6 **(a)** In a particular radioactive decay, Plutonium-241 ($^{241}_{94}Pu$) decays to form the daughter product Americium-241 ($^{241}_{95}Am$). A fresh sample of radioactive material contains only Plutonium-241 nuclei and no Americium-241. Fig. 6.1 shows the variation with time *t* of the activity *A* of Plutonium-241.

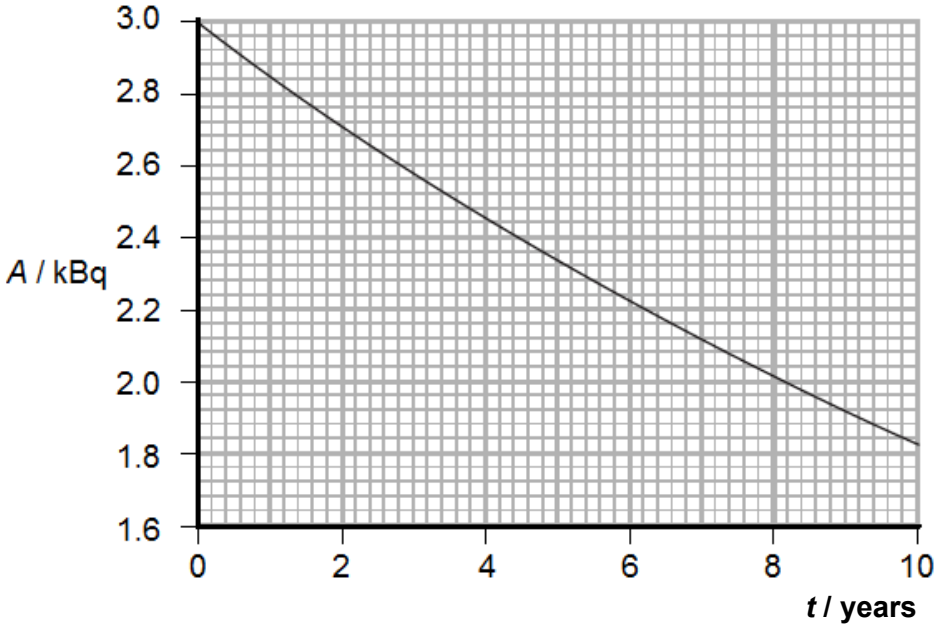

Fig. 6.1

Some data derived from Fig. 6.1 is shown in the table below.

Time *t* / years	Activity *A* / kBq
0.0	3.00
2.0	2.70
4.0	2.44
6.0	2.22
8.0	2.02
10.0	1.82

Fig. 6.2

(i) Using Fig. 6.2, show that the half-life of Plutonium-241 is 14 years.

[3]

(ii) Assume the half-life of Plutonium-241 is very much shorter than that of Americium-241 and Americium-241 is very stable once formed.

Deduce the age of the sample of radioactive material when

$$\frac{\text{Number of Americium} - 241 \text{ nuclei in sample}}{\text{Number of Plutonium} - 241 \text{ nuclei in sample}} = \frac{1}{3}.$$

age of the sample = ……..…….. years [2]

(b) The radioactive nuclide $^{60}_{27}$Co is used in radiotherapy. It has a half-life of 5.27 years and, at each disintegration, two γ-rays are emitted, one of energy 1.17 MeV and the other of energy 1.33 MeV.

In a radiotherapy treatment, it is necessary to determine the amount of energy absorbed from the radiation. A fresh 1.0 g sample of $^{60}_{27}$Co, which may be treated as a point source, is placed at a position 1.50 m from a patient.

Calculate the intensity of the radiation received by the patient.

intensity = ……..……. W m^{-2} [3]

(c) Radioactivity is often said to be a random process.

Explain what is meant by the word *random* in this context.

……..……..

……..……..

……..……..

……..… [2]

Section B

Answer **one** question from this Section in the spaces provided.