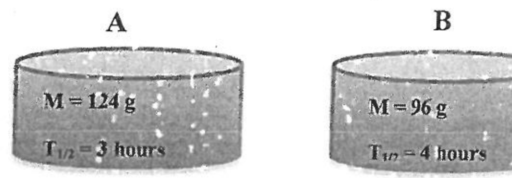
Post Activity Questions:

1. Shown at the right are samples of two radioactive elements. For each sample we are told how much of the radioactive element is initially present and the half-life of each element. After **12 hours** will the mass of element A that remains be *larger*, *smaller* or the *same* as the mass of element B?



Explain your reasoning.

A) 12 hours $= 4T_{1/2} \therefore (\frac{1}{2})^4 = \frac{1}{16} \cdot (124g) = 7.75g$

B) 12 hours $= 3T_{1/2} \therefore (\frac{1}{2})^3 = \frac{1}{8}$ (96g) = 12g $\therefore$ A is smaller than B.

2. A radioactive substance has a half-life of 20 minutes. How long would it take to lose 95% of the parent isotope?

95% lost so 5% remains

$N = .05N_0 = N_0 e^{-\lambda t}$

$\ln(.05) = -\lambda t$

$t = \frac{-\ln(.05)}{\ln(2)/20min} = 86.4$ min

3. From experimentation, it has been found that the ratio of ^{14}C to ^{12}C in CO_2 in the atmosphere is held constant at $1.3*10^{-12}$. When a living organism dies on Earth, it no longer consumes carbon into its body and so the ^{14}C starts to go through β^- decay. The 1/2life of ^{14}C is 5,730 years. Let's say an ancient wood club is found that contains 290 g of carbon and has an activity of 8.0 decays/sec. How old is the club? **(18,230 yrs)**

$N_{C_{12}} = \frac{.290 kg}{12 \cdot 1.66 \cdot 10^{-27}} = 1.456 \cdot 10^{25}$

$N_{0_{C_{14}}} = 1.3 \cdot 10^{-12} N_{C_{12}} = 1.89 \cdot 10^{13}$ atoms

$R = 8 = \lambda N$

$N = 8/\lambda = 8/\ln(2)/(5730 \cdot 365 \cdot 24 \cdot 3600)$

$= 2.09 \cdot 10^{12}$ atoms

$2.09 \cdot 10^{12} = 1.89 \cdot 10^{13} e^{-\lambda t}$

$0.11 = e^{-\lambda t}$

$t = \frac{-\ln(.11)}{\ln(2)/5730}$ = 18,230 yrs

4. The half-life of ^{216}Po is 1/7 s. What is the probability that any particular ^{216}Po atom will decay within one second? **(99%)**

in 1 sec, 7 $T_{1/2}$ have occurred $\therefore$ remaining is $(\frac{1}{2})^7 = \frac{1}{128} = .008$

% decay = 99.2%

5. Radon gas has a half-life of 3.83 days. If 3 g of radon gas is present at time t = 0, what mass of radon will remain after 36 hours? **(2.29 g)**

$\lambda = \frac{\ln(2)}{3.83 \cdot 24 \cdot 3600} = 2.09 \cdot 10^{-6}$

$m = m_0 e^{-\lambda t} = (3g) e^{-(2.09 \cdot 10^{-6})(36 \cdot 3600)}$

$= 2.29g$

6. A building has become accidently contaminated with radioactivity. The longest lived material in the building is strontium 90. (atomic mass of $^{90}_{38}Sr$ is 89.9077 u and ½life of 2.88 hours) If the building initially contained 5.0 kg of $^{90}_{38}Sr$ and the safe level of radioactivity is 10 decays/min $(\frac{1 min}{60 sec}) = \frac{1}{6} \frac{decays}{sec}$ how long will the building be unsafe? **(8 day and 20 hours)**

$\lambda = \frac{\ln(2)}{2.88 \cdot 3600} = 6.69 \cdot 10^{-5}$

$N_0 = \frac{5 kg}{89.9077 \cdot 1.66 \cdot 10^{-27}}$

$= 3.35 \cdot 10^{25}$ atoms

$N = R/\lambda = \frac{1/6}{6.69 \cdot 10^{-5}} = 2493$ atoms

$\frac{N}{N_0} = e^{-\lambda t} = \frac{2493}{3.35 \cdot 10^{25}} = 7.44 \cdot 10^{-23}$

$-\lambda t = -50.95$

t = 762139 sec = 211.7 hours = 8 days + 20 hours