

(13.8) 0.11 cm³ helium gas at NTP was isolated from 100 g of uranium mineral containing 5 ppm uranium. How old is the mineral?

As usual we first define some useful constants:

$$R := 0.08206 \cdot \text{liter} \cdot \text{atm} \cdot \text{mole}^{-1} \cdot \text{K}^{-1} \quad N_A := 6.0221367 \cdot 10^{23} \cdot \text{mole}^{-1} \quad M_U := 238 \cdot \frac{\text{gm}}{\text{mole}}$$

The volume of He-gas and the amount of uranium as given:

$$V := 0.11 \cdot 10^{-3} \cdot \text{liter} \quad m_U := 100 \cdot 5 \cdot 10^{-6} \cdot \text{gm}$$

NTP corresponds to: $T := 273.15 \cdot \text{K}$ $p := 1 \cdot \text{atm}$

$$n := \frac{p \cdot V}{R \cdot T} \quad \text{The general gas-law} \quad n = 4.907 \cdot 10^{-6}$$

$$t_{\text{halv}} := 4.468 \cdot 10^9 \cdot \text{yr} \quad \lambda := \frac{\ln(2)}{t_{\text{halv}}} \quad \text{The half-life of uranium.}$$

$$N := n \cdot N_A \quad \text{He atoms} \quad dN_U := \frac{N}{8} \quad \text{Decayed U atoms}$$

$$N_U := \frac{m_U}{M_U} \cdot N_A \quad \text{The number of uranium atoms present.}$$

$$t := \frac{\ln\left(\frac{dN_U}{N_U} + 1\right)}{\lambda} \quad \text{From eqn. (5.59)}$$

$$t = 5.211 \cdot 10^{16} \cdot \text{sec} \quad \text{or} \quad t = 1.65 \cdot 10^9 \cdot \text{yr}$$