833.

Problem 43.33E (HRW)

Cancer cells are more vulnerable to x and gamma radiation than are healthy cells. In the past, the standard source for radiation therapy was radioactive ^{60}Co, *which decays into an excited nuclear state of* ^{60}Ni, *which immediately drops into the ground state, emitting two gamma-ray photons, each with an approximate energy of* 1.2 MeV. *The controlling beta-decay half-life is* 5.27 y. *We have to find how many radioactive* ^{60}Co *nuclei were present in a* 6000 Ci *source of the type used in hospitals.*

Solution:

The beta-decay half-life of ^{60}Co is 5.27 y. Its decay constant will be

$$\lambda = \frac{\ln 2}{5.27 \times 3.156 \times 10^{7}\ \text{s}} = 4.167 \times 10^{-9}\ \text{s}^{-1}.$$

Unit Ci is defined as

$1\ \text{Ci} = 3.7 \times 10^{10}$ disintegrations per second .

$\therefore\ 6000\ \text{Ci} = 6000 \times 3.7 \times 10^{10}$ decays per second.

The decay rate

$$\left|\frac{dN}{dt}\right| = \lambda N.$$

Therefore, the number of $^{60}\mathrm{Co}$ nuclides that will have activity of 6000 Ci will be

$$N = \frac{6.0\times10^{3}\times3.7\times10^{10}}{4.167\times10^{-9}} = 5.33\times10^{22}.$$