12 (a) Define the *binding energy* of a nucleus.

.....

.....

.....[2]

(b) A stationary nucleus of uranium-238 ($^{238}_{92}U$) decays to form a nucleus of thorium-234 ($^{234}_{90}Th$). An α-particle and a gamma-ray photon are emitted. The equation representing the decay is

$$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He + {}^{0}_{0}\gamma$$

The masses of the nuclei are given in Fig. 12.1.

nucleus	mass / u
uranium-238	238.05076
thorium-234	234.04357
helium-4	4.00260

Fig. 12.1

(i) State the relationship between the binding energies of the nuclei that is consistent with this reaction being energetically possible.

.....

.....[1]

(ii) Calculate, for this reaction,

1. the change, in u, of the mass,

change of mass = ...u [1]

2. the total energy, in J, released.

energy = ...J [2]

(iii) State and explain whether the energy of the gamma-ray photon is equal to the energy released in the reaction.

.....

.....

.....[2]

[Total: 8]

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