(13.9) In a VdG accelerator a 100 μA beam of He^{2+} ions is accelerated to an energy of 5 MeV before striking a target. How many grams of radium are required to provide the same number of α-particles?

Constant and data:

$q_e := 1.6021773 \cdot 10^{-19} \cdot coul$ $\quad N_A := 6.022137 \cdot 10^{23} \cdot mole^{-1}$ $\quad M_{Ra} := 226 \cdot gm \cdot mole^{-1}$

$t_{half} := 1600 \cdot yr$ $\quad \lambda := \dfrac{ln(2)}{t_{half}}$ $\quad \lambda = 1.373 \cdot 10^{-11} \cdot sec^{-1}$

First compute the number of α-particles per second in the beam.

$z := 2$ $\quad I_{beam} := 100 \cdot \mu A$ $\quad N_\alpha := \dfrac{I_{beam}}{z \cdot q_e}$ $\quad N_\alpha = 3.121 \cdot 10^{14} \cdot sec^{-1}$

Assume pure ^{226}Ra without daughters. Then use eqn. (4.40b) to compute the equivalent number of ^{226}Ra atoms, and from that the radium weight.

$N_{Ra} := \dfrac{N_\alpha}{\lambda}$ $\quad N_{Ra} = 2.273 \cdot 10^{25}$ $\quad m_{Ra} := \dfrac{N_{Ra}}{N_A} \cdot M_{Ra}$ $\quad m_{Ra} = 8.53 \cdot 10^{3} \cdot gm$