

Decaying Physics

1. A sample of element A is known to have a half life of 1.0 days. It decays to stable element B. Suppose you start with a pure 64 mole sample of element A.

a. Complete the table of the amount of each element for each day.

| Day | Element A | Element B |
|-----|-----------|-----------|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

b. Sketch the graphs of the quantities of each element for each day.

2. The equation for decay can be written as $N = N_0 \left(\frac{1}{2}\right)^{\frac{t}{t_{1/2}}}$. It can also be written as $N = N_0 e^{-\lambda t}$ where λ is the decay constant. Find the relationship between λ and $t_{1/2}$.
3. A pure sample of 125 g is found to have decayed to contain 15.0 g of the original element after 24 hours. Calculate the half-life of the sample.
4. Carbon-14 has a half-life of 5730 years.
- What is the probability that a given nucleus will have decayed after one half-life has passed?
 - What is the probability that it will decay after three half-lives have passed?
 - A given nucleus has not decayed after three half-lives have passed. What is the probability that it will decay in the next half-life?
5. Polonium-210 decays through alpha decay with a half-life of 138 days. The daughter product is stable.
- Identify the daughter product of the decay.
 - A sample of pure Po-210 is created in a lab. Describe the composition of the sample:
 - 138 days later
 - 1 year later
 - 2 years later
6. The half-life of radium-226 is 1600 yr.
- Calculate the decay constant.
 - What is the activity of 1.0 g of radium-226 (molar mass = 226.025 g/mol)? (The unit for activity is Becquerel (Bq).)

7. The half-life of an unstable element is 12 days. Calculate the activity of a given sample of this element after 20 days if the initial activity was 3.5 MBq.

8. A radioactive isotope of half-life 6.0 days used in medicine is prepared 24 h prior to being administered to a patient. If the activity must be 0.50 MBq when the patient receives the isotope, what number of atoms of the isotope should have been prepared?

9. The age of very old rocks can be found from uranium dating. Uranium is suitable because of its very long half-life (4.5×10^9 yr). The final stable product in the decay series of U-238 is Pb-206. Find the age of rocks that are measured to have a ratio of lead to uranium atoms to 0.80. Assume that the only lead present is due to uranium decay.