1. a) The nuclides decay randomly – sometimes more, sometimes less.

   b) approximately 30 years

2. a) $\lambda = \frac{\ln 2}{T_{1/2}} = \frac{\ln 2}{30.17 \cdot 365 \cdot 24 \cdot 3'600 \text{ s}} = \underline{\underline{7.285 \cdot 10^{-10} \text{ s}^{-1}}}$

   b) $A = \lambda \cdot N = 7.285 \cdot 10^{-10} \text{ s}^{-1} \cdot 6.24 \cdot 10^{16} = \underline{4.55 \cdot 10^{7} \text{ Bq}}$

   c) $A = A_0 \cdot e^{-\lambda \cdot t} = 4.55 \cdot 10^{7} \text{ Bq} \cdot e^{-7.285 \cdot 10^{-10} \text{ s}^{-1} \cdot 4.89 \cdot 365 \cdot 24 \cdot 3600 \text{ s}} = \underline{\underline{4.07 \cdot 10^{7} \text{ Bq}}}$

   d) $N(t) = 6.24 \cdot 10^{16} - 2.75 \cdot 10^{14} = 6.21 \cdot 10^{16}$

   $N = N_0 \cdot e^{-\lambda \cdot t} \qquad \frac{N}{N_0} = e^{-\lambda \cdot t} \qquad \ln\left(\frac{N}{N_0}\right) = -\lambda \cdot t$

   $t = \frac{\ln\left(\frac{N}{N_0}\right)}{-\lambda} = \frac{\ln\left(\frac{6.2125 \cdot 10^{16}}{6.24 \cdot 10^{16}}\right)}{-7.285 \cdot 10^{-10} \text{ s}} = 6.06 \cdot 10^{6} \text{ s} = \underline{70.2 \text{ d}}$

3. a) $A = \frac{1'000 \text{ decays}}{60 \text{ s}} = 16.67 \text{ Bq} \qquad \lambda = \frac{\ln 2}{T_{1/2}} = \frac{\ln 2}{4.468 \cdot 10^{9} \cdot 365 \cdot 24 \cdot 3'600 \text{ s}} = 4.919 \cdot 10^{-18} \text{ s}^{-1}$

   $N = \frac{A}{\lambda} = \frac{16.67 \text{ Bq}}{4.919 \cdot 10^{-18} \text{ s}^{-1}} = \underline{3.388 \cdot 10^{18} \text{ nuclei}}$

   b) $m = N \cdot m_a \cdot u = 3.388 \cdot 10^{18} \cdot 238.051 \cdot 1.6605 \cdot 10^{-27} \text{ kg} = \underline{\underline{1.339 \cdot 10^{-6} \text{ kg}}} = \underline{\underline{1.339 \text{ mg}}}$

4. $\lambda = \frac{\ln 2}{T_{1/2}} = \frac{\ln 2}{12.8 \cdot 3'600 \text{ s}} = 1.504 \cdot 10^{-5} \text{ s}^{-1} \qquad A_0 = \frac{A}{e^{-\lambda \cdot t}} = \frac{20.0 \text{ Bq}}{e^{-(1.504 \cdot 10^{-5} \text{ s}^{-1} \cdot 20.0 \cdot 24 \cdot 3'600 \text{ s})}} = 3.89 \cdot 10^{12} \text{ Bq}$

   $N = \frac{A}{\lambda} = \frac{3.89 \cdot 10^{12} \text{ Bq}}{1.504 \cdot 10^{-5} \text{ s}^{-1}} = \underline{2.585 \cdot 10^{17} \text{ nuclei}}$

5. a) $N = \frac{A}{\lambda} = \frac{A \cdot T_{1/2}}{\ln 2} = \frac{0.250 \text{ Bq} \cdot 5.70 \cdot 10^{3} \cdot 365 \cdot 24 \cdot 3'600 \text{ s}}{\ln 2} = \underline{6.483 \cdot 10^{10} \text{ nuclei}}$

   b) The activity of 1.00 g of the piece of wood is 0.125 Bq (there's just half the amount):

   $t = -\frac{\ln\left(\frac{A}{A_0}\right)}{-\lambda} = -\frac{\ln\left(\frac{A}{A_0}\right) \cdot T_{1/2}}{\ln 2} = -\frac{\ln\left(\frac{0.125 \text{ Bq}}{15.3 \text{ Bq}}\right) \cdot 5.70 \cdot 10^{3} \text{ a}}{\ln 2} = 39532 \text{ a} = \underline{\underline{3.95 \cdot 10^{4} \text{ a}}}$

6. $t = -\frac{\ln\left(\frac{A}{A_0}\right) \cdot T_{1/2}}{\ln 2} = -\frac{\ln\left(\frac{0.10 \cdot A_0}{A_0}\right) \cdot T_{1/2}}{\ln 2} = -\frac{\ln(0.10) \cdot 1.600 \cdot 10^{3} \text{ a}}{\ln 2} = 5'315 \text{ a} = \underline{\underline{5.3 \cdot 10^{3} \text{ a}}}$