Your notes

GCSE Physics: revision notes

Radioactive decay and nuclear radiation

Contents

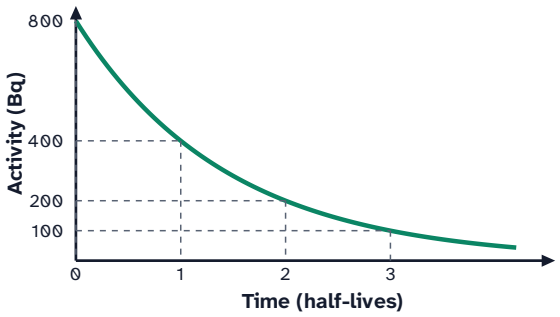
1. Start here: unstable nuclei
2. Radioactive decay
3. Types of nuclear radiation
4. Properties
5. Nuclear equations
6. Exam tip
7. Common mistakes
8. Worked examples
9. Key terms
10. Quick questions
11. What to do next

Start here: unstable nuclei

- Some nuclei are unstable: they have too many neutrons, or are too big. They give out radiation to become more stable. This is **radioactive decay**.
- Decay is random: you cannot say when one nucleus will decay, but with billions of them you can predict how quickly the **activity** falls.
- **Activity** is the number of nuclei that decay each second, measured in becquerels (Bq). The half-life is the time it takes for the **activity** to halve.

Radioactive decay

- Some atomic nuclei are unstable. The nucleus gives out radiation as it changes to become more stable. This is **radioactive decay**, and it is a random process.
- **Activity** is the rate at which a source of unstable nuclei decays, measured in becquerels (Bq). 1 Bq = 1 decay per second.
- **Count rate** is the number of decays recorded each second by a detector, such as a **Geiger–Müller tube**.



Types of nuclear radiation

- **Alpha particle** (α): two protons and two neutrons, the same as a helium nucleus.
- **Beta particle** (β): a high-speed electron ejected from the nucleus as a neutron turns into a proton.
- **Gamma ray** (γ): electromagnetic radiation from the nucleus.
- A nucleus can also emit a neutron.

Properties

- Alpha: strongly **ionising**; travels only a few centimetres in air; stopped by a sheet of paper or skin.
- Beta: moderately **ionising**; travels about a metre in air; stopped by a few millimetres of aluminium.
- Gamma: weakly **ionising**; travels a very long distance in air; reduced by several centimetres of lead or a thick layer of concrete.

Nuclear equations

- Alpha decay: the mass number goes down by 4 and the atomic number by 2. Example: $^{219}_{86}Rn \rightarrow {}^{215}_{84}Po + {}^{4}_{2}He$.
- Beta decay: the mass number stays the same and the atomic number goes up by 1. Example: $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$.
- Gamma emission does not change the mass or the charge of the nucleus.
- In every equation, the mass numbers and the atomic numbers must balance on both sides.

Exam tip

- Balance nuclear equations at the top and the bottom.
- To read a half-life from a graph, find the time the **count rate** takes to halve. Show the lines you've drawn.

Your notes

Common mistakes

- Thinking two half-lives leave nothing. They leave a quarter.
- Mixing up irradiation and contamination.
- Saying alpha is the most penetrating. It's the least penetrating, and the most **ionising**.

Worked examples

A source has an activity of 600 Bq and a half-life of 2 hours. What is its activity after 6 hours?

Work out how many half-lives have passed. **6 ÷ 2 = 3 half-lives**

Halve the activity once for each half-life. **600 → 300 → 150 → 75**

Answer: 75 Bq

Key terms

Radioactive decay	The random process in which an unstable nucleus gives out radiation to become more stable.
Activity	The rate at which a source decays, measured in becquerels (Bq).
Count rate	The number of decays recorded each second by a detector.
Alpha particle	Two protons and two neutrons (a helium nucleus).
Beta particle	A high-speed electron from the nucleus, formed when a neutron turns into a proton.
Gamma ray	High-energy electromagnetic radiation emitted from the nucleus.
Ionising	Able to knock electrons off atoms, forming ions.
Geiger–Müller tube	A detector that measures nuclear radiation.

Quick questions

Cover the answers and test yourself: remembering is what makes it stick.

1. What is an alpha particle made of?
2. What is a beta particle?
3. Which radiation is the most ionising?
4. Which radiation is stopped by a sheet of paper?
5. What is needed to reduce gamma radiation significantly?
6. What is the unit of activity?
7. In alpha decay, what happens to the mass number?

Your notes

8. In beta decay, what happens to the atomic number?

Answers

1. Two protons and two neutrons
2. A high-speed electron from the nucleus
3. Alpha
4. Alpha
5. Several centimetres of lead or thick concrete
6. Becquerel (Bq)
7. It decreases by 4
8. It increases by 1

What to do next

Practise 11 questions on this topic

Try 7 exam questions, with mark schemes

Read the lesson, one step at a time

Free revision for GCSE and KS3 at lycolearn.co.uk. Some notes are for one exam board only, and say so in brackets.

Your notes