

Chapter 38 Problem 43 †

Given

$$(N/V)_0 = 23 \text{ pCi/L}$$

$$(N/V)_{\text{epa}} = 4 \text{ pCi/L}$$

$$t_{1/2} = 3.82 \text{ days}$$

Solution

Find the time for the Radon-222 to reach acceptable EPA levels.

Convert the half-life to decay constant.

$$\lambda = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{3.82 \text{ days}} = 0.181 \text{ days}^{-1}$$

The radioactive decay equation is

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

Solve for time gives

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

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

$$t = \frac{-1}{\lambda} \ln \left(\frac{N}{N_0} \right)$$

Substitute in the appropriate values give

$$t = \frac{-1}{0.181 \text{ days}^{-1}} \ln \left(\frac{4 \text{ pCi/L}}{23 \text{ pCi/L}} \right) = 9.7 \text{ days}$$

†Problem from Essential University Physics, Wolfson