

**Marks**  
**3**

- Strontium-90 is one of the harmful nuclides resulting from nuclear fission explosions. Strontium-90 decays by beta particle emission with a half-life of 28.0 years. How long (in years) would it take for 99.0% of a sample of strontium-90 released in an atmospheric test of an atomic bomb to decay?

The number of nuclei at time  $t$ ,  $N_t$ , is related to the number of nuclei present at  $t = 0$ ,  $N_0$  by:

$$\ln\left(\frac{N_0}{N_t}\right) = \lambda t$$

where  $\lambda$  is the activity constant.

The half life,  $t_{1/2}$ , corresponds to the time required for half of the sample to decay:  $\frac{N_0}{N_t} = 2$  and so  $t_{1/2} = \frac{\ln 2}{\lambda}$ . Hence,  $\lambda = \frac{\ln 2}{t_{1/2}}$

If 99.0% of the sample has decayed, 1.0% is remaining and so  $\frac{N_0}{N_t} = \frac{100}{1}$ :

$$\ln\left(\frac{100}{1}\right) = \frac{\ln 2}{(28.0 \text{ years}^{-1})} \times t \text{ or } t = 186 \text{ years.}$$

Answer: **186 years**