SCIENCE FOUNDATIONS

Half-life calculations

Difficulty level: Advanced

Science Foundations

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Overview of the concept

This is how doctors work out how long a medicine or a radioactive tracer stays active in your body, and how scientists date ancient bones and rocks. A nuclear medicine tech times a scan so the tracer is still strong enough to show up but fades away soon after. An archaeologist dates a piece of charcoal by how much of its carbon has already decayed. Knowing half-life tells you how fast something fades, and how long to wait before it is effectively gone.



Rule

Half-life calculations: a half-life is the time for half of a sample to decay.

After each half-life, half of what was left remains, so after two half-lives $\frac{1}{4}$ remains and after three half-lives $\frac{1}{8}$ remains.

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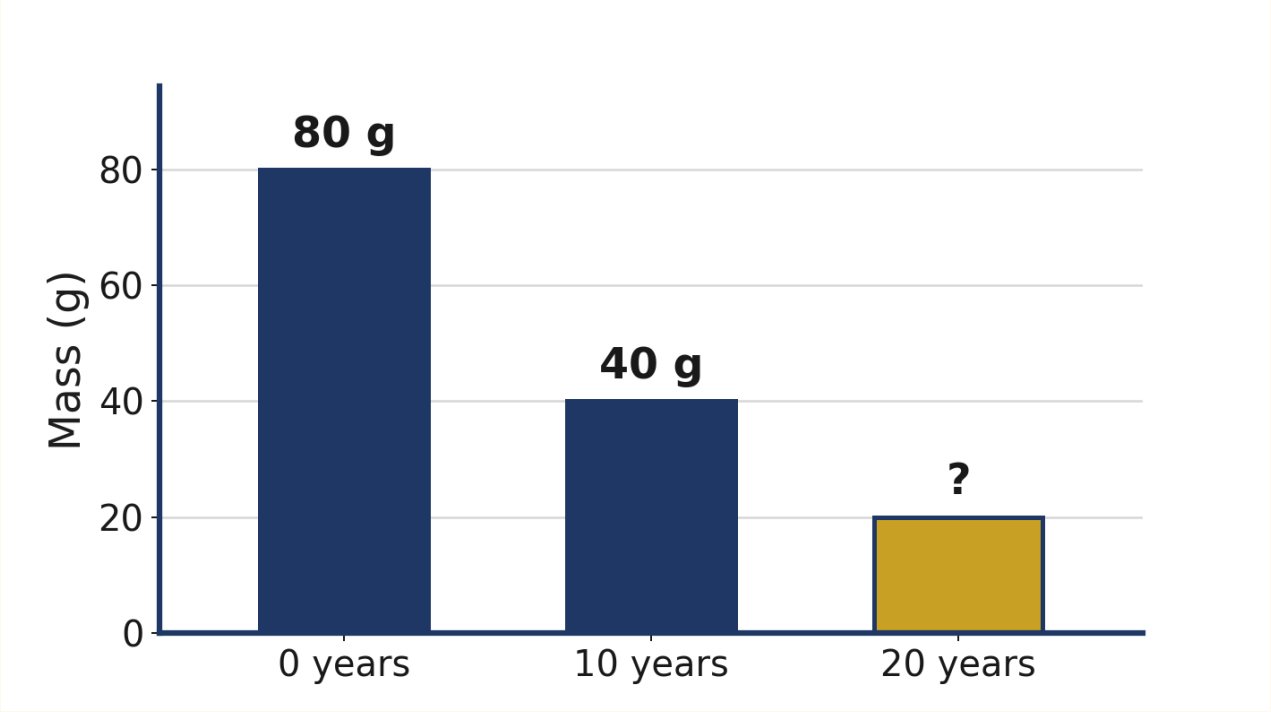
Worked examples

EXAMPLE 1

Q A sample of 80 g has a half-life of 10 years. Mass left after 20 years?



SOLUTION

Count half-lives:

20 ÷ 10 = 2 half-lives

Halve step by step: 80 to 40 after one, 40 to 20 after two.

State the remaining mass.

The result is 20 g remains.

