

4.12: Isotopes

The presence of neutrons in atomic nuclei accounts for the occurrence of **isotopes**— samples of an element whose atoms contain different numbers of neutrons and hence exhibit different "nuclidic masses". The **nuclidic mass** is the mass of a "nuclide", where a nuclide is the term used for any atom whose nuclear composition (Number of protons and neutrons) is defined. For example, naturally occurring hydrogen has two stable nuclides, ${}^1_1\text{H}$ and ${}^2_1\text{H}$, which also are isotopes of one another. More than 99.98 percent is "light" hydrogen, ${}^1_1\text{H}$. This consists of atoms each of which has one proton, one electron, and zero neutrons. The rest is "heavy" hydrogen or deuterium, ${}^2_1\text{H}$, which consists of atoms which contain one electron, one proton, and one neutron. Hence the nuclidic mass of deuterium is almost exactly twice as great as for light hydrogen. By **transmutation** of lithium, it is also possible to obtain a third isotope, tritium, ${}^3_1\text{H}$. It consists of atoms whose nuclei contain two neutrons and one proton. Its nuclidic mass is about 3 times that of light hydrogen.

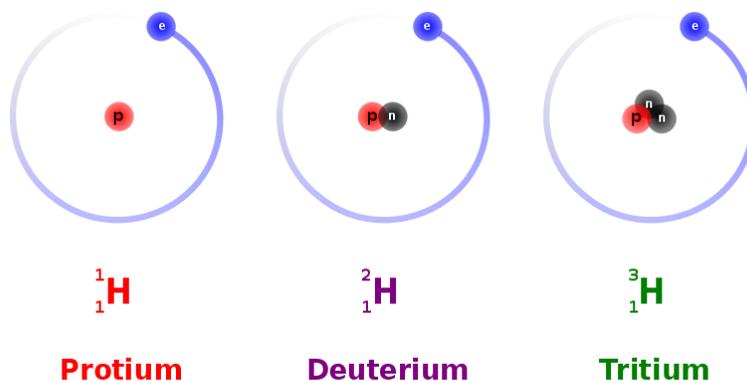


Figure 4.12.1: Above are the 3 isotopes of Hydrogen. Each have the same number of protons, but have different numbers of neutrons in the nucleus.

The discovery of isotopes and its explanation on the basis of an atomic structure built up from electrons, protons, and neutrons required a change in the ideas about atoms which John Dalton had **proposed**. For a given element all atoms are *not quite* identical in all respects—especially with regard to mass. It is the number and distribution of electrons which occupy most of the volume of an atom which determines the chemical behavior of atoms. The number of protons in the nucleus of each element is important in determining its chemical properties, because the total positive charge of the nucleus determines how the electrons are distributed. *All atoms of the same element have the same atomic number*, but different isotopes have different nuclidic masses.

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