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# WHAT IS AN ATOM

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## ABSTRACT

An atom a fundamental piece of matter (Matter is anything that can be touched physically). Everything in the universe (except energy) is made of matter, and, so, everything in the universe is made of atoms. Atoms are made out of three main parts: protons, neutrons and electrons. The idea that matter is made up of discrete units is a very old idea. There are lots of types of atoms and those types are called elements. When it comes to understanding atoms and the way they look and act, we only really need to know about protons, neutrons and electrons. But that's not really the end of the story.

**KEYWORDS:** Atom, Protons, Neutrons, Electrons, Elements

## INTRODUCTION

### What Is an Atom

An atom a fundamental piece of matter. (Matter is anything that can be touched physically.) Everything in the universe (except energy) is made of matter, and, so, everything in the universe is made of atoms.

An atom itself is made up of three tiny kinds of particles called subatomic particles: protons, neutrons, and electrons. The protons and the neutrons make up the center of the atom called the nucleus and the electrons fly around above the nucleus in a small cloud. The electrons carry a negative charge and the protons carry a positive charge. In a normal (neutral) atom the number of protons and the number of electrons are equal. Often, but not always, the number of neutrons is the same, too.

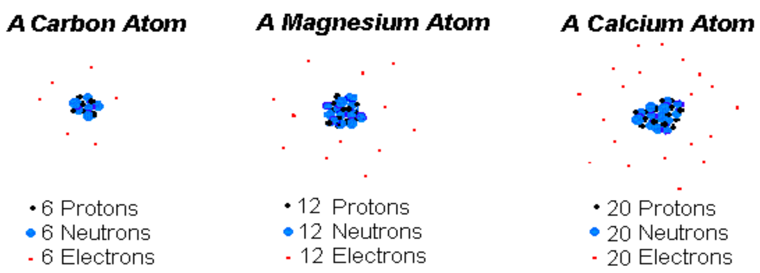


**Figure: 1**

### Protons, Neutrons & Electrons

Atoms are made out of three main parts: protons, neutrons and electrons. Protons and neutrons are contained inside the very center of the atom, which is called the **nucleus**. Electrons orbit around the outside of the nucleus, similar to how the Earth orbits the sun. Most of the atom is empty space - both the nucleus and the electrons are so tiny that even solid objects are mostly empty.

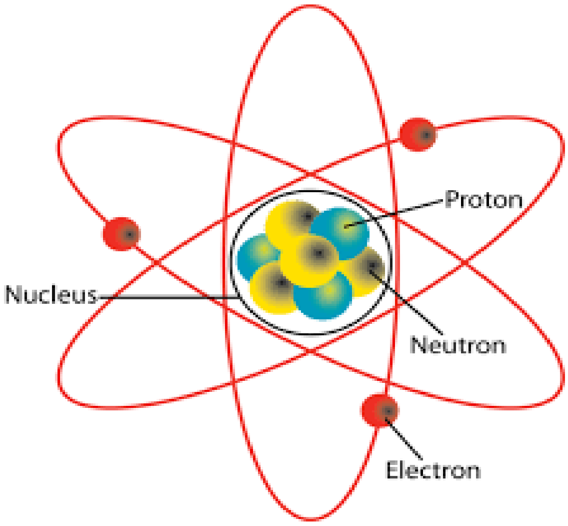


**Figure: 2**

so atoms are made out of protons, neutrons and electrons. But what are they? **Protons** are stable subatomic particles, with a positive +1 charge and a mass of approximately one atomic mass unit. **Neutrons** are stable subatomic particles with a neutral, or zero, charge and a mass of approximately one atomic mass unit. Neutrons have the same mass as protons but a neutral charge. That's why they're called neutrons... 'neutr' for 'neutral.' Last of all, **electrons** are stable subatomic particles, with a negative -1 charge and a mass 1/1836th of the mass of a proton. So, electrons are much smaller than protons or neutrons, but they contain a negative charge of the same size as much larger protons.

There are lots of types of atoms and those types are called elements. The element helium, for example, contains atoms with two protons in the nucleus. The element iron contains atoms with 26 protons. The element oxygen contains atoms with eight protons. And the element gold contains atoms with 79 protons.

