

P4 Radiation: hazards and medical uses

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Use alongside the shared topic notes. Foundation + Higher content.

Background and dose

Background radiation is always present. Natural sources include rocks and cosmic rays; artificial sources include fallout from weapons testing and nuclear accidents.

Sources vary with place and occupation



Natural sources + artificial sources

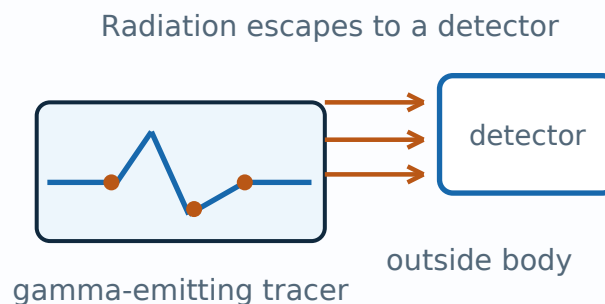
Dose depends on location and occupation. Compare evidence rather than assuming every exposure has the same risk.

Dose is measured in sieverts: **1 Sv = 1000 mSv**. AQA does not require recall of this unit.

Choose a useful half-life

Radioisotope half-lives range widely. For the same number of unstable nuclei, a shorter half-life gives a higher activity.

A short half-life may create a high initial hazard but activity falls quickly. A long half-life may keep material hazardous for much longer.



A medical tracer should emit radiation detectable outside the body and have a half-life long enough for the test, but short enough to limit the patient's dose.

Balance benefit and risk

Diagnosis: a suitable tracer follows a body process; a detector maps radiation leaving the body. Gamma radiation can escape from inside the patient.

Treatment: targeted radiation damages or destroys unwanted tissue. Healthy tissue can also be harmed, so dose and targeting matter.

External beams can be directed from several angles so the tumour receives a larger total dose than surrounding tissues.

Evaluate benefits against risks using the supplied data, the seriousness of the condition, dose and available alternatives.

Do not confuse: irradiation is exposure to radiation; contamination is the unwanted presence of radioactive material on or in something.

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P4 Nuclear fission and fusion

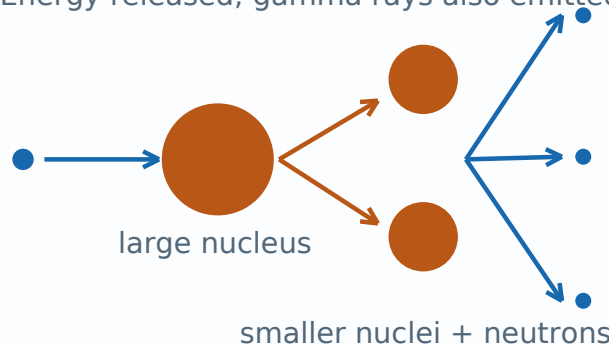
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Fission: a nucleus splits

Fission splits a large unstable nucleus, such as uranium or plutonium. Spontaneous fission is rare; usually a neutron is first absorbed.

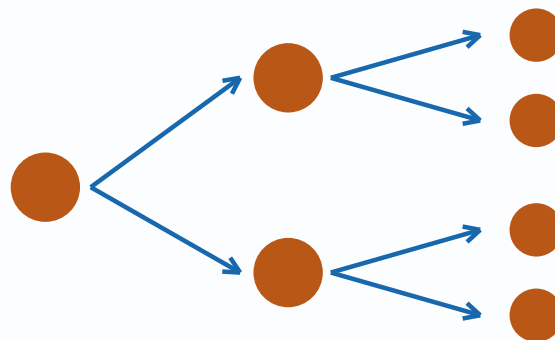
Energy released; gamma rays also emitted



Two smaller nuclei, two or three neutrons and gamma rays are produced. Energy is released; the fission products have kinetic energy.

Read diagrams by tracking the incident neutron, the parent nucleus and the emitted products.

A chain reaction develops



Emitted neutrons can trigger more fissions

Emitted neutrons can be absorbed by other unstable nuclei, causing further fissions and more neutron emission.

In a reactor the chain reaction is controlled so energy is released at a controlled rate. An uncontrolled chain reaction releases energy very rapidly.

Explain the chain: neutron absorbed → nucleus splits → neutrons released → more nuclei split.

A neutron that escapes the material or is absorbed without fission does not continue that branch of the chain.

Fusion: light nuclei join

Nuclei join; energy can be released



Fusion powers stars

Fusion joins two light nuclei to make a heavier nucleus. Some mass may be converted into the energy of radiation.

Very high temperatures allow nuclei to approach closely enough to fuse despite electrical repulsion between their positive charges.

Compare: fission splits a heavy nucleus; fusion joins light nuclei. Both can release energy through changes in nuclei.

Fusion is the source of energy in stars. It is a nuclear process, not chemical burning.