

# Half-Life Encyclopedia Article

## Half-Life

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# Half-Life

As defined by geophysicists, the half-life (or half-value period) of a substance is the time required for one-half of the atoms in any size sample to radioactively decay.

Radioactive elements have different isotopes that decay at different rates. As a result, half-life varies with regard to the particular isotope under consideration. Some isotopes have very short half-lives, for example oxygen-14 has a half-life of only 71 seconds, some are even shorter—with values measured in millionths of a second not being uncommon. Other elements' isotopes can have a much longer half-life, thallium-232 has a half-life of  $1.4 \times 10^{10}$  years and carbon-14 has a half-life of 5,730 years. This latter figure is used as the basis of radiocarbon dating.

While living, an organism takes in an amount of carbon-14 at a relatively constant rate. Once the organism dies no more carbon-14 is taken in and the amount of carbon-14 present overall starts to decrease, decreasing by half every 5,730 years. By measuring the ratio of carbon-12 to carbon-14 an estimate of the date when carbon-14 stopped being assimilated can be calculated. This figure can also be obtained by comparing the levels of **radioactivity** of the test material to that of a piece of identical material that is fresh. Other radioactive elements can be used to date older, inorganic materials (e.g., rocks).

Strontium-90 has a half-life of 29 years. If starting with a 2.2 lb (1 kg) mass of strontium-90, then after 29 years there will only be 1.11 lb (0.5 kg) of strontium-90 remaining. After a further 29 years there will only be 0.55 lb (0.25 kg). Strontium-90 decays to give yttrium-90 and one free electron. Half-life is independent of the mass of material present.

The half-life ( $t_{1/2}$ ) of a material can be calculated by dividing 0.693 by the decay constant (which is different for different radionucleotides). The decay constant can be calculated by dividing the number of observed disintegrations per unit time by the number of radioactive nuclei in the sample. The decay constant is usually given the symbol  $k$  or  $\lambda$ .

The half-life of a material is a measure of how reactive it is either in terms of radioactive decay or in participation in specific reactions.

## See Also

Atomic Mass and Weight; Atomic Number; Atomic Theory; Cosmic Microwave Background Radiation; Dating Methods; Geologic Time