

Lesson 2: Half-Lives

Objective:

- *Calculate the half-lives of selected nuclides*

Radioactive isotopes are unstable, which means that they spontaneously (readily) decay (break apart) into different isotopes or elements. Radioactive isotopes give off radiation during the process of radioactive decay. Radiation can be in the form of particles (alpha, beta, or positron) and/or pure energy (gamma rays). For radioactive isotopes, the rate (speed) of radioactive decay is constant. All radioactive isotopes have a specific **half-life**, or **time that it takes for exactly half of the sample to decay into something else and half of the sample to remain unchanged**. It is because of information about half-lives that we can know how old the Earth is and how old fossils are.

Half-Life Problems

Time Elapsed

1. How long will it take for 30. g of ^{222}Rn to decay to 7.5 g?

2. How long will it take for a 28 g sample of ^{226}Ra to decay to 3.5 g?

Amount Remaining

3. How many grams of ^{16}N will be left from a 16.0 g sample after 21.6 s?

4. After 9.8×10^{10} years, how many grams will be left from a 256 g sample of Th-232?

Fraction Remaining:

5. What fraction of a 100 g sample of K-42 will remain after 24.8 hours?
6. What fraction of a radioactive I-131 sample would remain unchanged after 32.28 days?

Number of Half-Lives

7. How many half-life periods will it take for 50 g of ^{99}Tc to decay to 6.25 g?
8. How many half-lives have elapsed if a 100 g sample of a radioactive isotope has only 12.5 g remaining?

Original Mass:

9. If 2 grams of an original sample of gold-198 remained after 13.45 days, what was the mass of the original sample?
10. If 16.5 g of uranium-235 remain after 2.84×10^9 years, how much of the radioactive isotope was in the original sample?

Half Life:

11. An original sample of the radioisotope fluorine-21 had a mass of 80.0 milligrams. Only 20.0 milligrams of this original sample remain unchanged after 8.32 seconds. What is the half-life of fluorine-21?
12. What is the half-life of a 208 g sample of sodium-24 if it decays to 13.0 g of sodium-24 within 60.0 hours?

Lesson 2: Half-Lives

Objective:

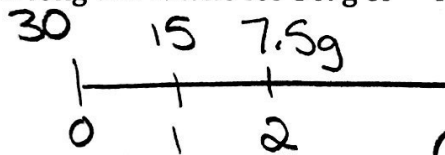
- Calculate the half-lives of selected nuclides

Radioactive isotopes are unstable, which means that they spontaneously (readily) decay (break apart) into different isotopes or elements. Radioactive isotopes give off radiation during the process of radioactive decay. Radiation can be in the form of particles (alpha, beta, or positron) and/or pure energy (gamma rays). For radioactive isotopes, the rate (speed) of radioactive decay is constant. All radioactive isotopes have a specific **half-life**, or **time that it takes for exactly half of the sample to decay into something else and half of the sample to remain unchanged**. It is because of information about half-lives that we can know how old the Earth is and how old fossils are.

Half-Life Problems

Time Elapsed

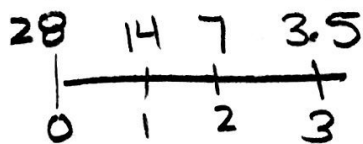
1. How long will it take for 30. g of ^{222}Rn to decay to 7.5 g?



$$\frac{1}{2} = 3.823\text{d (Table N)}$$

$$(3.823\text{d})(2) = \boxed{7.646\text{d}}$$

2. How long will it take for a 28 g sample of ^{226}Ra to decay to 3.5 g?



$$\frac{1}{2} = 1599\text{y}$$

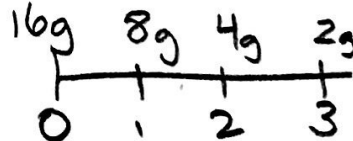
$$(1599\text{y})(3) = \boxed{4797\text{y}}$$

