Quiz 31.1A

A common nuclear isotope in the fallout of a nuclear fission weapon is Cobalt-60, which has a half-life of 5.26 years. You may assume the mass of Co-60 is 60.0 amu.

a) If the activity of a sample of Co-60 is 75,000 Curies, how many grams of Co-60 are present?

b) After how many years will the radioactivity of this sample fall to 1.00 Curies?

a) $a = 75{,}000\ Ci \cdot \frac{1\ Bq}{2.7\times10^{-11}\ Ci} = 2.78\times10^{15}\ Bq$

$T_{1/2} = 5.26\ yr \cdot \frac{3.16\times10^{7}\ s}{yr} = 1.66\times10^{8}\ s$

$\lambda = 0.693/T_{1/2} = 4.175\times10^{-9}$

$N = \frac{a}{\lambda} = \frac{2.78\times10^{15}}{4.175\times10^{-9}} = 6.659\times10^{23}\ atoms$

$m_{Tot} = N m_{Co} = (6.659\times10^{23})(60u)\left(\frac{1.66\times10^{-27}\ kg}{u}\right)$

$= .0663\ kg$ or $\boxed{66.3\ g}$

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b) $1 = 75000\, e^{-\lambda t}$

$\ln\left(\frac{1}{75000}\right) = -(4.175\times10^{-9})t$

$\Rightarrow t = 2.69\times10^{9}\ s \cdot \frac{1\ yr}{3.16\times10^{7}\ s} = \boxed{85.1\ yrs}$