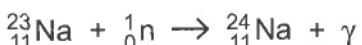


- 7 Slow-moving neutrons react with nuclei of sodium-23 to form the isotope sodium-24. The reaction is represented by the equation shown.



Sodium-23 is stable.

Data for some masses are given in Fig. 7.1.

| | | mass/u |
|-----------|-------------------------|----------|
| proton | ${}_{1}^1\text{p}$ | 1.00814 |
| neutron | ${}_{0}^1\text{n}$ | 1.00898 |
| sodium-23 | ${}_{11}^{23}\text{Na}$ | 22.99706 |
| sodium-24 | ${}_{11}^{24}\text{Na}$ | 23.99857 |

Fig. 7.1

The energy equivalent to 1.000 u is 931.4 MeV.

- (a) (i) State what is meant by the *binding energy* of a nucleus and how it is related to the mass defect.
-
.....
.....
.....

[2]

- (ii) Use data from Fig. 7.1 to determine, to three decimal places, the binding energy per nucleon, in MeV, of sodium-23.

binding energy per nucleon = MeV [3]





- (b) (i) For the absorption of a neutron by a sodium-23 nucleus, show that the mass change is 7.47×10^{-3} u.

[1]

- (ii) Assuming that all of the energy released in (b)(i) is in the form of the γ -ray photon, determine the wavelength of the γ -ray photon.

wavelength = m [3]

- (c) The isotope sodium-24 is radioactive.

A sample of sodium-24 takes 65 hours for its activity to be reduced to $\frac{1}{20}$ of its initial activity.

Determine the probability per hour of the decay of a sodium-24 nucleus.

probability = hour^{-1} [2]

[Total: 11]

