

## Some Nuclear Physics

1. The half-life of a particular radioactive isotope is 6.5 h. If there are initially  $48 \times 10^{19}$  atoms of this isotope, how many atoms of this isotope remain after 26 h?
2. A radioactive isotope of mercury,  $^{197}\text{Hg}$ , decays into gold,  $^{197}\text{Au}$ , with a disintegration constant of  $0.0108 \text{ h}^{-1}$ . (a) What is its half-life? (b) What fraction of the original amount will remain after three half-lives? (c) What fraction will remain after 10.0 days?
3. The radionuclide  $^{64}\text{Cu}$  has a half-life of 12.7 h. How much of an initially pure, 5.50-g sample of  $^{64}\text{Cu}$  will decay during the 2.0-h period beginning 14.0 h later?
4. A sample of the isotope of iodine  $^{131}\text{I}$  has an initial decay rate of  $1.8 \times 10^5$  decays/s. This isotope has a half-life of 8.04 days. It is shipped to a medical diagnostic laboratory where it will be used as a radioactive tracer. When the shipment arrives at the lab the decay rate has fallen to  $1.4 \times 10^5$  decays/s. How long did it take for the shipment to reach the laboratory?
5. The daughter nucleus formed in radioactive decay is often radioactive itself. Let  $N_{10}$  be the initial number of parent nuclei at  $t = 0$ ,  $N_1(t)$  be the number of parent nuclei at some later time  $t$ , and  $\lambda_1$  be the decay constant. Suppose the number of daughter nuclei at  $t = 0$  is zero and let  $N_2(t)$  be the number of daughter nuclei at time  $t$  and  $\lambda_2$  be the decay constant of the daughter. (a) Show that  $N_2(t)$  satisfies

$$\frac{dN_2}{dt} = \lambda_1 N_1 - \lambda_2 N_2 \quad (1)$$

- (b) Verify this differential equation has the following solution.

$$N_2(t) = \frac{N_{10}\lambda_1}{\lambda_1 - \lambda_2} (e^{-\lambda_2 t} - e^{-\lambda_1 t}) \quad (2)$$

- (c) Where will  $N_2(t)$  be a maximum?

6. Generate the decay chain of  $^{239}\text{Pu}$  until it reaches a stable isotope. Use the interactive table of nuclides at <http://atom.kaeri.re.kr/>.