844.

Problem 54.57 (RHK)

An activity of $3.94\ \mu\text{Ci}$ *is needed in a radioactive sample to be used in a medical procedure. One week before the treatment, a nuclide sample with a half-life of* $1.82\times10^{5}\ \text{s}$ *is prepared. We have to find the activity of the sample at the time of preparation in order that it has the required activity at the time of treatment.*

Solution:

A nuclide sample with a half-life of $1.82\times10^{5}\ \text{s}$ is to be prepared so that a week later it has an activity of $3.94\ \mu\text{Ci}$.

The disintegration constant of the nuclide will be

$$\lambda=\frac{\ln 2}{1.82\times10^{5}\ \text{s}}=3.808\times10^{-6}\ \text{s}^{-1}.$$

We note that

$$t=7\ \text{d}=7\times8.640\times10^{4}\ \text{s}=6.048\times10^{5}\ \text{s}.$$

We recall that variation of decay rate with time is given by the relation

$$R(t)=R(t=0)e^{-\lambda t}.$$

We require $R\left(t = 6.048 \times 10^5 \text{ s}\right) = 3.94\ \mu\text{Ci}$.

Therefore,

$$\begin{aligned} R(t=0) &= 3.94\ \times \exp\left(3.808 \times 10^{-6} \times 6.048 \times 10^5\right)\ \mu\text{Ci} \\ &= 3.94\ \times \exp\left(2.303\right)\ \mu\text{Ci} \\ &= 3.94 \times 10\ \mu\text{Ci} = 39.4\ \mu\text{Ci}. \end{aligned}$$