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5 All radioactive isotopes have a characteristic half-life.

(a) Define the term *half-life*.

....

....

.... [2]

(b) A radioactive isotope of sodium (Na) decays by β emission to produce an isotope of magnesium (Mg).

Complete the nuclear equation for this decay.

$$^{24}_{11}\text{Na} \rightarrow$$

[2]

(c) A student performs an experiment to determine the half-life of a radioactive isotope.

(i) A radiation detector is used to determine the background radiation. The total radiation count in 10.0 minutes with no radioactive source present is found to be 2400 counts.

Determine the background count rate.

background count rate = ... s^{-1} [1]

(ii) A sample of the radioactive source is placed close to the radiation detector. The count rate is determined once an hour.

The count rate *A*, corrected for background radiation, is recorded in Table 5.1.

Table 5.1

t/hours	A/s^{-1}	ln (A/s^{-1})
0.00	296	5.690
1.00	279	5.631
2.00	264	5.576
3.00	249	5.517
4.00	235	5.460

Determine the uncorrected count rate for t = 2.00 hours.

count rate = ... s^{-1} [1]

(d) Fig. 5.1 shows a graph of the data in Table 5.1.

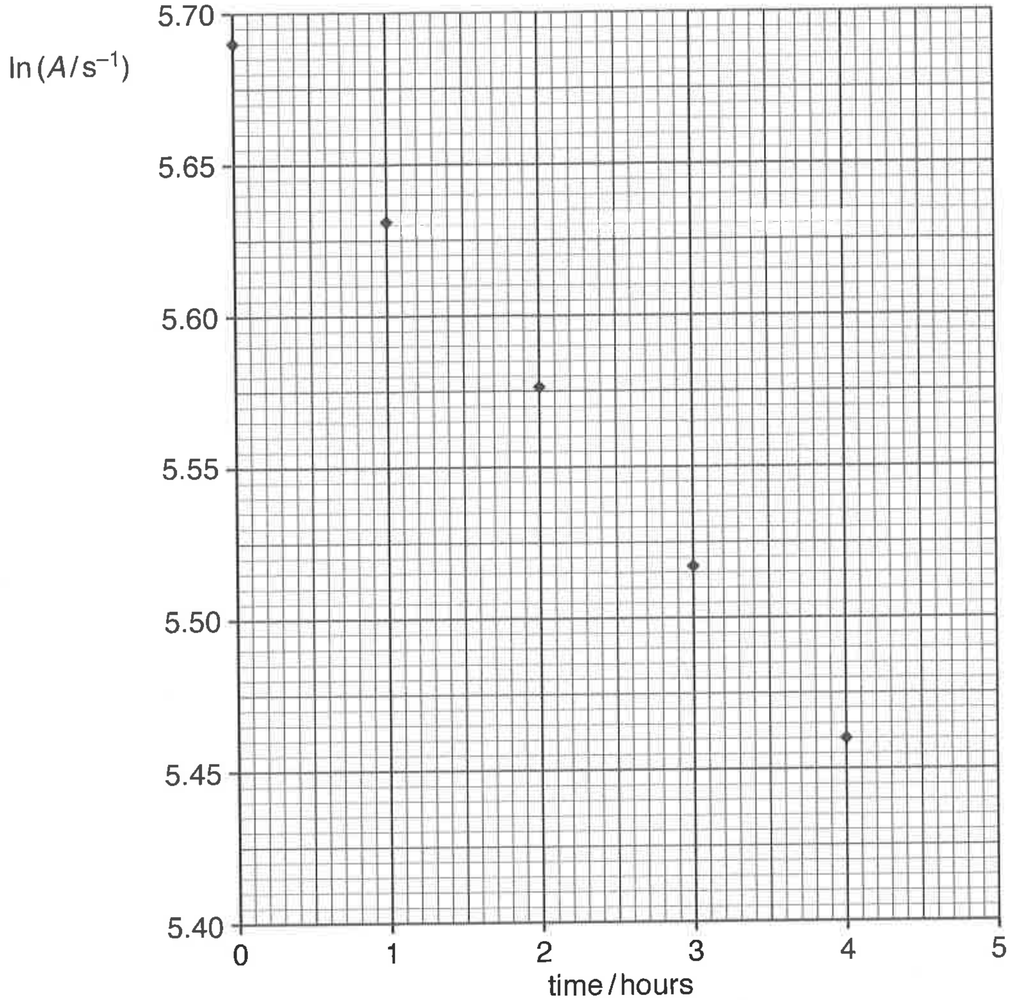

Fig. 5.1

(i) Add a line of best fit to the graph in Fig. 5.1. [1]

(ii) The corrected count rate A is related to the time t by the equation

$$\ln(A/\mathrm{s}^{-1}) = -\frac{0.693}{\tau}\,t + k$$

where τ is the half-life and k is a constant.

Use the graph to calculate a value for the half-life of the radioactive source.

half-life = ... hours [3]

[Total: 10]