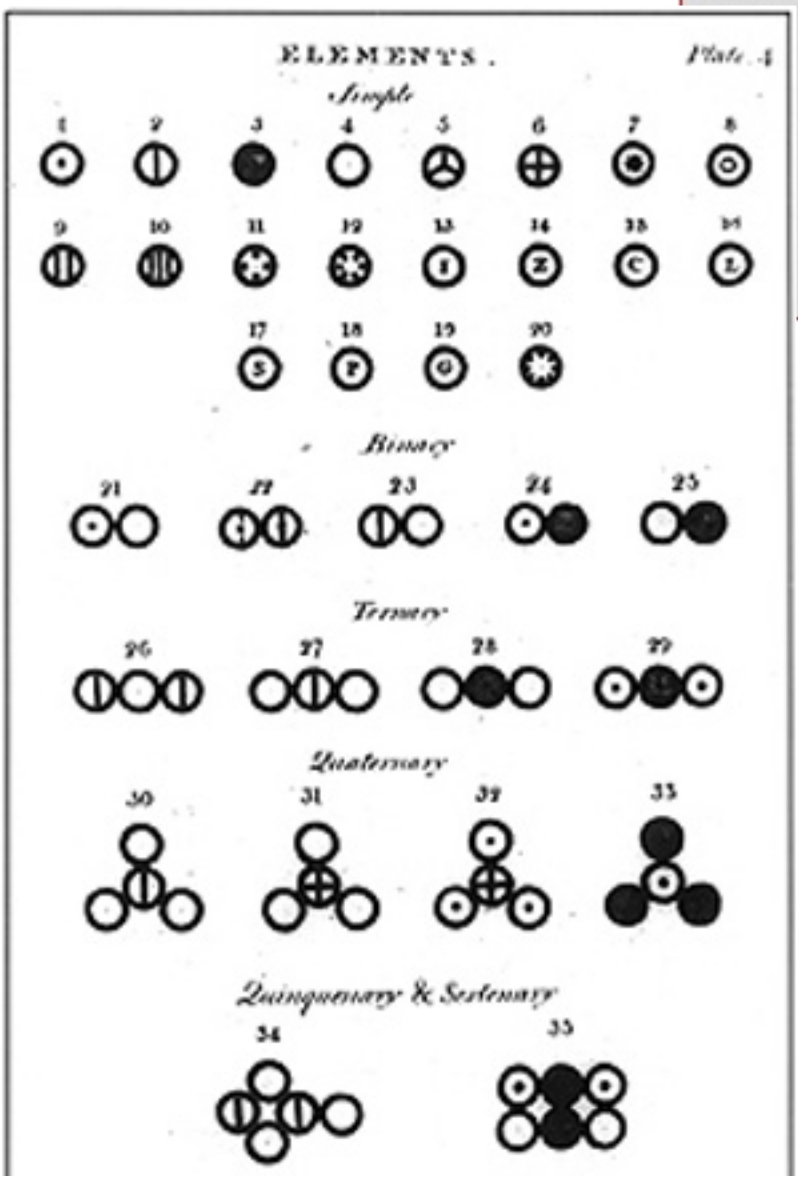
John Dalton Information

Democritus first suggested the existence of the atom but it took almost two millennia before the atom was placed on a solid foothold as a fundamental chemical object by John Dalton (1766-1844). Many unexplained chemical phenomena were quickly explained by Dalton with his theory. Dalton's theory quickly became the theoretical foundation in chemistry.

These are the symbols Dalton used to describe different elements:



John Dalton Biography

John Dalton

John Dalton (1766-1844) was an English chemist with a Quaker background. His religious beliefs, and perhaps his modesty, prevented him from accepting much of his deserved fame and recognition. Today Dalton is known primarily for his atomic theory, although his inquisitive nature and diligent research led him to make many important discoveries in fields other than chemistry. He made a careful study of color-blindness, a condition from which he suffered. Dalton was also a pioneer meteorologist, keeping daily records of the weather for 57 years. His fascination with weather and the atmosphere led to his research into the nature of gases, which in turn became the foundation on which he built his atomic theory.

Dalton's Atomic Theory

1) All matter is made of atoms. Atoms are indivisible and indestructible.