When it comes to understanding atoms and the way they look and act, we only really need to know about protons, neutrons and electrons. But that's not really the end of the story.

## HISTORY OF ATOMIC THEORY

### Atoms in Philosophy

The idea that matter is made up of discrete units is a very old idea, appearing in many ancient cultures such as Greece and India. The word "atom" was coined by ancient Greek philosophers. However, these ideas were founded in philosophical and theological reasoning rather than evidence and experimentation. As a result, their views on what atoms look like and how they behave were incorrect. They also could not convince everybody, so atomism was but one of a number of competing theories on the nature of matter. It was not until the 19th century that the idea was embraced and refined by scientists, when the blossoming science of chemistry produced discoveries that only the concept of atoms could explain.

### First Evidence-Based Theory

In the early 1800s, John Dalton used the concept of atoms to explain why elements always react in ratios of small whole numbers (the law of multiple proportions). For instance, there are two types of tin oxide: one is 88.1% tin and 11.9% oxygen and the other is 78.7% tin and 21.3% oxygen (tin(II) oxide and tin dioxide respectively). This means that 100g of tin will combine either with 13.5g or 27g of oxygen. 13.5 and 27 form a ratio of 1:2, a ratio of small whole numbers. This common pattern in chemistry suggested to Dalton that elements react in whole number multiples of discrete units—in other words, atoms. In the case of tin oxides, one tin atom will combine with either one or two oxygen atoms.[1]

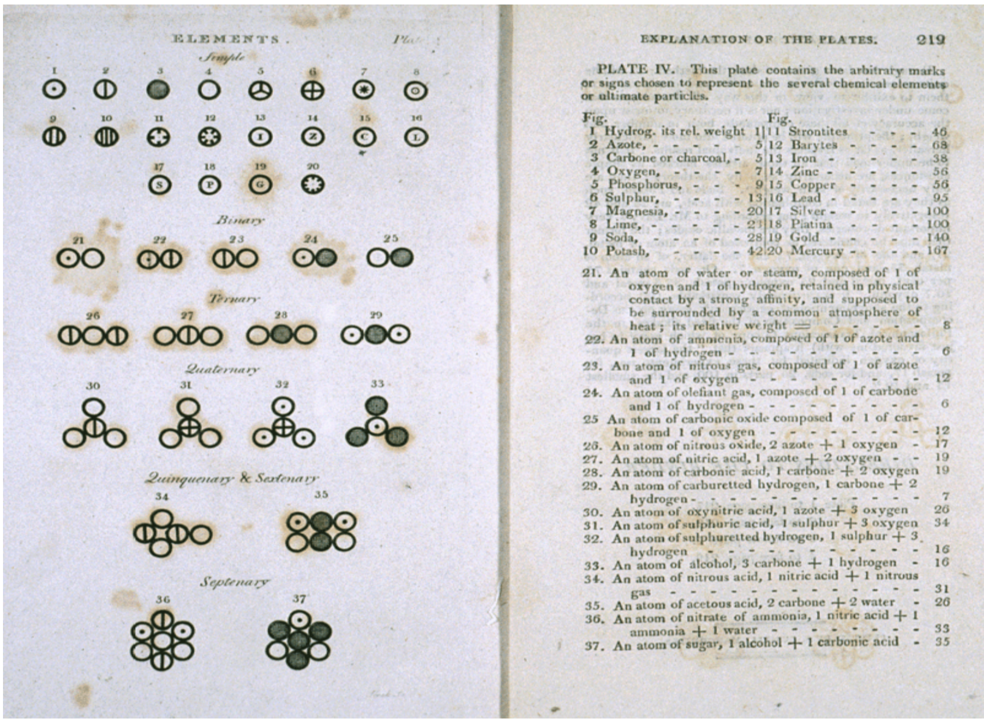


**Figure: 3**

Dalton also believed atomic theory could explain why water absorbs different gases in different proportions. For example, he found that water absorbs carbon dioxide far better than it absorbs nitrogen.[2] Dalton hypothesized this was due to the differences between the masses and configurations of the gases' respective particles, and carbon dioxide molecules ($CO_2$) are heavier and larger than nitrogen molecules ($N_2$).

