

- 7 (a) A nucleus Z undergoes nuclear fission to form strontium-93 ( $^{93}_{38}\text{Sr}$ ) and xenon-139 ( $^{139}_{54}\text{Xe}$ ) according to

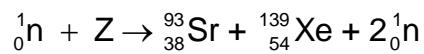


Fig. 7.1 shows the binding energies of the strontium-93 and xenon-139 nuclei.

| Nucleus                | binding energy / J     |
|------------------------|------------------------|
| $^{93}_{38}\text{Sr}$  | $1.25 \times 10^{-10}$ |
| $^{139}_{54}\text{Xe}$ | $1.81 \times 10^{-10}$ |

Fig. 7.1

The fission of 1.00 mol of Z releases  $1.77 \times 10^{13}$  J of energy.

Determine the binding energy per nucleon, in MeV, of Z.

$$\text{binding energy per nucleon} = \dots \text{MeV} [4]$$

- (b)** Plutonium-238 ( $^{238}_{94}\text{Pu}$ ) is unstable and undergoes alpha decay.

The power source in a space probe contains 0.874 kg of plutonium-238. The half-life of plutonium-238 is 87.7 years.

- (i)** Show that the initial number  $N_0$  of nuclei of plutonium-238 in the power source is  $2.21 \times 10^{24}$ .

[1]

- (ii)** Determine the initial activity of the source.

activity = .....Bq [2]

- (iii)** The space probe will continue to function until the power output from the plutonium in the source decreases to 65.3% of its initial value.

Calculate the time, in years, for which the space probe will function.

time = .....years [2]

- (iv)** An alternative power source uses energy generated from the radioactive decay of polonium-210. This isotope has a half-life of 0.378 years. The mass of the isotope needed for the same initial power output as produced by plutonium-238 is 3.37 g.

Suggest one disadvantage of using polonium-210 as the source of energy.

.....  
..... [1]

[Total: 10]