

Half-Life Practice Problems

Name: KEY

Unknown final amount

1. Cobalt-60 is a radioactive element used as a source of radiation in the treatment of cancer. Cobalt-60 has a half-life of 5 years. If a hospital starts with a 1000-mg supply, and none is used, how much will remain after 10 years?

$$1000 \text{ mg} \xrightarrow{5y} 500 \text{ mg} \xrightarrow{5y} \boxed{250 \text{ mg}}$$

2. Potassium-42 has a half-life of 12.4 hours. How much of an 848 g sample of potassium-42 will be left after 62.0 hours?

$$\frac{62.0 \text{ h}}{12.4 \text{ h}} = 5 \text{ half-lives}$$

$$848 \text{ g} \rightarrow 424 \text{ g} \rightarrow 212 \text{ g} \rightarrow 106 \text{ g} \rightarrow 53 \text{ g} \rightarrow \boxed{26.5 \text{ g}}$$

3. Carbon-14 has a half-life of 5730 years. How much of a 144-gram sample of carbon-14 will remain after 1.719×10^4 years?

$$\frac{1.719 \times 10^4 \text{ years}}{5730 \text{ years}} = 3 \text{ half-lives}$$

$$144 \text{ g} \rightarrow 72 \text{ g} \rightarrow 36 \text{ g} \rightarrow \boxed{18 \text{ g}}$$

Unknown initial amount

4. A sample of Sodium-24 decays to 30 grams in 4 half-lives. What was the mass of the original sample?

$$\boxed{480 \text{ g}} \rightarrow 240 \text{ g} \rightarrow 120 \text{ g} \rightarrow 60 \text{ g} \rightarrow 30 \text{ g}$$

5. If the half-life of uranium-235 is 7.04×10^8 years and 12.5 g of uranium-235 remain after 2.82×10^9 years, how much of the radioactive isotope was in the original sample?

$$\frac{2.82 \times 10^9 \text{ yr}}{7.04 \times 10^8 \text{ yr}} = 4 \text{ half-lives}$$

$$\boxed{200 \text{ g}} \rightarrow 100 \text{ g} \rightarrow 50 \text{ g} \rightarrow 25 \text{ g} \rightarrow 12.5 \text{ g}$$

Find the half-life of an isotope

6. If 100.0 g of carbon-14 decays until only 25.0 g of carbon is left after 11,460 years, what is the half-life of carbon-14?

$$100.0 \text{ g} \rightarrow 50.0 \text{ g} \rightarrow 25.0 \text{ g} \quad \frac{11460 \text{ y}}{2 \text{ half-lives}} = \boxed{5730 \text{ years}}$$

7. What is the half-life of a 100.0 g sample of nitrogen-16 that decays to 12.5 g of nitrogen-16 in 21.6 seconds?

$$100.0 \text{ g} \rightarrow 50.0 \text{ g} \rightarrow 25.0 \text{ g} \rightarrow 12.5 \text{ g} \quad \frac{21.6 \text{ s}}{3} = \boxed{7.2 \text{ secs}}$$

8. A sample of Francium-212 will decay to one-sixteenth its original amount after 80 minutes. What is the half-life of francium-212?

$$1 \rightarrow \frac{1}{2} \rightarrow \frac{1}{4} \rightarrow \frac{1}{8} \rightarrow \frac{1}{16}$$

$$\frac{80 \text{ min.}}{4 \text{ half-lives}} = \boxed{20 \text{ minutes}}$$

Unknown total decay time (or number of half-lives)

9. The half-life of hafnium-156 is 0.025 s. How long will it take a 560-gram sample to decay to one-fourth its original mass?

$$1 \rightarrow \frac{1}{2} \rightarrow \frac{1}{4}$$

(560 g) (280 g) (140 g)

$$(2 \text{ half-lives})(0.025 \text{ s}) = \boxed{0.050 \text{ seconds}}$$

10. If the half-life of iodine-131 is 8.10 days, how long will it take a 50.00-gram sample to decay to 6.25 g?

$$50.00 \text{ g} \rightarrow 25.00 \text{ g} \rightarrow 12.5 \text{ g} \rightarrow 6.25 \text{ g}$$

$$(3 \text{ half-lives})(8.10 \text{ days}) = \boxed{24.3 \text{ days}}$$

Non-whole-number of half-lives (must use equation!)

11. The half-life of protactinium-234 is 6.75 hours. If you start with 5.00 grams of Pa-234, how many grams of the sample will remain after exactly 16 hours?

$$\frac{16 \text{ h}}{6.75 \text{ h}} = 2.37037 \text{ half-lives}$$

$$(5.00 \text{ g})(0.5)^{2.37037} = \boxed{0.967 \text{ grams}}$$

12. The half-life of Rn-222 is 3.823 days. What was the original mass of a sample of this isotope if 0.0500 g remains after exactly one week?

$$\frac{7 \text{ days}}{3.823 \text{ days}} = 1.831 \dots \text{ half-lives}$$

$$0.0500 \text{ g} = X(0.5)^{1.831}$$

$$X = \frac{0.0500 \text{ g}}{(0.5)^{1.831 \dots}} = \boxed{0.178 \text{ g}}$$

13. The half-life of Th-227 is 18.2 days. How many days are required for 0.345 grams of a given sample of the isotope to decay to 0.0875 g?

$$0.0875 \text{ g} = (0.345 \text{ g})(0.5)^n$$

$$\frac{0.0875}{0.345} = (0.5)^n$$

$$\log\left(\frac{0.0875}{0.345}\right) = n \log 0.5$$

$$n = \frac{\log\left(\frac{0.0875}{0.345}\right)}{\log 0.5}$$

$$n = 1.979 \text{ half-lives}$$

$$(1.979) \times (18.2 \text{ days}) = \boxed{36.02 \text{ days}}$$