7 **(a)** **(i)** State what is meant by nuclear fusion.

....

....

.... [1]

(ii) On Fig. 7.1, sketch the variation of binding energy per nucleon with nucleon number A for values of A between 1 and 250. Label the value of A where binding energy per nucleon is the highest.

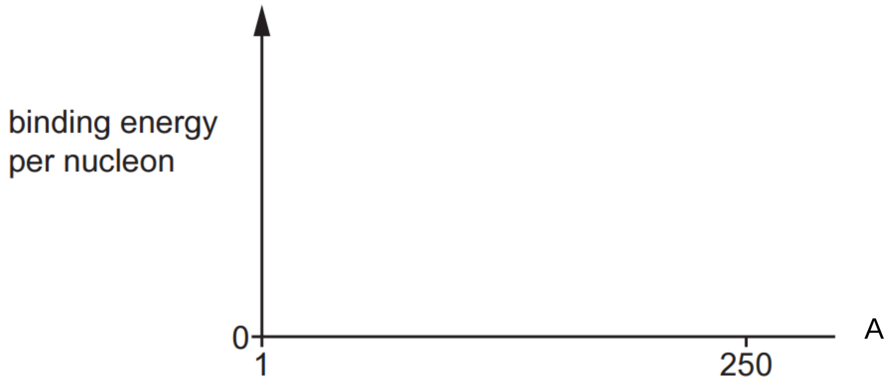

Fig. 7.1

[1]

(iii) On your line in Fig. 7.1, label:

1. a point X that could represent a nucleus that undergoes alpha-decay. [1]

2. a point Y that could represent a nucleus that undergoes nuclear fusion. [1]

(iv) A nucleus Z undergoes nuclear fission to form strontium-93 ($3893Sr$) and xenon-139 ($54139Xe$) according to

$$01n + \mathrm{Z} \rightarrow 3893Sr + 54139Xe + 201n.$$

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

Table. 7.1

nucleus	binding energy / J
${}^{93}_{38}\mathrm{Sr}$	1.25×10^{-10}
${}^{139}_{54}\mathrm{Xe}$	1.81×10^{-10}

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

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

binding energy per nucleon = ... MeV [3]

(b) Fluorine-18 ($^{18}_{9}F$) is a radioactive nuclide that is used as a tracer in positron emission tomography (PET scanning). Fluorine-18 decays to a nuclide of oxygen and emits 2 gamma-rays. The half-life of fluorine-18 is *T*. A patient is injected with amount of substance *n* of fluorine-18.

(i) Determine an expression for the initial value R_0 of the rate *R* of production of gamma-ray photons by the tracer, in terms of *n, T* and the Avogadro constant N_A. Explain your working.

R_0 = ... [2]

(ii) On Fig. 7.2, sketch the variation with time *t* of *R*.

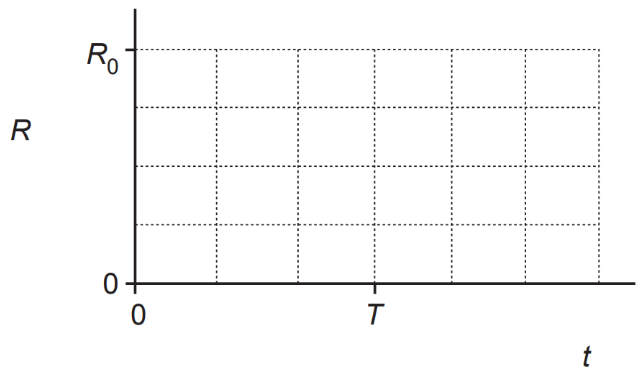

Fig. 7.2

[2]