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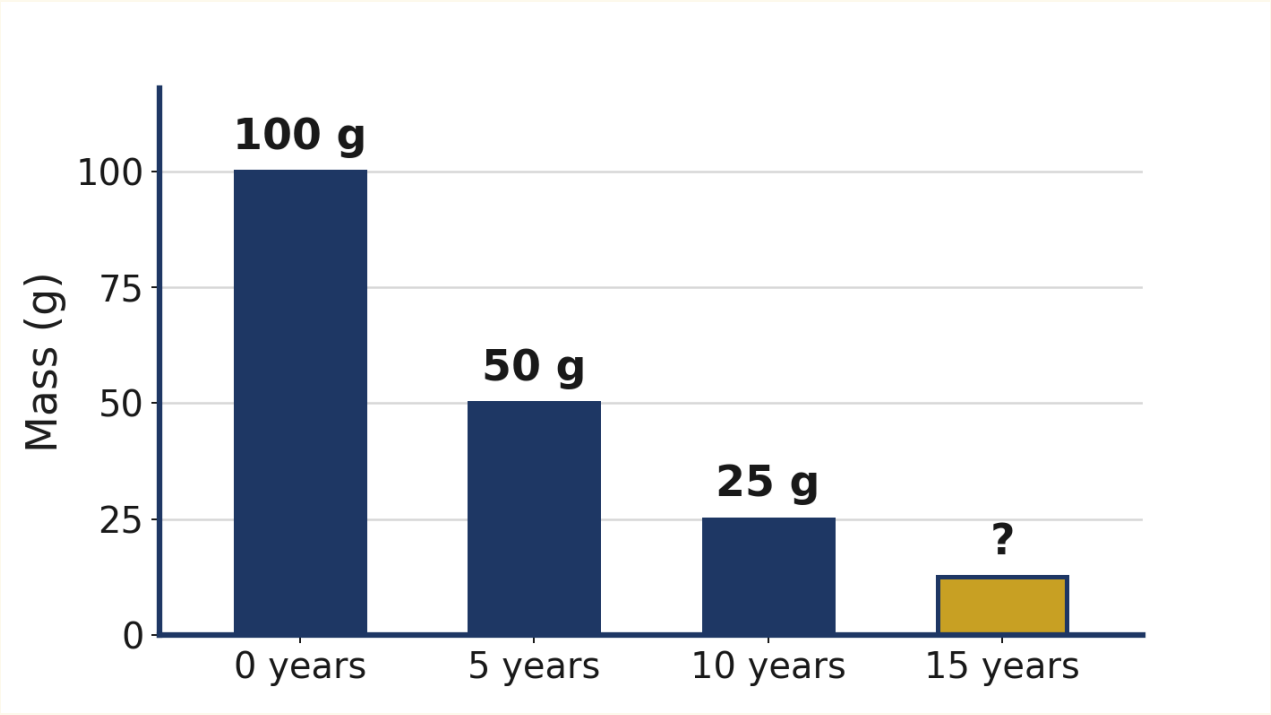
EXAMPLE 2

Q A sample of 100 g has a half-life of 5 years. Mass left after 15 years?



SOLUTION

Count half-lives:

15 ÷ 5 = 3 half-lives

Halve step by step: 100 to 50, to 25, to 12.5.

State the remaining mass.

The result is 12.5 g remains.

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Practice questions

1 Half-life definition?

- A The time for a whole sample to decay
- B The time for half of a sample to decay
- C Half the mass of a sample
- D The time for a sample to double

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2 120 g, half-life 8 years, after 24 years?

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3 **A sample has a half-life of 6 years. How many half-lives pass in 18 years?**

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4 **After one half-life, what fraction remains?**

A One quarter

B One half

C One eighth

D Three quarters

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5 A sample of 64 g decays to 16 g. How many half-lives have passed?

- **A** 2
- **B** 1
- **C** 3
- **D** 4

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6 A sample has a half-life of 4 days. How long until only one eighth of it remains?

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7 A sample decays from 200 g to 25 g. Its half-life is 2 hours. How long did that take?

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8 After 3 days, 6.25 g remains from a 50 g sample. What is the half-life?

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9 Does half-life depend on sample size?

A Yes

B No

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10 A sample of 80 g has a half-life of 10 years. After 40 years, what fraction of the original sample remains?

A $\frac{1}{16}$

B $\frac{1}{2}$

C $\frac{1}{4}$

D $\frac{1}{8}$

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ANSWER KEY

1. The time for half of a sample to decay

2. 15 g

3. 3

4. One half

5. 2

6. 12 days

7. 6 hours

8. 1 day

9. No

10. $\frac{1}{16}$

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