

Answer on Question#38467, Physics, Nuclear Physics

Question:

Calculate the number of alpha particles emitted per second from 1g of radium. Assume half-life of radium is 1600 years. Calculate the volume of helium gas produced by 1g of radium in 1 year.

Answer:

The equation that describes decay is (for $\Delta t \ll t_{\frac{1}{2}}$):

$$\Delta N = \lambda N \Delta t$$

where λ is the decay constant of radionuclide related to its half-lives $t_{\frac{1}{2}}$ by

$$\lambda = \frac{\ln(2)}{t_{\frac{1}{2}}}$$

Number of atoms in 1g of radium equals:

$$N = N_A \frac{m}{M}$$

where M is molar mass, N_A is Avogadro constant.

Therefore:

$$\Delta N = \frac{\ln(2)}{t_{\frac{1}{2}}} N_A \frac{m}{M} \Delta t = 3.7 * 10^{10}$$

Answer: $3.7 * 10^{10}$

For 1 year:

$$\Delta N = \frac{\ln(2)}{t_{\frac{1}{2}}} N_A \frac{m}{M} \Delta t = 3.2 * 10^{15}$$

Volume equals:

$$V = V_m \frac{\Delta N}{N_A} = 22.4 \frac{l}{mol} \frac{3.2 * 10^{15}}{6.02 * 10^{23} \frac{1}{mol}} = 1.2 * 10^{-7} l$$

Answer: $1.2 * 10^{-7} l$