



Figure 7

The radioactive isotope carbon-14 has a half-life of 5715 years. In each successive 5715-year period, half the remaining carbon-14 nuclei decay to nitrogen-14.

A *decay curve* is a plot of the number of radioactive parent nuclei remaining in a sample as a function of time. A typical decay curve for a radioactive sample is shown in **Figure 7**. After each half-life, half the remaining parent nuclei have decayed. This is represented in the circles to the right of the decay curve. The blue spheres are the parent nuclei (carbon-14), and the red spheres are daughter nuclei (nitrogen-14). Notice that the total number of nuclei remains constant, while the number of carbon atoms continually decreases over time.

For example, the initial sample contains 8 carbon-14 atoms. After one half-life, there are 4 carbon-14 atoms and 4 nitrogen-14 atoms. By the next half-life, the number of carbon-14 atoms is reduced to 2, and the process continues. As the number of carbon-14 atoms decreases, the number of nitrogen-14 atoms increases.

Living organisms have a constant ratio of carbon-14 to carbon-12 because they continuously exchange carbon dioxide with their surroundings. When an organism dies, this ratio changes due to the decay of carbon-14. Measuring the ratio between carbon-14, which decays as shown in **Figure 7**, and carbon-12, which does not decay, provides an approximate date as to when the organism was alive.

SECTION REVIEW

1. Explain the main differences between alpha, beta, and gamma decays.
2. Complete the following radioactive decay formulas:
 - a. ${}_{90}^{232}\text{Th} \rightarrow ? + {}_2^4\text{He}$
 - b. ${}_{5}^{12}\text{B} \rightarrow ? + {}_{-1}^0e + \bar{\nu}$
 - c. $? \rightarrow {}_2^4\text{He} + {}_{60}^{145}\text{Nd}$
3. A radioactive sample consists of 5.3×10^5 nuclei. There is one decay every 4.2 h.
 - a. What is the decay constant for the sample?
 - b. What is the half-life for the sample?
4. **Critical Thinking** The ${}^{14}\text{C}$ content decreases after the death of a living system with a half-life of 5715 years. If an archaeologist finds an ancient fire pit containing partially consumed firewood and if the ${}^{14}\text{C}$ content of the wood is only 12.5 percent that of an equal carbon sample from a present-day tree, what is the age of the ancient site?