(5.5) 0.11 cm^3 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 som useful constants:

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

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

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

NTP corresponds to: $T := 273.15 \cdot K$ $\quad p := 1 \cdot atm$

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

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

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

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

$t := \frac{ln\left(\frac{dN_U}{N_U} + 1\right)}{\lambda}$ From eqn. (4.41a)

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