

# Half-Life

## How long does material remain radioactive?

Some atomic nuclei are very unstable, existing for a few minutes or seconds.

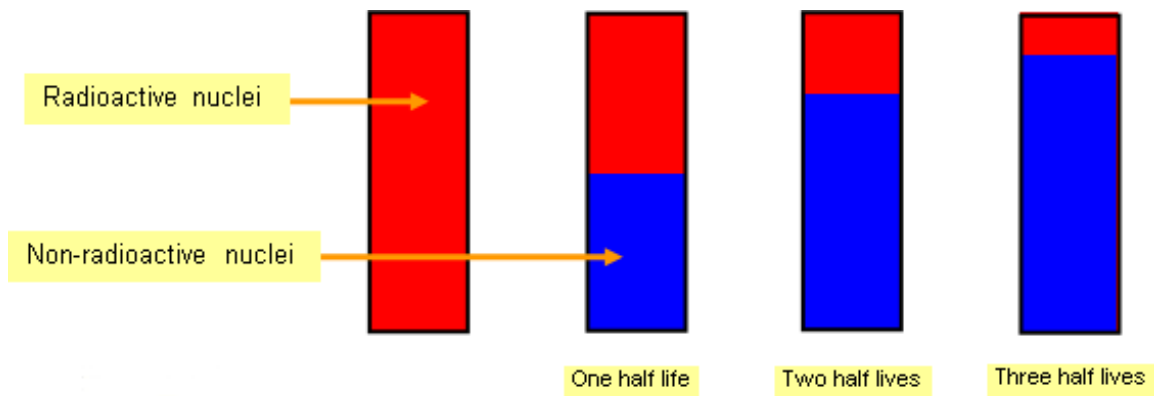
Examples of some common half-lives:

Material	Half life
Carbon 14	5700 years
Uranium 238	4500 000 000 years
Radium 226	1600 years
Plutonium 239	24000 years

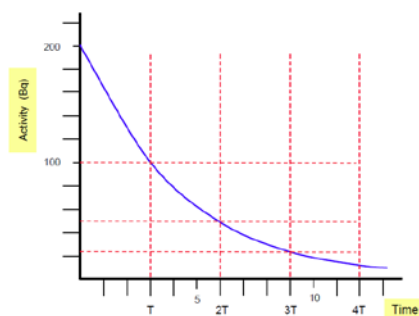
Others are very stable and take millions of years to decay to form another atom. The half-life of a radioisotope is the average time it takes for half of the remaining radioactive atoms to decay to a different atom. The radioactivity of any sample will decrease with time as the unstable atoms decay to more stable atoms, though sometimes by complex decay series route. Used radioisotopes and nuclear fuel must be processed into a safer form and the waste stored in long-term leak-proof containers which could be buried in a deep and well shielded storage area underground. Nuclear reactor/weapon waste is dangerously radioactive initially due to radioisotopes with short half-lives so it is stored in containers under water until it has 'cooled off' and is safer to handle.

### Half-Life:

Half-life is the time it takes for half of the radioactive **atoms** in radioactive material to **decay**. For example if the half-life of a substance was 1 hour - this means that after a time of 1 hour the number of radioactive atoms would reduce by half. After another hour the number of radioactive atoms would be halved again (i.e. the number of radioactive atoms remaining would be 1/2 of the original number). After another hour the number of radioactive atoms would be 1/4 of the original and so on. The overall mass of the container and its contents would be virtually unchanged (apart from the minimal mass lost as radioactive particles).