**Brownian Motion**

In 1827, botanist Robert Brown used a microscope to look at dust grains floating in water and discovered that they moved about erratically, a phenomenon that became known as "Brownian motion". This was thought to be caused by water molecules knocking the grains about. In 1905, Albert Einstein proved the reality of these molecules and their motions by producing the first Statistical physics analysis of Brownian motion.[3][4][5] French physicist Jean Perrinused Einstein's work to experimentally determine the mass and dimensions of atoms, thereby conclusively verifying Dalton's atomic theory.[6]

**Discovery of the Electron**

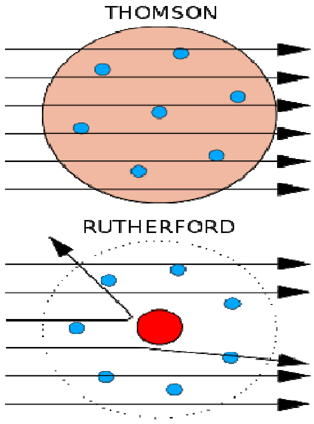


**Figure: 4**

The physicist J. J. Thomsonmeasured the mass of cathode rays, showing they were made of particles, but were around 1800 times lighter than the lightest atom, hydrogen. Therefore, they were not atoms, but a new particle, the first *subatomic*particle to be discovered, which he originally called "*corpuscle*" but was later named *electron*, after particles postulated by George Johnstone Stoney in 1874. He also showed they were identical to particles given off by photoelectric and radioactive materials.[7]It was quickly recognized that they are the particles that carry electric currents in metal wires, and carry the negative electric charge within atoms. Thomson was given the 1906 Nobel Prize in Physics for this work. Thus he overturned the belief that atoms are the indivisible, ultimate particles of matter.[8]Thomson also incorrectly postulated that the low mass, negatively charged electrons were distributed throughout the atom in a uniform sea of positive charge. This became known as the plum pudding model

**Discovery of the Nucleus**

In 1909, Hans Geiger and Ernest Marsden, under the direction of Ernest Rutherford, bombarded a metal foil with alpha particles to observe how they scattered. They expected all the alpha particles to pass straight through with little deflection, because Thomson's model said that the charges in the atom are so diffuse that their electric fields could not affect the alpha particles much. However, Geiger and Marsden spotted alpha particles being deflected by angles greater than 90°, which was supposed to be impossible according to Thomson's model. To explain this, Rutherford proposed that the positive charge of the atom is concentrated in a tiny nucleus at the center of the atom.[9] Rutherford compared his findings to one firing a 15-inch shell and it coming back to hit the person who fired it.[10]

**Bohr Model**

In 1913 the physicist Niels Bohrproposed a model in which the electrons of an atom were assumed to orbit the nucleus but could only do so in a finite set of orbits, and could jump between these orbits only in discrete changes of energy corresponding to absorption or radiation of a photon.[13] This quantization was used to explain why the electrons orbits are stable (given that normally, charges in acceleration, including circular motion, lose kinetic energy which is emitted as electromagnetic radiation, see *synchrotron radiation*) and why elements absorb and emit electromagnetic radiation in discrete spectra.[14]

Later in the same year Henry Moseley provided additional experimental evidence in favor of Niels Bohr's theory. These results refined Ernest Rutherford's and Antonius Van den Broek's model, which proposed that the atom contains in its nucleusa number of positive nuclear charges that is equal to its (atomic) number in the periodic table. Until these experiments, atomic number was not known to be a physical and experimental quantity. That it is equal to the atomic nuclear charge remains the accepted atomic model today.[15]

**Discovery of the Neutron**

His development of the mass spectrometer allowed the mass of atoms to be measured with increased accuracy. The device uses a magnet to bend the trajectory of a beam of ions, and the amount of deflection is determined by the ratio of an atom's mass to its charge. The chemist Francis William Aston used this instrument to show that isotopes had different masses. The atomic mass of these isotopes varied by integer amounts, called the whole number rule. The explanation for these different isotopes awaited the discovery of the neutron, an uncharged particle with a mass similar to the proton, by the physicist James Chadwick in 1932. Isotopes were then explained as elements with the same number of protons, but different numbers of neutrons within the nucleus.

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