

Radioactivity - Unit 1

What is the basic structure of an atom?	An atom is a small central nucleus composed of protons and neutrons surrounded by orbiting electrons.
What is a proton?	It is a positively charged particle that is found in the nucleus of an atom. It has a mass of 1u and a charge of +1
What is a neutron?	It is a neutrally charged particle that is found in the nucleus of an atom. It has a mass of 1u and a charge of 0
What is an electron?	It is a negatively charged particle that is found orbiting the nucleus of an atom. It has a negligible (NOT zero!) mass of and a charge of -1
What is the significance of the number of protons in the nucleus?	The atoms of an element always have the same number of protons
What is an isotopes of an element?	Isotopes of an element all contain the same number of protons but different numbers of neutrons in the nucleus.
What does radioactive mean?	Some isotopes give out nuclear radiation from the nuclei of their atoms all the time. These substances are said to be radioactive.
What can we do to change the rate of radioactive emission by a radioactive isotope?	Nothing! No change in external conditions like temperature or pressure changes the rate at which radiation is give out because the process is spontaneous.
What is nuclear radiation?	Radiation emitted from the nucleus of a radioactive atom
Name the three types of nuclear radiation.	Alpha, Beta and gamma
What is an alpha particle?	A helium nucleus (not atom!!!) - two neutrons and two protons bound together as a single particle.
What is a beta particle?	A beta particle is a high energy electron emitted from the nucleus. (This happens when a neutron changes into a proton and ejects an electron)
What is a gamma ray?	It is high frequency electromagnetic radiation emitted from the nucleus.
What is the charge and mass of an alpha particle?	Mass 4u (four atomic units) and charge +2
What is the charge and mass of a beta particle?	Mass is negligible (NOT zero!!) It is 1/1836 (about 1/2000 of an atomic unit) and charge -1
What is the charge and mass of a gamma ray?	Mass zero and charge zero
Which is the most ionising nuclear radiation?	Alpha (it doesn't get far so ionised densely in a small area near the source)
Which is the most penetrating nuclear radiation?	Gamma - gets a long way before interacting with matter as it has no charge or mass.
What is the range of alpha particles in air?	6cm
What is the range of beta particles in air?	1m
What is the range of gamma rays in air?	1km
What property has a particle got to have if it is to be deflected by a magnetic or electric field?	Charge
Which nuclear radiations are deflected by a magnetic field?	Alpha and beta (not gamma as it has no charge)

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Which nuclear radiations are deflected by electric fields?	Alpha and beta (not gamma as it has no charge)
If nuclear radiation interacts with matter what does it do to it?	It ionises it (makes the atoms lose electrons and become ions)
Why is nuclear radiation dangerous to humans?	Because it can ionise DNA in cells resulting in mutations or tumours (cancer)
Which of the nuclear radiations is the most hazardous to human health?	Outside the body - gamma (because it can penetrate and damage cells of internal organs); Ingested - alpha (because the high ionisation power results in highly localised damage to tissue near to the source)
What happens to the activity of a source with a long half life?	A long half-life source will have a steady output at whatever rate it is emitting at initially - steady stream of radiation. This is because it takes millions of years for the activity to halve - so in a few weeks the change would not be noticeable!
What happens to the activity of a source with a short half life?	Its output will rapidly decrease to background level (halving every half life period - every few minutes or hours)
What can we use to absorb all of the emissions from an alpha source?	A piece of paper
What can we use to absorb all of the emissions from a beta source?	A few mm of aluminium
What can we use to absorb all of the emissions from a gamma source?	A thick piece of lead or several metres of dense concrete.
What is used to detect nuclear radiation?	A Geiger counter
Does paper absorb gamma rays?	Some will interact with the paper but a large percentage of the rays will go straight through - a detector would probably not notice the difference.
Does paper absorb beta particles?	Some will interact with the paper but a large percentage of them will go straight through - a detector would probably not notice much difference.
What happens as you use a thicker sheet of aluminium to shield a beta source?	The thicker the sheet of aluminium the more betas will be absorbed, so the count on the Geiger counter gets lower.
What safety precautions should you take when handling radioactive sources?	You should handle them with tongs (NOT tongues!); point them away from yourself and others; never drop them; wash your hands after dealing with them; store them in a lead-lined box whenever not in use in a securely locked cupboard.
What does a radioactive tracer do?	A radioactive tracer allows us to follow the path that a particular compound or element takes through a system (often through a living system - plant or animal) by tagging it by using a radioactive version of an atom to replace the normally used non-radioactive one.
What are short half life gamma ray emitters used for?	(1) Medical tracers - used with gamma camera (2) Tracers in industry - detecting routes of underground rivers and streams

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What are long half life gamma emitters used for?	(1) High activity - radiotherapy (2) High activity - sterilisation of medical surgical instruments (3) High activity - irradiation of food to kill bacteria and prolong shelf life (4) Thickness control of metal sheets (when too thick for beta) in manufacturing and industry
What are long half life beta emitters used for?	(1) Thickness control of very thin metal sheets (aluminium foil), paper or cardboard in manufacturing and industry (2) Emergency sign lighting
What are short half life beta emitters used for?	(1) Tracers in industry - detecting leaks in pipes (2) Tracers in botany experiments - e.g. phosphorus 32 is a beta emitter - taken up by the plant - can be detected outside the plant as beta penetrates thin plant structures easily - half life of 14 days makes it ideal for this.
What are long half life alpha emitters used for?	(1) Smoke detectors; (2) Gas lamp mantles; (3) Nuclear batteries
What are short half life alpha emitters used for?	Nothing! - too dangerous!
Define half-life.	The half-life of a radioactive isotope is defined as the time it takes for the number of nuclei of the radioisotope in a sample to halve or the time it takes for the count rate from a sample containing the isotope to fall to half its initial level.