5. The function \( Q(t) = Q_0e^{-kt} \) may be used to model radioactive decay. \( Q \) represents the quantity remaining after \( t \) years; \( k \) is the decay constant, 0.00011. How long, in years, will it take for a quantity of plutonium-240 to decay to 25% of its original amount?

A: 12,602 years  
B: 1,575 years  
C: 3,150 years  
D: 9,450 years

Solution:

\[
Q(t) = Q_0e^{-kt}
\]

\[
\frac{Q(t)}{Q_0} = 0.25
\]
\[
e^{-kt} = 0.25
\]

If \( k = 0.00011 \), then

\[
e^{-0.00011t} = 0.25
\]
\[
-0.00011t = \ln(0.25)
\]
\[
t = \frac{\ln(0.25)}{-0.00011}
\]
\[
t \approx 12,602.68
\]

Answer: A: 12,602 years.

4. Plutonium-240 decays according to the function \( Q(t) = Q_0e^{-kt} \). How long will it take 27 grams of plutonium-240 to decay to 9 grams?

K is the decay constant, 0.00011  
A: 2,100 years  
B: 1.44 years  
C: 18,900 years  
D: 9,987 years

Solution:

\[
Q(t) = Q_0e^{-kt}
\]

\[
9 = 27e^{-kt}
\]
\[
e^{-kt} = \frac{9}{27} = \frac{1}{3}
\]

If \( k = 0.00011 \), then

\[
e^{-0.00011t} = \frac{1}{3}
\]
\[
-0.00011t = \ln\left(\frac{1}{3}\right)
\]
\[
t = \frac{\ln\left(\frac{1}{3}\right)}{-0.00011}
\]
\[
t \approx 9,937.38
\]

Answer: D: 9,987 years.