2) All atoms of a given element are identical in mass and properties

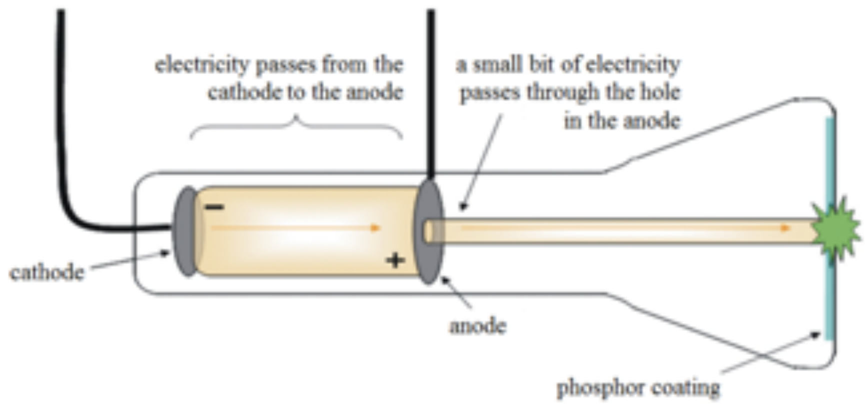
3) Compounds are formed by a combination of two or more different kinds of atoms.

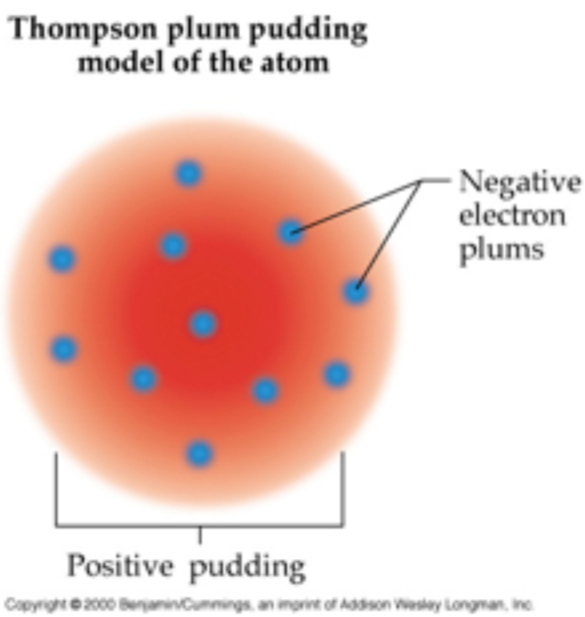
4) A chemical reaction is a rearrangement of atoms.

J.J. Thomson Information

In 1897 the British physicist Joseph John (J. J.) Thomson (1856–1940) discovered the electron in a series of experiments designed to study the nature of electric discharge in a high-vacuum cathode-ray tube, an area being investigated by numerous scientists at the time. Thomson interpreted the deflection of the rays by electrically charged plates and magnets as evidence of "bodies much smaller than atoms."

The idea that electricity was transmitted by a charged smallest unit related to the atom was put forward in the 1830s. In the 1890s J.J. Thomson made experiments with charged particles in gases and managed to estimate its magnitude. In 1897 he showed that cathode rays, radiation emitted in a low pressure glass tube when a voltage is applied between two metal plates, consist of particles, electrons, that carry electricity. <u>Thomson also concluded that electrons were part of the atom.</u>





In 1906 Thomson suggested that atoms contained far fewer electrons, a number roughly equal to the atomic number. This is only one electron in the case of hydrogen, far fewer than the thousands originally suggested.

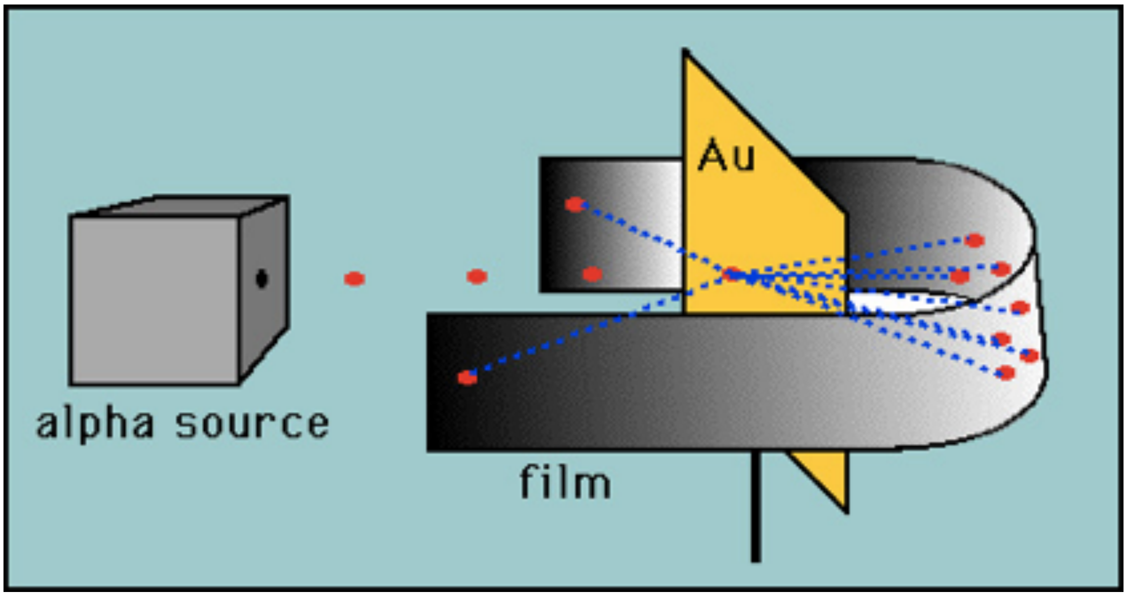
These electrons must have been balanced by some sort of positive charge. The distribution of charge and mass in the atom was unknown. Thomson proposed a 'plum pudding' model, with positive and negative charge filling a sphere only one ten billionth of a meter across.