Amount Remaining

3. How many grams of ^{16}N will be left from a 16.0 g sample after 21.6 s?

$$\frac{1}{2} = 7.13\text{s (Table N)}$$

$$\frac{21.6\text{s}}{7.13\text{s}} = 3$$

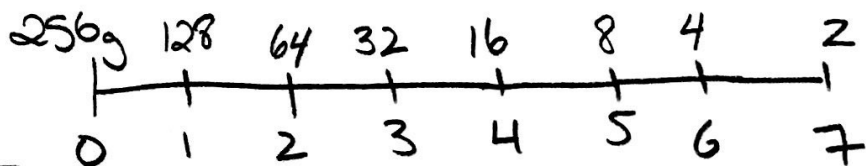


$$\boxed{2\text{g}}$$

4. After 9.8×10^{10} years, how many grams will be left from a 256 g sample of Th-232?

$$\frac{9.8 \times 10^{10}}{1.4 \times 10^{10}} = 7$$

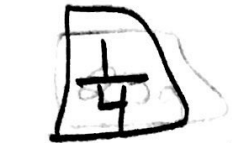
$$\frac{1}{2} = 1.40 \times 10^{10}\text{y}$$



$$\boxed{2\text{g}}$$

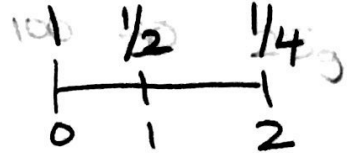
Fraction Remaining:

5. What fraction of a 100 g sample of K-42 will remain after 24.8 hours?

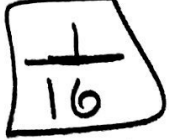


$\frac{1}{2} = 12.36h$

$\frac{24.8h}{12.36h} = 2$

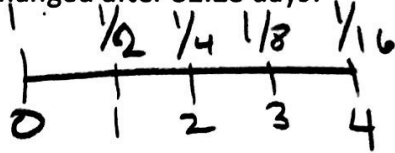


6. What fraction of a radioactive I-131 sample would remain unchanged after 32.28 days?



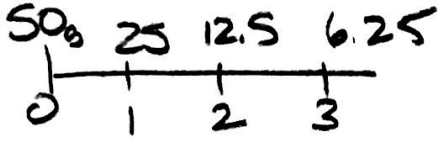
$8.021d$

$\frac{32.28}{8.021} = 4$



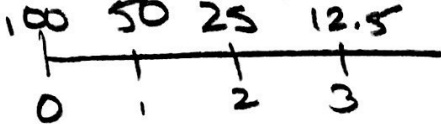
Number of Half-Lives

7. How many half-life periods will it take for 50 g of ⁹⁹Tc to decay to 6.25 g?



3

8. How many half-lives have elapsed if a 100 g sample of a radioactive isotope has only 12.5 g remaining?

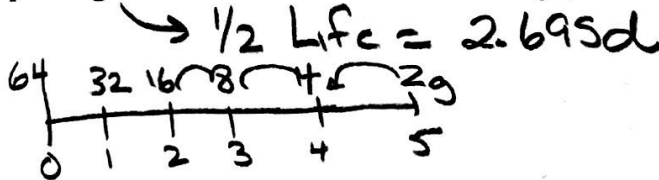


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Original Mass:

9. If 2 grams of an original sample of gold-198 remained after 13.45 days, what was the mass of the original sample?

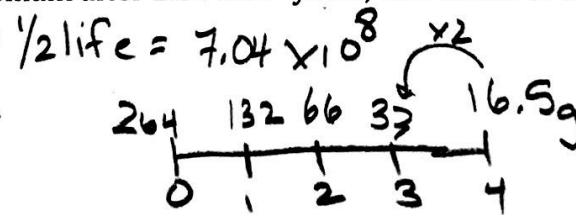
$\frac{13.45d}{2.695d} = 5$



64g

10. If 16.5 g of uranium-235 remain after 2.84×10^9 years, how much of the radioactive isotope was in the original sample?

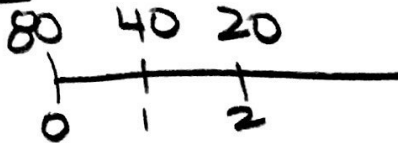
$\frac{2.84 \times 10^9}{7.04 \times 10^8} = 4$



264g

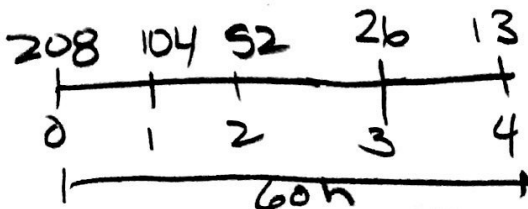
Half Life:

11. An original sample of the radioisotope fluorine-21 had a mass of 80.0 milligrams. Only 20.0 milligrams of this original sample remain unchanged after 8.32 seconds. What is the half-life of fluorine-21?



$\frac{8.32s}{2} = 4.16s$

12. What is the half-life of a 208 g sample of sodium-24 if it decays to 13.0 g of sodium-24 within 60.0 hours?



$\frac{60h}{4} = 15h$