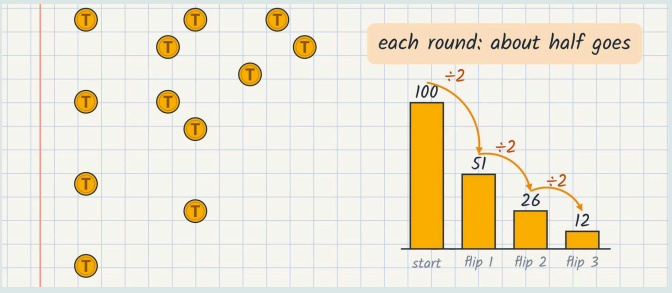
Half-life

random decay, graphs and net decline

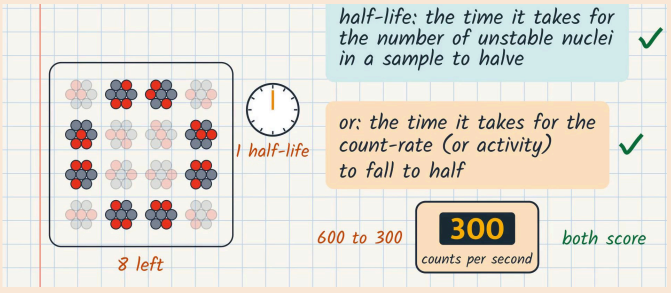
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Summary sheet

1 The coin model



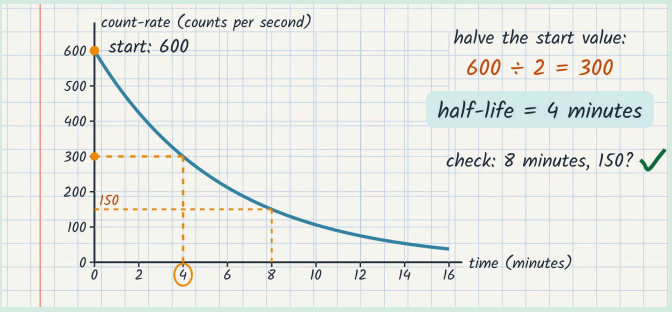
- Radioactive decay is **random**: we can't say which nucleus decays next. Model: flip 100 coins; heads = decayed, taken away. Each round **about half** of what's left goes (100, about 50, 25, 12).
- A nucleus never decays by half: each one decays **completely**, at a random moment. It's the **group** that halves.

2 What half-life means



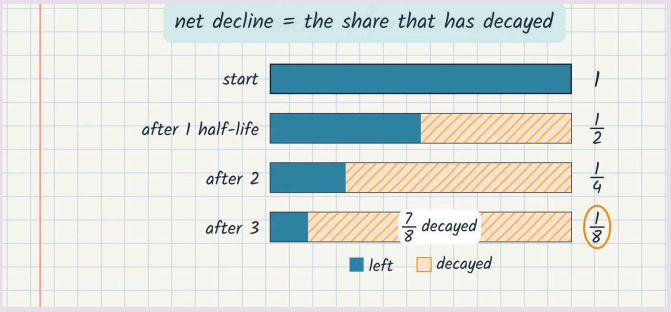
- **Half-life**: the time it takes for the number of **unstable nuclei** in a sample to halve.
- Or: the time it takes for the **count-rate** (or **activity**) to fall to half. Both definitions score. Every isotope has its own half-life, from a fraction of a second to thousands of years, and it never changes.

3 Reading a graph



- Halve the start value (600 to 300 counts per second), go **across** to the curve, then **down** to the time axis: half-life = 4 minutes. Check: after 8 minutes it is 150.
- From numbers, use a **halving ladder**: 960, 480, 240, 120, 60 is **4 halvings** = 4 half-lives. Don't divide 960 by 60 (16 is wrong).

4 Net decline (Higher)



- After 1, 2, 3 half-lives the fraction left is 1/2, 1/4, 1/8. After 3 half-lives 7/8 have decayed: the **net decline** is 7/8 of the start.
- Example: 1600 Bq, half-life 5 days, after 15 days: 15 ÷ 5 = 3 half-lives; 1/8 × 1600 = 200 Bq left; decline = 1400 Bq (7/8 of the start). After n half-lives: left = $(1/2)^n$, decline = $1 - (1/2)^n$.

Exam tip
Count-rate is counts per second. Half-life is a time, so its unit is seconds, minutes, days or years.

Check yourself

- 1 A count-rate falls from 800 to 200 in 6 hours. What is the half-life?
- 2 Higher: what fraction of the nuclei have decayed after 2 half-lives?

Answers: 1. 3 hours (800, 400, 200: 2 half-lives in 6 h) 2. Three quarters (a quarter is left)