While Thomson discovered the electron, he needed to figure out how it was part of the atom. He decided on the plum-pudding model which is in the picture above.

Rutherford Information

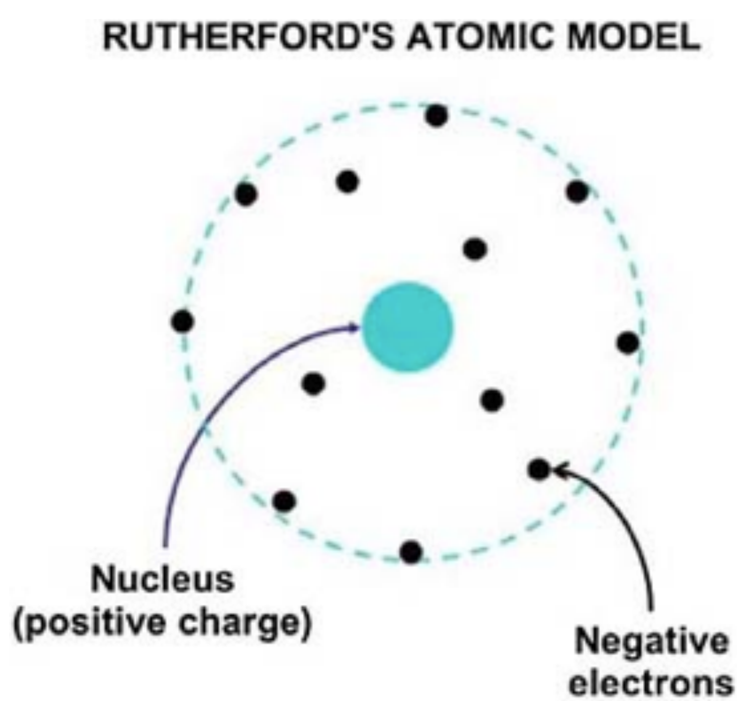
By 1911 the components of the atom had been discovered. The atom consisted of subatomic particles called protons and electrons. However, it was not clear how these protons and electrons were arranged within the atom.

Rutherford tested other scientists models by devising his "gold foil" experiment. Which is pictured below:



Rutherford reasoned that if other models were correct then the mass of the atom was spread out throughout the atom. Then, if he shot high velocity alpha particles (helium nuclei) at an atom then there would be very little to deflect the alpha particles. He decided to test this with a thin film of gold atoms. As expected, most alpha particles went right through the gold foil but to his amazement a few alpha particles rebounded almost directly backwards.

Rutherford was forced to discard other models of the atom and reasoned that the only way the alpha particles could be deflected backwards was if most of the mass in an atom was concentrated in a nucleus. He thus developed the planetary model of the atom which put all the protons in the nucleus and the electrons orbited around the nucleus like planets around the sun.



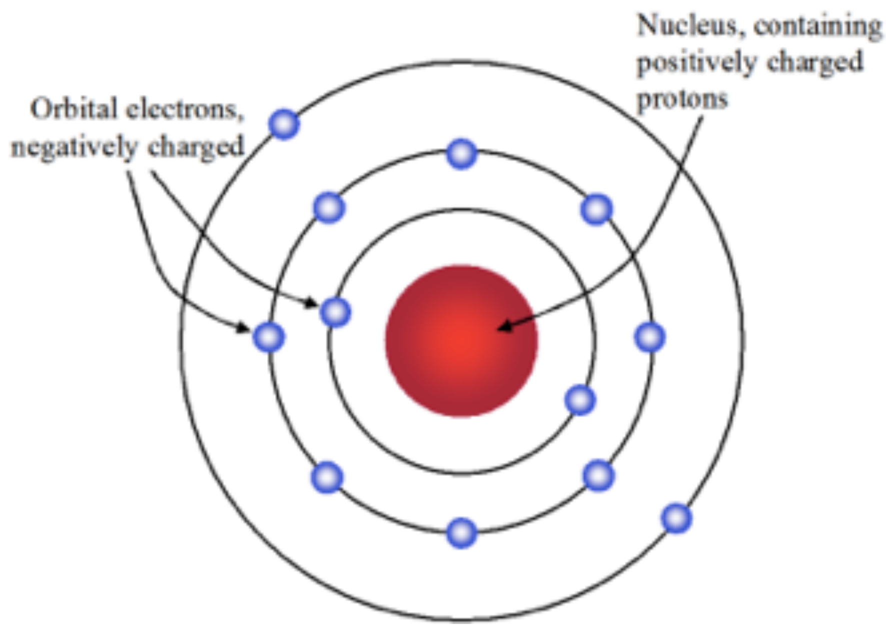
Observation: Most alpha particles went right through the gold foil.
Conclusion: The atom is mostly empty space.

