

## Introduction

Chemistry is the study of the properties and behaviour of matter. **Matter** is the physical material of the universe; it is anything that has mass and occupies space.

Although the materials in our world vary greatly in their properties, everything is formed from only about 100 elements and, therefore, from only about 100 chemically different kinds of atoms. (118 elements have been discovered so far but the heavier atoms are short lived and not found naturally.)

### 1.1 The atomic theory of matter

Philosophers from the earliest times speculated about the nature of the fundamental components from which the world is made. **Empedocles** (~ 440 BC) believed that the four elements-earth, fire, air and water made up all things. The Hindus believed that the four elements stated above makeup the world and space. However, **Democritus** (460–370 BC) and other early Greek philosophers described the material world as being made up of tiny, invisible, indivisible particles that they called ‘atomos’, meaning “indivisible” or “uncuttable.”

Later, however, **Plato** and **Aristotle** formulated the notion that there can be no ultimately indivisible particles, and the “atomic” view of matter faded for many centuries during which Aristotelean philosophy dominated the Western culture.

It was in 1808 that an English scientist and school teacher, **John Dalton** (1766-1844), formulated a precise definition of the indivisible building blocks of matter that we call atoms. Dalton’s atomic theory was based on four postulates.

1. Elements are made out of extremely small, indivisible particles called atoms.
2. All atoms of a given element are identical in mass and size, but the atoms of one element are different from the atoms of all other elements.
3. Atoms of one element cannot be changed into atoms of a different element by chemical reactions; atoms are neither created nor destroyed in chemical reactions.
4. Compounds are formed by union of two or more atoms of different elements in a simple numerical ratio.

Dalton’s atomic model is called the "Golf ball model".



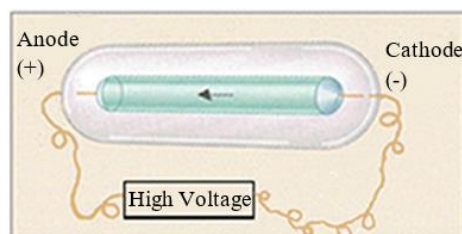
(a)



(b)

**Figure1.1** (a) John Dalton and (b) the golf ball model

**Johnstone G. Stoney** (1826-1911) named the fundamental unit carrying electricity as “electrons” in 1891 but did not have any experimental evidence of its existence. During the mid-1800s, scientists began to study electrical discharge through a glass tube pumped almost empty of air. This device was an invention of the British chemist and physicist **Sir William Crookes** (1832-1919) and is called **Crookes tube** or **cathode ray tube**.

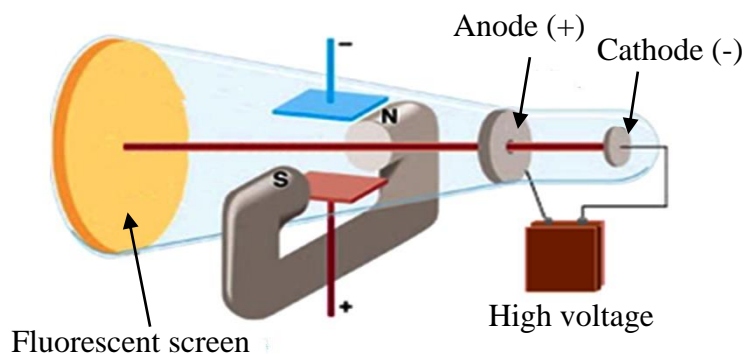


**Figure 1.2** A cathode ray tube

The experiment of Crookes and the others showed that when two electrodes are connected to a high-voltage source, the heated negatively charged plate, called the cathode, produced a stream of invisible radiation. Although the rays could not be seen, their presence was detected because they cause gases at low pressure to glow and which made other substances to fluoresce, or to give off light. The radiation emitted from the cathode was given the name '**cathode rays**'.

Later it was known that these rays could be deflected by a magnetic field and they carried a negative electrical charge. Some scientists felt that these rays were waves and others were inclined to think they were particles.

The British scientist **J. J. Thomson** (1856–1940) observed that cathode rays are the same regardless of the identity of the cathode material or the gas in the tube. In 1897 he described cathode rays as streams of negatively charged particles. He used a cathode tube with an anode that had a hole at the centre. Using experimental measurements obtained from that cathode tube he then calculated a value of  $1.76 \times 10^8$  coulombs per gram ( $C\ g^{-1}$ ) for the ratio of the electron's electrical charge to its mass.



**Figure 1.3** Thomson's cathode ray tube