Chapter 38 Problem 43 [†]

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

Solution
a) Find the fraction of radon left after 1 day.

The relationship between half-life and the decay constant is

$$t_{1/2} = \frac{\ln 2}{\lambda}$$

Solving for the decay constant gives

$$\lambda = \frac{\ln 2}{t_{1/2}}$$

$$\lambda = \frac{\ln 2}{3.82\ dy} = 0.181\ dy^{-1}$$

The rate of radioactive decay is calculated using the equation

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

The fraction left is then the ratio N/N_0.

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

Substituting in the provided values gives

$$\frac{N}{N_o} = e^{-(0.181\ dy^{-1})(1\ dy)} = 0.834$$

After 1 day 83.4% of the radon would still be present.

b) Find the fraction of radon left after 1 week.

Using the development in part (a) and using a time period of 7 days we get

$$\frac{N}{N_o} = e^{-(0.181\ dy^{-1})(7\ dy)} = 0.282$$

After 1 week 28.2% of the radon would still be present.

c) Find the fraction of radon left after 1 month.

Using the development in part (a) and using a time period of 30 days we get

$$\frac{N}{N_o} = e^{-(0.181\ dy^{-1})(30\ dy)} = 0.00438$$

After 1 month 0.438% of the radon would still be present.

[†]Problem from Essential University Physics, Wolfson