Observation: Some alpha particles bounced back.
Conclusion: There is a hard, dense, positive, nucleus.

Bohr Information

In 1912, Bohr joined other scientists in the study of the atom. He realized that a different model wasn't quite right. By all rules of classical physics, the model of the atom should be very unstable. For one thing, the electrons should give off energy and eventually spiral down into the nucleus, making the atom collapse. Or the electrons could be knocked out of position if a charged particle passed by.

Bohr turned to a famous physics theory, Planck's quantum theory to explain the stability of most atoms. He found that the ratio of energy in electrons and the frequency of their orbits around the nucleus was equal to Planck's constant (the proportion of light's energy to its wave frequency, or approximately 6.626 x 10-23). Bohr suggested the revolutionary idea that electrons "jump" between energy levels (orbits) in a quantum fashion, that is, without ever existing in an in-between state. Thus when an atom absorbs or gives off energy (as in light or heat), the electron jumps to higher or lower orbits. Bohr published these ideas in 1913 to mixed reaction. Many people still hadn't accepted the idea of quanta, or they found other flaws in the theory because Bohr had based it on very simple atoms. But there was good evidence he was right: the electrons in his model lined up with the regular patterns (spectral series) of light emitted by real hydrogen atoms.



Bohr's theory that electrons existed in set orbits around the nucleus was the key to the periodic repetition of properties of the elements. The shells in which electrons orbit have different quantum numbers and hold only certain numbers of electrons -- the first shell holds no more than 2, the second shell up to 8, the third 10, the fourth 14. Atoms with less than the maximum number in their outer shells are less stable than those with "full" outer shells. Elements that have the same number of electrons in their outermost shells appear in the same column in the periodic table of elements and tend to have similar chemical properties.

Over the years other investigators refined Bohr's theory, but his bold application of new ideas paved the way for the development of quantum mechanics. Bohr went on to make enormous contributions to physics and, like Rutherford, to train a new generation of physicists. But his atomic model remains the best known work of a very long career.

Chemistry Before Dalton

THREE HUNDRED YEARS ago, more or less, the last serious alchemists finally gave up on their attempts to create gold from other metals, dropping the curtain on one of the least successful endeavors in the history of human striving.

Centuries of work and scholarship had been plowed into alchemical pursuits, and for what? Countless ruined cauldrons, a long trail of empty mystical symbols, and precisely zero ounces of transmuted gold. As a legacy, alchemy ranks above even fantasy baseball as a great human icon of misspent mental energy.

But was it really such a waste? A new generation of scholars is taking a closer look at a discipline that captivated some of the greatest minds of the Renaissance. And in a field that modern thinkers had dismissed as a folly driven by superstition and greed, they now see something quite different.

Alchemists, they are finding, can take credit for a long roster of genuine chemical achievements, as well as the techniques that would prove essential to the birth of modern lab science. In alchemists' intricate notes and diagrams, they see the early attempt to codify and hand down experimental knowledge. In the practices of alchemical workshops, they find a masterly refinement of distillation, sublimation, and other techniques still important in modern laboratories.

Alchemy had long been seen as a kind of shadowy forebear of real chemistry, all the gestures with none of the results. But it was an alchemist who discovered the secret that created the European porcelain industry. Another alchemist discovered phosphorus. The alchemist Paracelsus helped transform medicine by proposing that disease was caused not by an imbalance of bodily humors, but by distinct harmful entities that could be treated with chemicals. (True, he believed the entities were controlled by the planets, but it was a start.)

"We've got people who are trying to make medicines, which are pharmaceuticals; we've got people who are trying to understand the material basis of the world - very much like a modern engineer, or someone in technology," says Lawrence Principe, a professor of chemistry and the history of science at Johns Hopkins University who is a leading thinker in the revival of alchemy studies.

The field has begun to coalesce as its own academic specialty. Last fall, alchemy scholars gathered at their second academic conference in three years, and in January, Yale University opened an exhibit of rare alchemical manuscripts. For the first time, the leading academic journal of scientific history is planning to publish a special section on alchemy.