The radioactive decay formula

* define the terms activity and decay constant and recall and solve problems using *A* = λ*N*.
* solve problems using the relation λ = 0.693/*t*½.

The meaning of the decay constant .

definition of the **decay constant **: **the probability or chance that an *individual* nucleus will decay per second.**

Units:  is measured in **s-1** (or h-1, year-1, etc).

If you have a sample of *N* undecayed nuclei, what will its activity *A* be? In other words, how many of the *N* will decay in a second?

*A* =

As time passes, *N* will get smaller, so *A* represents a *decrease* in *N*. To make the formula reflect this, it needs a minus sign.

*A* =

The more undecayed nuclei you have, and the greater the probability that an individual one will decay, the greater the activity of the sample.

In calculus notation, this is

**d*N*/d*T* = -*N***

put this equation into words.

 This is the underlying relationship in any process that follows *exponential decay*.

More generally: if the rate of change is proportional to what is left to change, then exponential decay follows.

Conversely if data gives an exponential decay graph, then you know something about the underlying process.

The link with half-life.

If a nuclide has a large value of , will it have a long or short *T*1/2? (High probability of decay => it will decay quite quickly => a short half life, and vice versa.)

What type of proportionality does this suggest?

Thus  ~ 1/T1/2. In fact, *T*1/2 = ln 2/ = 0.693/

This is a very important and useful formula. Depending which of  or *T*1/2 is easiest to measure experimentally, the other can be determined. In particular it allows very long half lives (sometimes millions of years) to be determined.

How could we measure the 4.5 billion year half-life of uranium-238? ( Think paper 5)

Smoothed out radioactive decay

Here is the first step in making a model – idealisation and simplification of a messy process



Half-life and time constant

Here is the relationship between these two, explained



Now complete questions on p 345 and 347 Adams and Allday