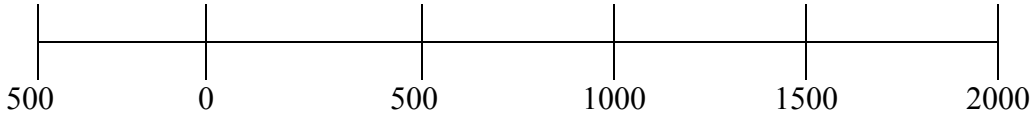
## The Nature of Matter

Everything in the universe is made up of what we call ***matter***. For thousands of years, people have been trying to determine what matter is made of.

Below is a summary of some of the most important contributions to this quest.




**BCE (Before the Common Era)** **AD (Anno Domini)**

**Ancient Greek Philosophers**

- wondered why matter behaves as it does
- manipulated ideas in their minds
- did almost no experimentation

- 450 BCE
  - **Empedocles** proposed that matter was composed of four elements: earth, air, fire, and water.

- 400 BCE
  - **Democritus** suggested that matter was made of tiny particles that could not be broken down further
  - called these particles "**atomos**," which means indivisible

- 350 BCE
  - after the death of Democritus
  - **Aristotle** and **Socrates** reject the idea of atoms and adopt Empedocles' four element theory
  - this model dominated scientific thinking for almost 2000 years

**Alchemists**

- 500 – 1600 AD
- the first people to perform hands-on experimentation
- part philosopher, mystic, magician, and chemist
- had three main beliefs:
  - some elements can be changed into others (e.g. turn lead into gold)
  - a substance exists that would give them eternal life
  - a "universal solvent" exists that will dissolve all substances

**Modern Chemists**

- 1600 AD – Present
- used the scientific method to investigate the physical world
- focused on determining the properties of pure substances and trying to determine their composition

- **Sir Francis Bacon** (*1600s*)
  - one of the first scientists to develop new knowledge as a result of experimentation

- **Robert Boyle** (*1650*)
  - believed the "four element" theory could be improved on
  - defined an element as "certain simple unmingled bodies…"
  - helped lay the foundation for the concepts of elements and compounds
  - recognized that elements could be combined to form compounds
  - believed air was a mixture, not an element

- **Joseph Priestly** (*late 1700s*)
  - produced oxygen by burning mercury with a magnifying glass
  - did not know that oxygen was an element

- **Antoine Lavoisier** (*late 1700s*)
  - defined the term "***element***" as **a pure substance that cannot be chemically broken down into simpler substances**
  - discovered and identified 23 elements
  - recognized the existence of mixtures
  - identified air as a mixture

- **Henry Cavendish** (*late 1700s*)
  - mixed a metal with an acid to produce a flammable gas that was lighter than air (hydrogen)
  - burned hydrogen in oxygen to produce water vapor (showing that water was not an element)