Chapter 38 Problem 49 [†]

Given
$(N/V)_0 = 23\ pCi/L$
$(N/V)_{epa} = 4\ pCi/L$
$t_{1/2} = 3.82\ days$

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

Convert the half-life to decay constant.

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

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

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

[†]Problem from Essential University Physics, Wolfson