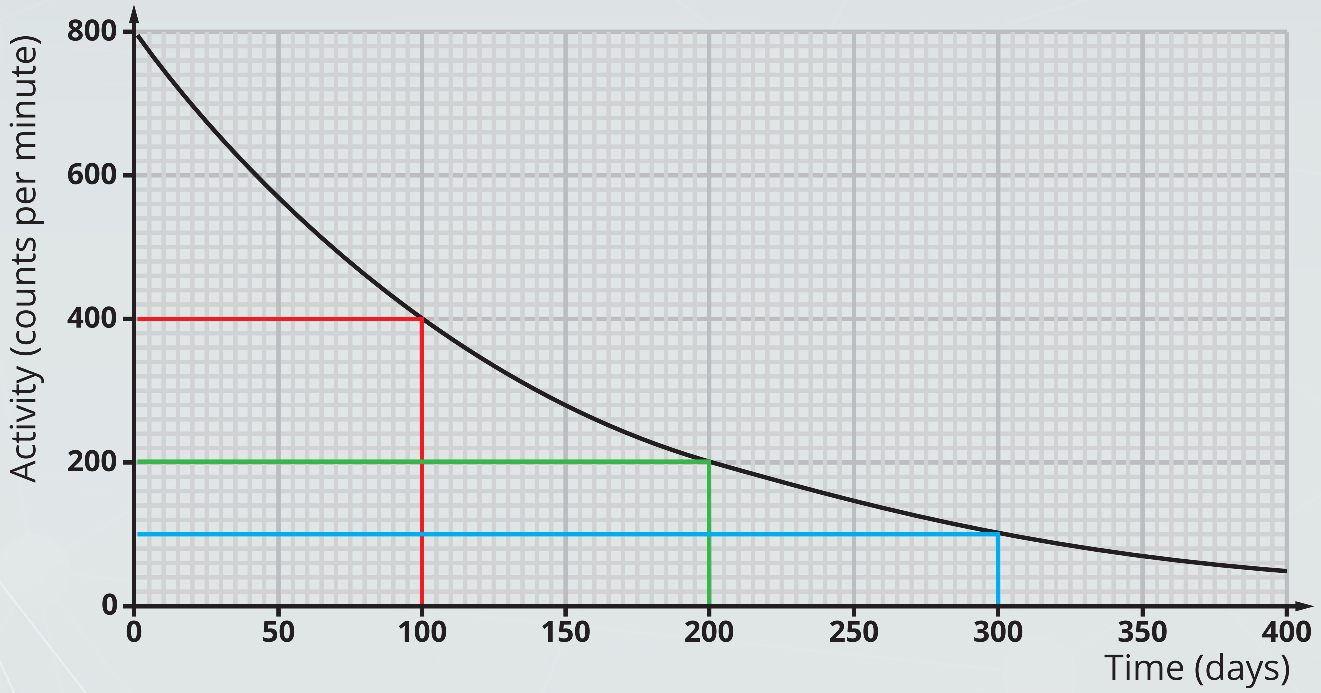
GCSE Physics Unit 2

2.8/6.6 Half-life

Half-life

Half life is defined as the **time** it takes for the activity of a radioactive source to **halve**, or the **time** it takes for **half** the radioactive nuclei to decay.

The half life for the radioactive source shown on the graph below is **100 days**. The time it takes for the activity to halve from 800 to 400 counts per minute(cpm) is 100 days, it takes the same time to halve from 400 to 200 cpm and from 200 to 100 cpm. The half-life of a radioactive isotope is always the same.



Calculations using half-life

At the start, 100% of the source has not decayed, after 1 half life this will be 50% and after 2 half lives 25%.

100% —1 half-life→ 50% —2 half-lives→ 25% —3 half-lives→ 12.5%

You can use the half-life of a material and this method to calculate the age of a sample or to predict the amount of a sample that will be left after a certain time.
For example, strontium-90 has a half-life of 29 years. The time it takes for the number of radioactive nuclei to drop to $\frac{1}{8}$ of its original value can be calculated using this technique.

$1 \xrightarrow{\text{1 half-life}} \frac{1}{2} \xrightarrow{\text{2 half-lives}} \frac{1}{4} \xrightarrow{\text{3 half-lives}} \frac{1}{8}$

Three half-lives would be; 3 × 29 years = 87 years

Uses of radioactive materials

Radioactive materials have many uses and are determined by their half-life and by the properties of the radiation they release, alpha, beta or gamma.

Use	Type of radiation	Half-life
Tracer A radioactive material is injected into the body and cameras are used to make an image of where the radiation is. This can take very detailed images of inside the body.	**Gamma** • Weakly ionising so it will have less effect on the cells in the body. • Very penetrating so it can pass through the body to be detected by the camera.	**Short** Activity decays to a safe level quickly.
Treating cancer inside the body A radioactive material is placed inside the tumour to kill the cancer cells.	**Beta** • Strongly ionising so it will kill the cells it is absorbed by. • Moderately penetrating so it can pass through the whole tumour to kill all the cells without affecting healthy cells.	**Short** Activity decays to a safe level quickly.
Treating cancer from outside the body Radiation is aimed at the tumour from outside the body.	**Gamma** • Very penetrating so can pass through the body to reach the cancer cells. • Weakly ionising so it has less effect on the healthy cells.	**Long** As the source is outside the body it can be stored safely and used time and time again.
Monitoring the thickness of paper or foil A source is placed on one side of a sheet of paper or foil and a detector on the other side. If the count is too low, not enough radiation could penetrate and the paper is too thick.	**Beta** • Moderately penetrating, can pass through the paper but the count wold be affected by the thickness. Alpha would not penetrate the paper at all, and gamma would not be affected by changing the thickness.	**Long** As the source can be stored safely and used time and time again.
Smoke detectors Radiation in the detector ionises the air, which creates a current. If there was smoke in the detector it would block the radiation and the current would change, setting off the alarm.	**Alpha** • Very ionising to create the current. • Least penetrating so will be blocked by smoke particles.	**Long** So that the activity does not change enough to change the current produced.