A tumor is injected with 0.5 grams of Iodine-125, which has a decay rate of 1.15% per day. To the nearest day, how long will it take for half of the Iodine-125 to decay?

Solution

The half-life is the time it takes a substance to decay to half of the amount that is present.

To find how long it will take for half of the Iodine-125 to decay, we can use the model for continuous exponential decay, \( y = A_0 e^{kt} \). When the substance has decayed in half, the output will be half of the original amount, \( y = 0.5A_0 \). To find the half-life we can set up an equation and solve for \( t \).

\[
0.5(0.5) = 0.5e^{-0.0115t} \\
0.25 = 0.5e^{-0.0115t} \\
0.5 = e^{-0.0115t} \\
\ln(0.5) = \ln(e^{-0.0115t}) \\
\ln(0.5) = -0.0115t \cdot \ln(e) \\
\ln(0.5) = -0.0115t \\
\frac{\ln(0.5)}{-0.0115} = t \\
60.27 \approx t
\]

We could also use the formula for the relationship between \( k \) and the half-life \( t \), \( t = \frac{-\ln(2)}{k} \).

\[
t = \frac{-\ln(2)}{-0.0115} \approx 60.27
\]

The half-life of the iodine-125 is approximately 60 years.