Exercise 5-4   The radioactive decay equation for a certain material is given by $n(t) = n_0 e^{-t/\tau}$, where $n_0$ is the initial count at $t = 0$. If $\tau = 2 \times 10^8$ s, how long is its half-life? [Half-life $t_{1/2}$ is the time it takes a material to decay to 50% of its initial value.]

Solution: Given

$$n(t) = n_0 e^{-t/(2 \times 10^8)},$$

The time $t$ at which $n(t) = n_0/2$ is obtained by solving for $t$ in

$$\frac{n_0}{2} = n_0 e^{-t/(2 \times 10^8)},$$

or

$$\ln \frac{1}{2} = \frac{-t}{2 \times 10^8},$$

which gives $t = -2 \times 10^8 \ln 2 = 1.386 \times 10^8$ s = 4 years, 144 days, 12 hours, 10 minutes, and 36 s.