Isotopes and Nuclear Radiation

Isotopes

Different forms of the same element. Isotopes of an element have the same number of protons but a different number of neutrons:

$^{16}_{8}O$ 8 protons, **8 neutrons**

$^{18}_{8}O$ 8 protons, **10 neutrons**

All elements have isotopes but there are only a few that are stable. Others **decay** into other elements to become more **stable** by giving out radiation.

Radioactive Decay

	Type of particle	Properties	How ionising	Uses
Alpha α	alpha particle – two protons and two neutrons (helium nuclei).	Can only travel a few cm in air and are absorbed by a sheet of paper.	Very	Smoke alarms. The α-particles ionises air particles, causing a current to flow. Smoke will bind to the ions, stopping the current so the alarm sounds.
Beta β	A fast moving electron.	Have no mass and a charge of -1. Travel a few meters in air and are absorbed by about 5mm of aluminium.	Moderate	Testing thickness of sheets of metal.
Gamma γ	Are electromagnetic waves.	Usually pass through materials. Absorbed by thick sheets of lead or several meters of concrete.	Weakly	See EM waves sheet.

Irradiation and Contamination

Exposure to radiation (**irradiation**) can damage living cells by **ionising** atoms within them. Radioactive sources should be kept in lead lined boxes. Irradiation does not make something radioactive.

Contamination is where radioactive atoms get into something. Touching a radioactive source without gloves will contaminate your hands. The contaminating atoms can then **decay**, releasing harmful radiation.

Decay

Alpha decay causes the **charge** and **mass** of the nucleus to **decrease**:

Uranium-238 → Thorium-234 + α particle

$$^{238}_{92}U \rightarrow {}^{234}_{94}Th + {}^{4}_{2}He$$

Beta decay causes the **charge** of the nucleus to **increase**. When an electron is lost a proton is changed into a neutron:

Carbon-14 → Nitrogen-14 + β particle

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$$

Gamma rays do not change the mass or charge.

Half Life

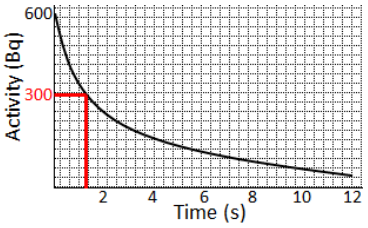
The time taken for the number of radioactive nuclei in an isotope to halve. Activity (the rate at which a source decays) is measured in becquerels Bq (1Bq = 1 decay per second).

eg. if the initial activity of a sample is 320Bq what will it be after two half-lives?

1 half life = 320 ÷ 2 = 160

2 half lives = 160 ÷ 2 = **80Bq**

As a % this is (80 ÷ 320) x 100 = 25%



Finding half-life from a graph:

- Mark where half the activity level is.
- Find the corresponding time (1.8s in this example)