

# History:

## Early Atomic Theory:

The first time anyone thought of matter as atoms occurred about 400 B.C. Greek philosopher Democritus suggested that the world is made up of two things-empty space and tiny particles he called "atoms". He had no proof or suggestions of proof.

## Four Elements?:

Aristotle holds one of the earliest theories on the nature of matter. Around 350 B.C. he hypothesized that everything is made of fire, air, water, and earth. In his book Meteorology Aristotle wrote, "Fire, air, water, earth, we assert, originate from one another, and each of them exists potentially in each, as all things do that can be resolved into a common and ultimate substrate."

## Dalton's Hypothesis:

In the early 1800's John Dalton, an English chemist, was the first to predict that everything is made up of atoms. He claimed the atom was the smallest substance. In addition he claimed that atoms of the same element were exactly alike, but atoms of different elements were quite unlike.

## The Development of Sub-Atomic Particles:

In the early part of the 1900's, several scientists around the world began to predict that atoms could be broken down. By 1930, researchers were able to prove the existence of three separate particles, which make up atoms: **protons, neutrons, and electrons**. Eventually scientists proved that these particles possessed identical characteristics regardless of the substance from which they originated.

# Current Curriculum:

## Atomic Theory:

In recent years chemistry curricula have included atomic structure as the following:

Matter is made up of elements.

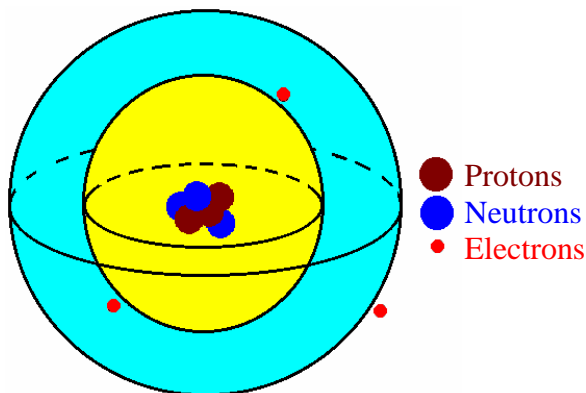
Elements are made up of atoms.

Atoms are made up of protons, neutrons, and electrons.

Protons are massive, positively charged, and contained in the nucleus of an atom.

Neutrons are a massive, neutrally charged, and contained in the nucleus of an atom.

Electrons are insignificantly massed, negatively charged, and orbit the nucleus of an atom at a high speed.



These statements summarize what students traditionally learn in science courses. However, as soon as the existence of protons, neutrons and electrons was proved, scientist began to search for smaller pieces. We have found them.

# New Curriculum:

## What is a Particle Accelerator?:

In recent years scientists hypothesized that if it were possible to slam pieces of matter together at high speeds, the pieces created from such a collision would be the basic building blocks of matter. This collision is the job of a particle accelerator.

## Results:

As many scientists had predicted, several new types of particles were discovered. If protons, neutrons, and electrons were the basic building blocks of matter, they would be the only particles produced in these collisions.

## The New "Elementary Particles":

There are three new classes of "elementary particles" (see chart on the back of this brochure). Some of these particles make up protons and neutrons. It appears that at least the electron, part of a group of particles called leptons, is an elementary particle. However, protons and neutrons are not elementary particles but are made up of a group of elementary particles called quarks.

Protons are composed of two "up" quarks and a "down" quark, while neutrons are made up of two "down" quarks and an "up" quark. This makes our current picture of the atom quite different. (See back panel)

## What Are All of These Other Particles:

The other elementary particles listed are less common than those in the atom; but are being used to explain many different phenomena: gamma rays, anti-matter, nuclear decay and many others.

**We must teach students about these new developments. As science advances, so should our curriculum.**