Handout 5

Half-Life Practice Problems

To find half-lives that have passes...	*To find remaining amount...*
$n = \frac{p}{t}$	**If you have the # of $t_{1/2}$...** $r = i(.5)^n$ **If you DON'T have the # of $t_{1/2}$...** $r = i(.5)^{p/t}$
To find one half-life	***Total time passed***
$t = \frac{p}{n}$	$p = nt$
Symbols used i= initial amount r= remaining amount $t_{1/2}$= time of one half life p=time passed n= # of half lives passed	

Solve for the problems. Be sure to identify each piece of information.

1. The half-life of cesium-137 is 30.2 years. If the initial mass of a sample of cesium-137 is 1.00 kg, how much will remain after 151 years?

   $t_{1/2}$ =
   i=
   p=
   n=

   $n = \frac{151 \text{ yrs}}{30.2 \text{ yrs}} = 5$

   $r = i(.5)^n = 1.00 \text{ kg}(.5)^5 = .03125 \text{ kg} = \boxed{.0313 \text{kg}}$

2. Give that the half-life of carbon-14 is 5730 years, consider a sample of fossilized wood that, when alive, would have contained 24 g of carbon-14. It now contains 1.5 g of carbon-14. How old is the sample?

   $t_{1/2}$ =
   i=
   r=
   n=

   $24\text{g} \rightarrow 12\text{g} \rightarrow 6\text{g} \rightarrow 3\text{g} \rightarrow 1.5\text{g}$

   $n = 4$

   $p = nt = (4)(5730 \text{ yrs}) = \boxed{22920 \text{ yrs}}$

3. A 64-g sample of germanium-66 is left undisturbed for 12.5 hours. At the end of that period, only 2.0 g remain. What is the half-life of this material?

   $t_{1/2}$ =
   i=
   p=
   n=

   $64\text{g} \rightarrow 32\text{g} \rightarrow 16\text{g} \rightarrow 8\text{g} \rightarrow 4\text{g} \rightarrow 2\text{g}$

   $n = 5$

   $p = 12.5 \text{ hrs}$

   $t = \frac{p}{n} = \frac{12.5 \text{ hrs}}{5} = \boxed{2.5 \text{ hrs}}$

4. With a half-life of 28.8 years, how long will it take for 1 g of strontium-90 to decay 125 mg?

$1000g \rightarrow 500g \rightarrow 250g \rightarrow 125g$

$n = 3$

$p = nt = 3(28.8 \text{ yrs}) = \boxed{86.4 \text{ yrs}}$

5. Cobalt-60 has a half-life of 5.3 years. If a pellet that has been in storage for 26.5 years contains 14.5 g of cobalt-60, how much of this radioisotope was present when the pellet was put into storage?

$n = \frac{26.5 \text{ yrs}}{5.3 \text{ yrs}} = 5 \qquad r = i(.5)^n \Rightarrow i = \frac{r}{(.5)^n} = \frac{14.5 \text{ g}}{(.5)^5} = \boxed{464 \text{ g}}$

6. A 1.000-kg block of phosphorus-32, which has a half-life of 14.3 days, is stored for 100.1 days. At the end of this period, how much phosphorus-32 remains?

$n = \frac{p}{t} = \frac{100.1 \text{ days}}{14.3 \text{ days}} = 7$

$r = i(.5)^n = 1.000 \text{ kg}(.5)^7 = .0078125 \text{ kg} = .00781 \text{ kg} = \boxed{7.81 \text{ g}}$

7. A sample of air from a basement is collected to test for the presence of radon-222, which has a half-life of 3.8 days. However, delays prevent the sample from being tested until 7.6 days have passed. Measurements indicate the presence of 6.5 μg of radon-222. How much radon-222 was present in the sample when it was initially collected?

$n = \frac{p}{t} = \frac{7.6}{3.8} = 2$

$i = \frac{r}{(.5)^n} = \frac{6.5 \text{ μg}}{(.5)^2} = \boxed{26 \text{ μg}}$

8. The half-life of sodium-25 is 1.0 minute. Starting with 1 kg of this isotope, how much will remain after half an hour?

$p = 30 \text{ min}, \quad t = 1 \text{ min} \Rightarrow n = 30$

$r = i(.5)^n = 1 \text{ kg}(.5)^{30} = 9.31 \times 10^{-10} \text{ kg} = \boxed{.931 \text{ μg}}$

9. What is the half-life of polonium-214 if, after 820 seconds, a 1.0-g sample decays to 31.25 mg?

$1.0g = 1000 \text{ mg} \rightarrow 500 \text{ mg} \rightarrow 250 \text{ mg} \rightarrow 125 \text{ mg} \rightarrow 62.5 \text{ mg} \rightarrow 31.25 \text{ mg}$

$n = 5$

$n = \frac{p}{t} \Rightarrow t = \frac{p}{n} = \frac{820 \text{ sec}}{5} = \boxed{164 \text{ sec}}$