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

$$^{23}_{11}Na + ^{1}_{0}n \rightarrow ^{24}_{11}Na + \gamma$$

Sodium-23 is stable.

Data for some masses are given in Fig. 7.1.

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