Half-life example calculations

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Boston University

Half-life calculations

Fundamental relation

$(1/2)^n N_0 = N$

1. Half life is n for $N/N_0 = 1/2$; independent of N_0.
2. Given N/N_0 after time t, calculate n, and then $t_{half} = t/n$
3. Given n, calculate N/N_0, the fraction remaining after $t = n\ t_{half}$

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Half-life is 33 minutes. **What fraction remains** after 75 minutes?

Strategy: Use n = 75/33 and then
fraction remaining = $N/N_0 = (1/2)^n$

Answer: n = 75/33 = 2.3, $(1/2)^n$ = **0.21 (21%)**

Half-life calculations

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Half-life is 11 days. **How long to decay** by 10%?

Strategy: Use $N/N_0 = 0.90$, solve $N/N_0 = (1/2)^n$ for $n = time/t_{half}$, and so time = n x t_{half}

Answer: $\log[(1/2)^n] = -\ n \log(2) = \log(N/N_0)$
so $n = -\log(N/N_0)/\log(2)$
$= -\log(0.90)/\log(2) = 0.152$,
hence, time = 0.152 x 11 days = **1.7 days**

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A sample decays by 25% in 15 minutes. **What Is its half-life**?

Strategy: Use $N/N_0 = 0.75$ and n = 15 min/t_{half},
solve $N/N_0 = (1/2)^n$ for $n = time/t_{half}$,
and so t_{half} = time/n

Answer: $n = -\log(N/N_0)/\log(2)$
$= -\log(0.75)/\log(2) = 0.415$,
hence t_{half} = 15/0.415 minutes = **36 minutes**

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CPS lesson: Half-life examples

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