5 **(a)** When a neutron is captured by a Uranium-235 nucleus, the outcome may be represented by the nuclear equation shown below.

$$^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{95}_{42}\text{Mo} + ^{139}_{57}\text{La} + 2\,^{1}_{0}\text{n} + 7\,^{0}_{-1}\text{e}$$

The energy released in the nuclear reaction above is 182 MeV. Fig. 5.1 shows how the binding energy per nucleon varies with mass number *A*.

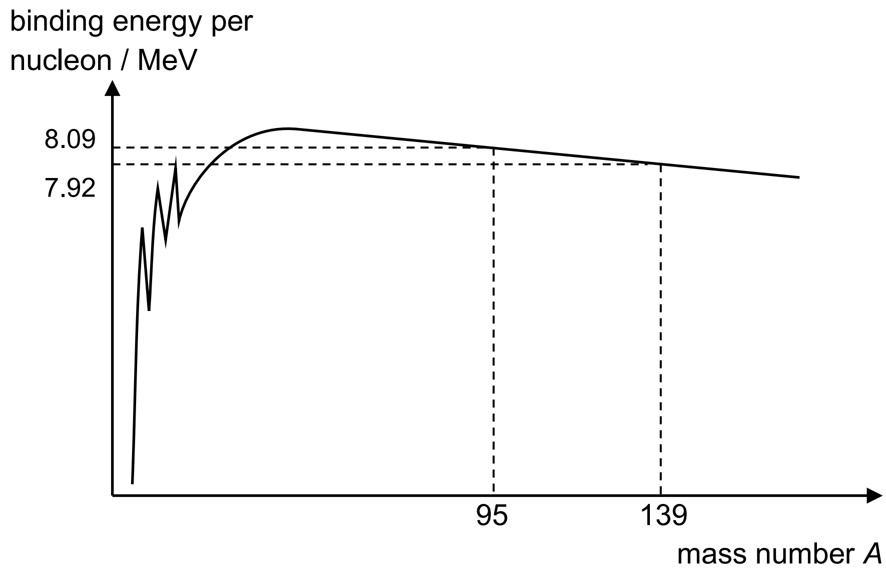

Fig. 5.1

(i) Determine the binding energy, in MeV, of a nucleus of Uranium-235.

binding energy = ………………………. MeV [3]

(ii) Calculate the mass defect, in kg, of a nucleus of Uranium-235.

mass defect = ………………… kg [2]

(b) The nuclide Potassium-42 $\left({}^{42}_{19}\mathrm{K}\right)$ undergoes radioactive decay to become Calcium-42 $\left({}^{42}_{20}\mathrm{Ca}\right)$. A radioactive sample contains N_0 atoms of Potassium-42 and no atoms of Calcium-42 at time $t = 0$. Fig. 5.2 shows the variation with time t of the ratio $\dfrac{N}{N_0}$ where N is the number of atoms of Potassium-42.

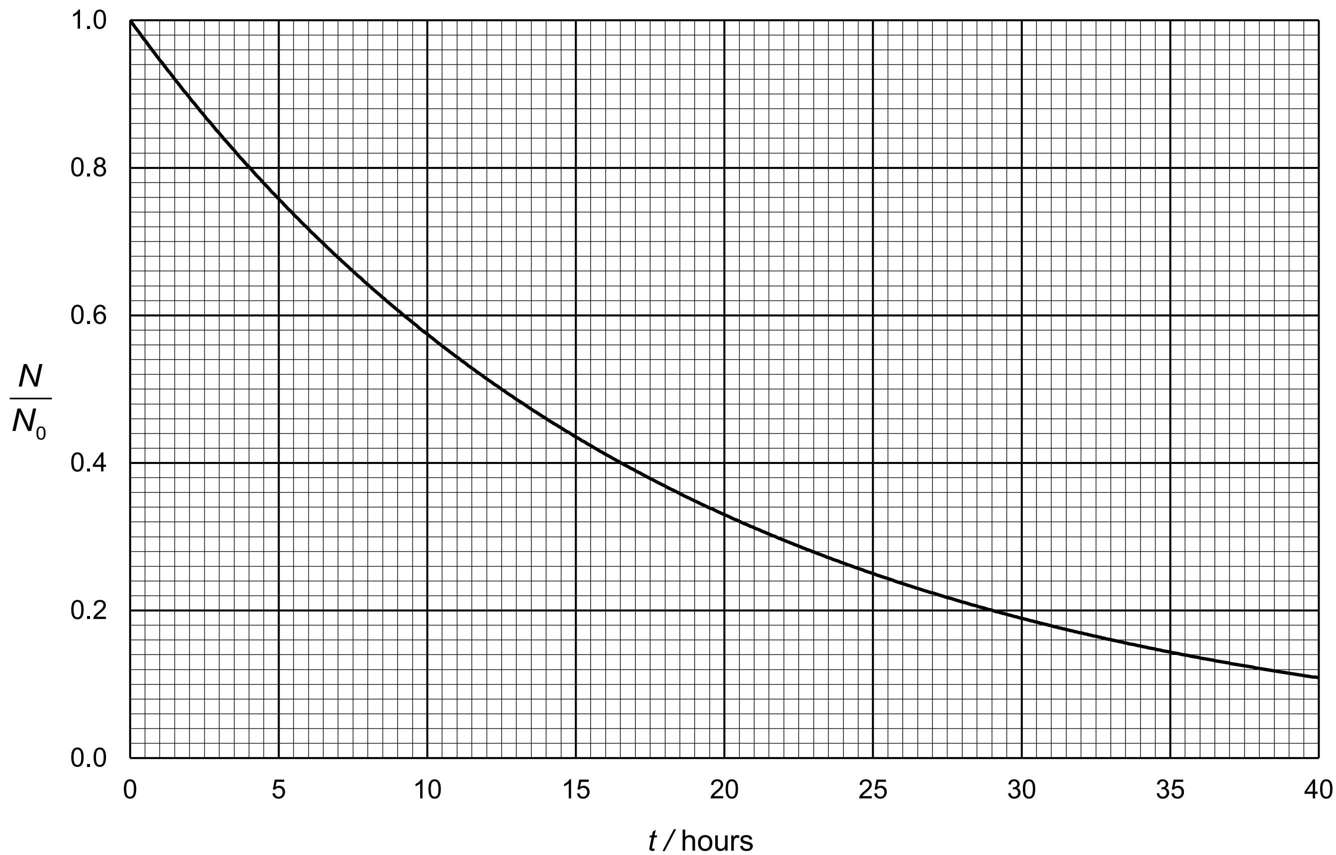

Fig. 5.2

(i) Write down the equation for the decay of Potassium-42 to Calcium-42. [1]

(ii) Use Fig. 5.2 to estimate the half-life of Potassium-42.

half-life = ……………….. hours [1]

(iii) Calcium-42 is stable. Using the axes of Fig. 5.2, sketch a graph to show the variation with time *t* of the ratio of Calcium-42 atoms to N_0 in the sample. [1]

(iv) By reference to Fig. 5.2 or otherwise, determine the age of the radioactive sample when the ratio

$$\frac{\text{number of Calcium - 42 atoms}}{\text{number of Potassium - 42 atoms}}$$

is equal to 4.0.

age = ……………………………. hours [2]

[Total: 10]

Section B

Answer **one** question from this Section in the space provided.