Lesson 5 – Waves & radiation part 2

(all answers are given in the online video)

1. First Question – discussing some uses of nuclear radiation.

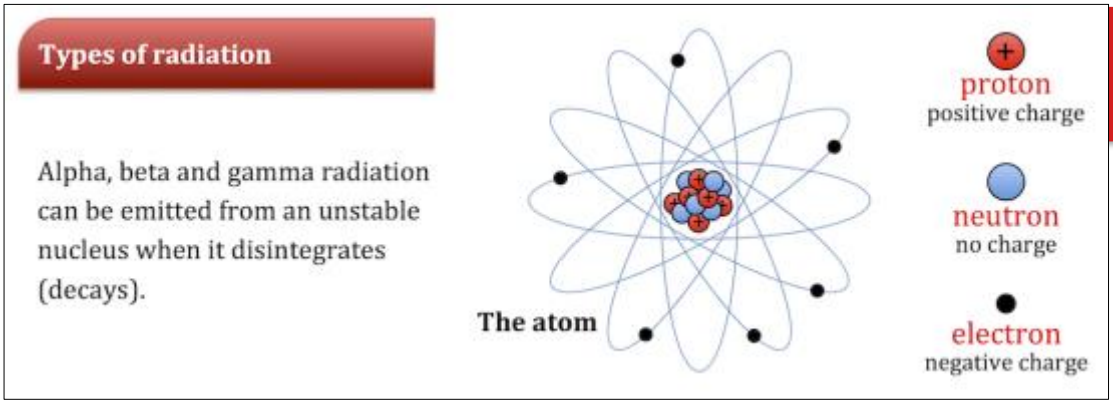
A smoke detector contains Americium-241, which is a source of alpha radiation, with a half-life of 432 years.

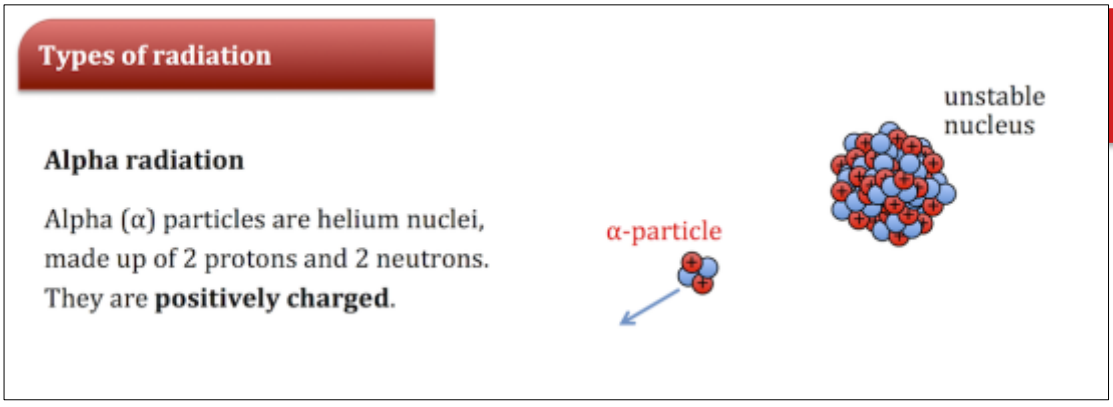
(a) State two reasons why Americium-241 would be a poor choice as a radioactive tracer to be injected into a patient's body.

A smoke detector contains Americium-241, which is a source of alpha radiation, with a half-life of 432 years.

(b) State two other uses of nuclear radiation.

2. A quick lesson on the nature and properties of alpha, beta and gamma radiation.





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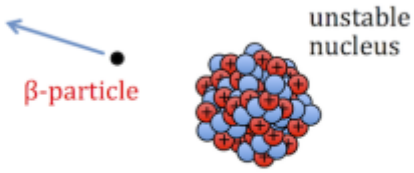
Types of radiation

Beta radiation

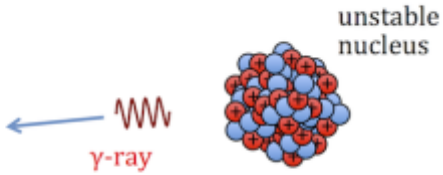
Beta (β) particles are fast moving electrons, travelling at ~90% of the speed of light. They are **negatively charged**.



