Half-life

Sample Question 1

The graph below shows the decay curve for a radioactive substance Y.

Activity / counts s^{-1}
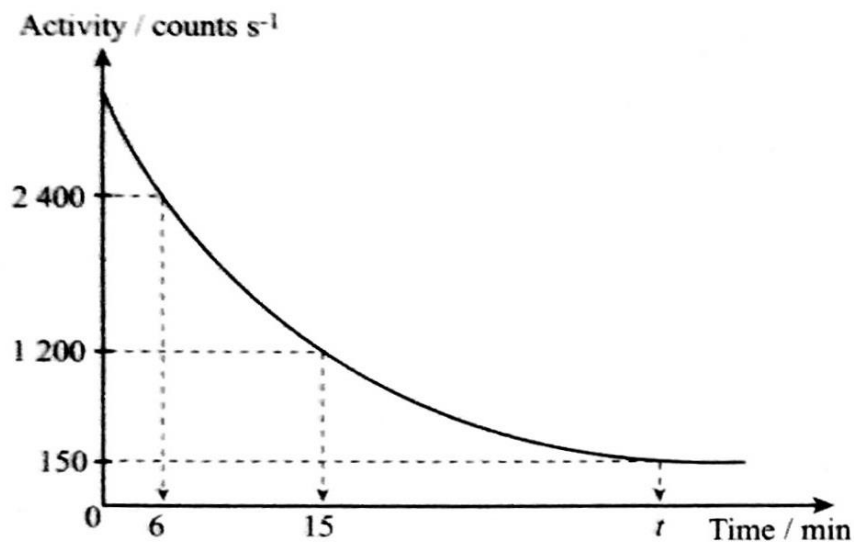
(a) What is the half-life of substance Y?
(b) Determine the value of t.

Solution ▶

(a) From the graph, at time $t = 6$ min, activity = 2 400.
     The activity is halved to 1 200 at time $t = 15$ min.
     ∴ Half-life = $15 - 6 = 9$ min
(b) $1\ 200 \rightarrow 600 \rightarrow 300 \rightarrow 150$
     Number of half-lives for activity to be reduced from 1 200 to 150 = 3
     ∴ $t = 15 + (3 \times 9)$
         $= 15 + 27$
         $= 42$ min

Sample Question 2

An archaeologist successfully dug out some bones, believed to belong to the first man on Earth. A test found that the activity of carbon-14 in the bones is 34 counts per second. If the original activity of carbon-14 in the bones is 4 352 counts per second, how old is the bones? (Half-life of carbon-14 = 5 700 years)

Solution ▶

$$N = \left(\frac{1}{2}\right)^{x} N_o$$

$$34 = \left(\frac{1}{2}\right)^{x} \times 4\,352$$

$$\left(\frac{1}{2}\right)^{x} = \frac{1}{128}$$

$$= \left(\frac{1}{2}\right)^{7}$$

$$\therefore \quad x = 7$$

Age of the bones $= 7 \times 5\,700$

$$= 39\,900 \text{ years}$$

Q1.

A sample of sodium-24 contains 40 million atoms. After 2 days, the number of sodium-24 atoms reduces to 5 million atoms. Calculate the half-life of sodium-24.

Q2.

The mass of a radioactive substance reduces from 32 g to 1 g in 100 days. Calculate the half-life of the radioactive substance.

Q3.

The activity of a radioactive sample reduces to 12.5% of its original activity in 6 days. Calculate the half-life of the radioactive substance.

Q4.

The half-life of a radioactive substance X is 5 days. Calculate the time required for 96 g of X to reduce its mass by 90g.

Q5.

A GM tube detects the activity of a radioactive substance as 42 counts per second. If the half-life of the radioactive substance is 4 hours what is the activity of this radioactive substance 1 day ago?

Q6.

During an expedition into the Pacific Ocean a scientist found an old rock. A test was conducted on the rock and found that the activity of plutonium-239 in the rock is 3.125% of its original activity. If the half-life of plutonium-239 is 24000 years, how old is the rock?