

## Nuclear Chemistry Problems

1. Boron-12 (atomic mass = 12.014352 amu) has a half-life of 0.0202 s. What is the activity of a 1.00 g sample of B-12 in Ci?

$$A = kN = \left[ \left( \frac{\ln 2}{0.0202 \text{ s}} \right) \right] \left[ (1.00 \text{ g}) \left( \frac{1 \text{ mol}}{12.014352 \text{ g}} \right) \left( \frac{6.022 \times 10^{23} \text{ nuc}}{\text{mol}} \right) \right] \left( \frac{1 \text{ Ci}}{3.7 \times 10^{10} \text{ nuc s}^{-1}} \right)$$

$$= 4.65 \times 10^{13} \text{ Ci}$$

2. Chlorine-36 has an atomic mass of 35.9683070 amu. If a 2.50 g sample has an activity of 0.0827 Ci, what is the half-life of this isotope in years?

$$k = \frac{A}{N} = \frac{0.0827 \text{ Ci} \left( \frac{3.7 \times 10^{10} \text{ nuc s}^{-1}}{1 \text{ Ci}} \right)}{2.50 \text{ g} \left( \frac{1 \text{ mol}}{35.9683070 \text{ g}} \right) \left( \frac{6.022 \times 10^{23} \text{ nuc}}{\text{mol}} \right)}$$

$$= 7.3104897103487213550315509797409 \times 10^{-14} \text{ s}^{-1}$$

$$\lambda = \frac{\ln 2}{k} = \frac{\ln 2}{7.3104897103487213550315509797409 \times 10^{-14} \text{ s}^{-1}} \times \frac{1 \text{ y}}{3.15 \times 10^7 \text{ s}} = 3.01 \times 10^5 \text{ y}$$

3. What mass of Scandium-46 (atomic mass = 45.955172 amu) is needed to have an activity of 0.453 Ci? The half-life is 83.81 days.

$$k = \frac{\ln 2}{\lambda} = \frac{\ln 2}{83.81 \text{ d}} \times \frac{1 \text{ d}}{86400 \text{ s}} = 9.5722906718009832289475329097863 \times 10^{-8} \text{ s}^{-1}$$

$$N = \frac{A}{k} = \frac{0.453 \text{ Ci} \left( \frac{3.7 \times 10^{10} \text{ nuc s}^{-1}}{1 \text{ Ci}} \right)}{9.5722906718009832289475329097863 \times 10^{-8} \text{ s}^{-1}} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ nuc}} \times \frac{45.955172 \text{ g}}{\text{mol}}$$

$$= 1.34 \times 10^{-5} \text{ g Sc-46}$$