Types of radiation

Gamma radiation

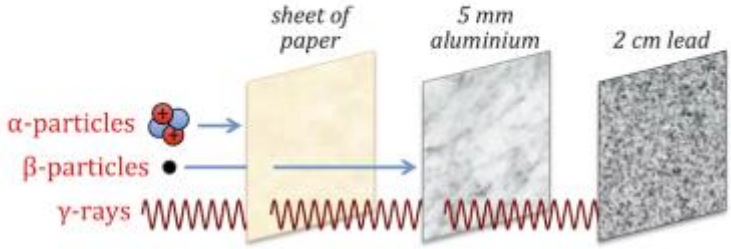
Gamma (γ) rays are part of the electromagnetic spectrum, travelling at the speed of light. They have **no charge**.



penetrating power…

Types of radiation

Gamma rays are most penetrating, followed by beta particles then alpha particles.

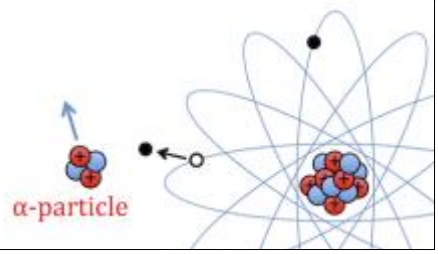


and, finally, ionisation…

Types of radiation

Ionisation – the removal of an electron from a neutral atom, leaving it positively charged.

most ionising - α-particles
then - β-particles
least ionising - γ-rays



All diagrams and questions by Mr I. Smith

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3. The first of two questions on half-life.

The half-life of Francium-223 is 20 minutes.

Calculate the time taken for the activity of a sample of Francium-223 to decrease to $\frac{1}{32}$ of its original value.

4. Be careful with this one – note that the values give are **total** count rate (not corrected for background).

During an experiment, a **total** count rate of 340 counts per minute (cpm) was recorded when a sample of Iodine-131 was placed close to a Geiger-Müller tube and counter.

When the experiment was repeated 24 days later with the same source, the total count rate was found to be 60 cpm. The background count rate was measured to be 20 cpm.

(a) Calculate the half life of the Iodine-131 source.

During an experiment, a **total** count rate of 340 counts per minute (cpm) was recorded when a sample of Iodine-131 was placed close to a Geiger-Müller tube and counter.

When the experiment was repeated 24 days later with the same source, the total count rate was found to be 60 cpm. The background count rate was measured to be 20 cpm.

(b) State one factor which affects the background radiation level.

During an experiment, a **total** count rate of 340 counts per minute (cpm) was recorded when a sample of Iodine-131 was placed close to a Geiger-Müller tube and counter.

When the experiment was repeated 24 days later with the same source, the total count rate was found to be 60 cpm. The background count rate was measured to be 20 cpm.

(c) State the meaning of the term half-life.

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5. If you're struggling with the terms in these equations and their units, visit *physics-podcast.co.uk* for the PDF document 'Help with the relationships sheet'.

Radiation equations

$$A = \frac{N}{t} \qquad D = \frac{E}{m}$$

$$H = D\omega_R \qquad \dot{H} = \frac{H}{t}$$

- A – *activity (bequerels, Bq)*
- N – *number of nuclei decaying*
- t – *time (s)*
- D – *absorbed dose (grays, Gy or $J kg^{-1}$)*
- E – *energy (joules, J)*
- m – *mass (kg)*
- H – *equivalent dose (sieverts, Sv)*
- ω_R – *radiation weighting factor (no units)*
- $\dot{H}$ – *equivalent dose rate ($Sv s^{-1}$ / $Sv m^{-1}$ etc...)*

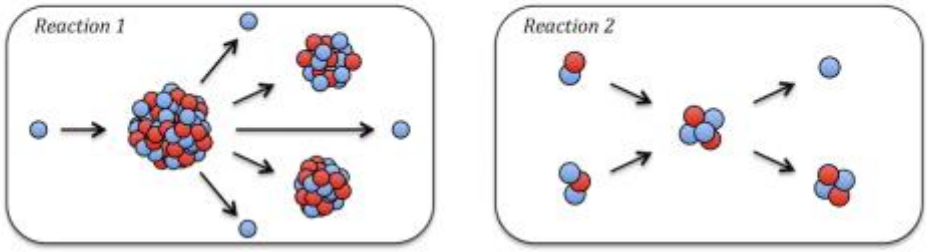
6. Remember to spend some time working with all four of the equations – this is just a quick example.

A worker in a nuclear power plant spends 9 hours in an area where the equivalent dose rate is 190μSvh^{-1}.

Calculate the equivalent dose the worker receives during the 9 hour period.

7. Last one!

The diagram below illustrates two types of nuclear reaction. Name both and state the difference between the two reactions.



All questions and slides were covered in the lesson.