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?

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

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?

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

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

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?

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

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

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?

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

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?

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

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

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?

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

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?

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

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?

$$1 \rightarrow \frac{1}{2} \rightarrow \frac{1}{4}$$
$$(560\text{ g}) \quad (280\text{ g}) \quad (140\text{ g})$$

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

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 protactnium-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?

$$\frac{16\text{ h}}{6.75\text{ h}} = 2.37\overline{037} \text{ half-lives}$$

$$(5.00\text{ g})(0.5)^{2.37\overline{037}} = \boxed{0.967 \text{ grams}}$$

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?

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

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

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

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?

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

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

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

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

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

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