829.

Problem 54.30 (RHK)

The radionuclide ^{64}Cu *has a half-life of* 12.7 h. *We have to find how much of an initially pure* 5.50-g *sample of* ^{64}Cu *will decay during the* 2-h *period beginning* 14.0 h *later.*

Solution:

The radioactive decay law is

$N = N_0 e^{-\lambda t}$,

where N_0 is the number of radioactive nuclides present at $t = 0$. It is given that the half-life of ^{64}Cu is 12.7 h. Its decay constant will be

$$\lambda = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{12.7}\ \text{h}^{-1} = 0.0546\ \text{h}^{-1}.$$

As the number of nuclides in a pure sample is proportional to the mass of the sample, the amount of ^{64}Cu radionuclide from a sample of 5.50 g that would remain after 14.0 h will be

$$5.50 \times \exp\left(-0.0546 \times 14\right)\ \text{g} = 2.5608\ \text{g}.$$

Therefore, of the 2.56 g of radionuclide ^{64}Cu that will remain after 2 h of radioactive decay will be

$2.5608 \exp\left(-0.0546 \times 2\right)\ \text{g} = 2.2958\ \text{g}.$

Therefore, of an initially pure 5.50-g sample of ^{64}Cu that will decay during the 2-h period beginning 14.0 h later will be $\left(2.5608 - 2.2958\right)\ \text{g} = 0.2649\ \text{g}$=265 mg.