8 A uranium-238 (U) nucleus, originally at rest in a cloud chamber, undergoes spontaneous decay by emitting an α-particle to form a thorium (Th) nucleus.

(a) State what is meant by the number *238*.

.....

..... [1]

(b) Complete the nuclear equation below for the decay.

$$\square^{238}U \rightarrow \square^{\square}_{90}Th + \square^{4}He$$

[2]

(c) The α-particle travels 40.0 mm in the cloud chamber to produce a track of ion-pairs which causes the α-particle's path to be visible due to condensation taking place on the ions produced.

On average, an α-particle produces 5.90×10^{3} ion-pairs per mm of track in the cloud chamber and the energy required to produce an ion-pair is 2.70×10^{-18} J.

(i) Show that the kinetic energy of the α-particle is 6.37×10^{-13} J.

[1]

(ii) Determine the momentum of the thorium nucleus.

momentum = ... N s [2]

(iii) Determine the total kinetic energy of the α-particle and the thorium nucleus.

total kinetic energy = ... MeV [3]

(iv) State an assumption you made in your calculations in **(c)(ii)** and **(c)(iii)**.

.....

..... [1]

(d) Fig. 8.1 shows the variation with nucleon number A of the nuclear binding energy per nucleon B_E.

The nuclear binding energy per nucleon of uranium-238 nucleus is 7.57 MeV and that of the α-particle is 7.08 MeV.

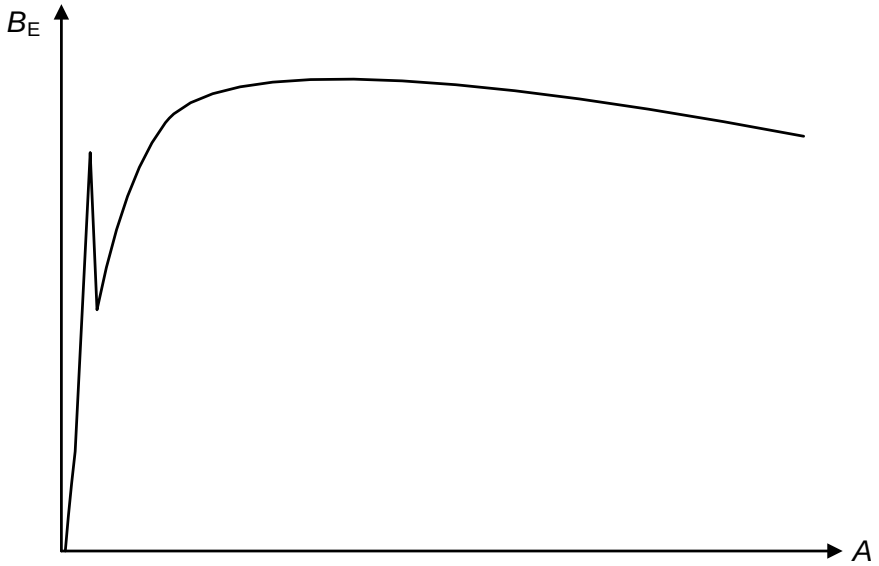

Fig. 8.1

(i) Explain the term *nuclear binding energy*.

.....

.....

..... [1]

(ii) State the nuclide with the highest B_E and its B_E to 2 significant figures.

nuclide : .....

B_E : ..... MeV [2]

(iii) Determine the nuclear binding energy per nucleon of the thorium nucleus.

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

(iv) On the curve in Fig. 8.1, mark the approximate positions of the nuclei of

1. uranium-238 (label the position U),

2. thorium (label the position Th),

3. α-particle (label the position α). [2]

(v) Nuclear fusion is a nuclear reaction that releases energy.

1. Explain the term *nuclear fusion*.

.....

..... [1]

2. One such type of nuclear fusion reaction is $A + B \rightarrow C$.

On Fig. 8.1, mark the approximate positions of the nuclei of A, B and C. [1]

End of Paper 3 Section B

