

38. We have one alpha particle (helium nucleus) produced for every plutonium nucleus that decays. To find the number that have decayed, we use Eq. 43-14, Eq. 43-17, and adapt Eq. 43-20:

$$N_0 - N = N_0 \left(1 - e^{-t \ln 2 / T_{1/2}}\right) = N_A \frac{12.0 \text{ g/mol}}{239 \text{ g/mol}} \left(1 - e^{-20000 \ln 2 / 24100}\right)$$

where  $N_A$  is the Avogadro constant. This yields  $1.32 \times 10^{22}$  alpha particles produced. In terms of the amount of helium gas produced (assuming the  $\alpha$  particles slow down and capture the appropriate number of electrons), this corresponds to

$$m_{\text{He}} = \left( \frac{1.32 \times 10^{22}}{6.02 \times 10^{23} / \text{mol}} \right) (4.0 \text{ g/mol}) = 87.9 \times 10^{-3} \text{ g} .$$