(5.9) A hospital has a 1.5 Ci source of ^{226}Ra in the form of $RaBr_2$ solution. If the ^{222}Rn is pumped out each 48 h, what is (a) the radon activity (in Bq) at that moment, (b) the radon volume at STP?

First the usual definitions of various constants:

$Bq := sec^{-1}$ $\quad Ci := 3.7 \cdot 10^{10} \cdot Bq$ $\quad M_{Ra} := 226 \cdot \frac{gm}{mole}$ $\quad M_{Rn} := 222 \cdot \frac{gm}{mole}$ $\quad M_{Br} := 79.91 \cdot \frac{gm}{mole}$

$N_A := 6.022 \cdot 10^{23} \cdot mole^{-1}$ $\quad R_{gas} := 0.08206 \cdot liter \cdot atm \cdot mole^{-1} \cdot K^{-1}$ $\quad M_{RaBr2} := M_{Ra} + 2 \cdot M_{Br}$

Then the values given in Table 5.1 for half-lives:

$t_{226} := 1600 \cdot yr$ $\qquad t_{222} := 3.825 \cdot day$

$\lambda_{226} := \frac{ln(2)}{t_{226}}$ $\qquad \lambda_{222} := \frac{ln(2)}{t_{222}}$ $\qquad$ Eqn. (5.62)

We need also the acticity of ^{226}Ra in the source, which is given as:

$R_{Ra} := 1.5 \cdot Ci$ $\qquad R_{Ra} = 5.55 \cdot 10^{10} \cdot Bq$

and the time for buildup of new radon: $t := 48 \cdot hr$

$R_{Rn} := R_{Ra} \cdot \left(1 - exp\left(-\lambda_{222} \cdot t\right)\right)$ $\qquad$ Eqn. (5.76) with $R = N^* \lambda$ $\qquad R_{Rn} = 1.687 \cdot 10^{10} \cdot Bq$

STP corresponds to: $\quad Temp := 273.15 \cdot K$ $\qquad p := 1 \cdot atm$

Number of Rn atoms, N_{Rn}, the number of Rn moles, n_{Rn}, and the corresponding volume, V_{Rn}, are given by:

$N_{Rn} := \frac{R_{Rn}}{\lambda_{222}}$ $\qquad n_{Rn} := \frac{N_{Rn}}{N_A}$ $\qquad n_{Rn} = 1.336 \cdot 10^{-8}$

$V_{Rn} := \frac{n_{Rn} \cdot R_{gas} \cdot Temp}{p}$ $\qquad$ (the general gas-law)

Hence:

$V_{Rn} = 2.994 \cdot 10^{-10} \cdot m^3$ or $V_{Rn} = 2.994 \cdot 10^{-7} \cdot liter$ or $V_{Rn} = 2.994 \cdot 10^{-4} \cdot mL$