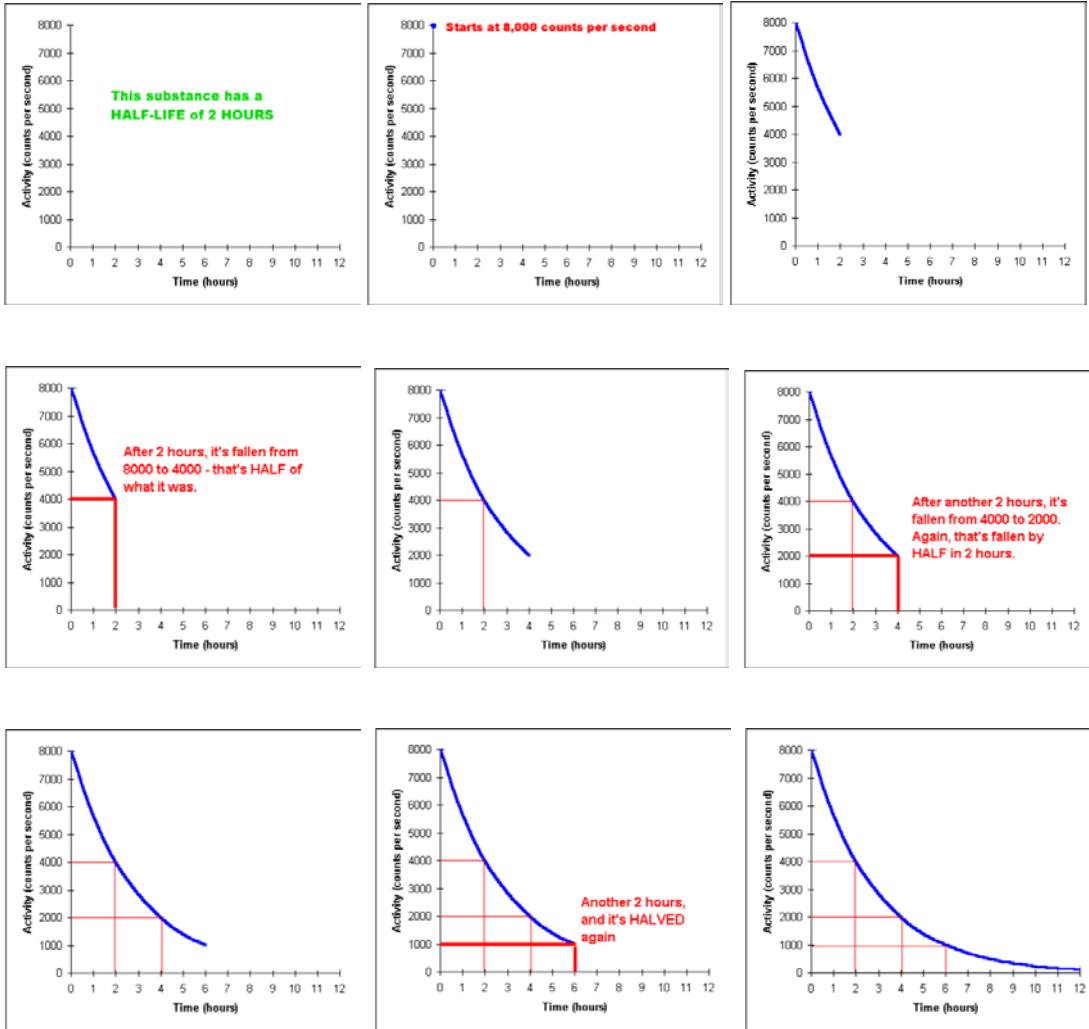


Since the activity of radioactive material is proportional to the number of radioactive atoms present, the activity reduces by half for each half-life.

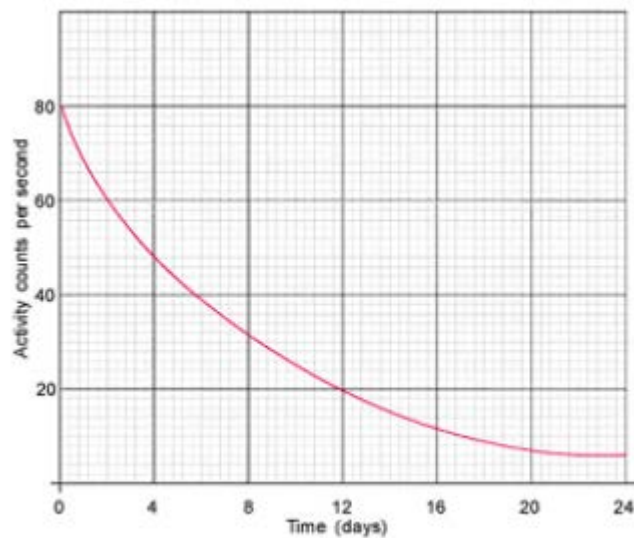


For example if the activity of a sample is 200 Bq, then after 1 half-life has elapsed the activity would be halved (i.e. 100 Bq). After two half-lives the activity would be 50 Bq and so on.

How to draw a half-life graph:



A half-life graph should be drawn at least 3.5 half-lives long.



If a radioactive substance has a very long half-life its radioactivity remains virtually constant. For example, many houses have a smoke alarm using a weak alpha source. A typical smoke detector uses a small amount of radioactive americium-241 which decays by alpha decay to neptunium with a half-life of 460 years so the radioactivity it gives off per second (Bq) is relatively constant.