6 **(a)** When an α−particle bombards a stationary nitrogen−14 nucleus, the following nuclear reaction may occur.

$$^{14}_{7}N + ^{4}_{2}He \rightarrow ^{17}_{8}O + ^{1}_{1}H$$

The rest masses of the nuclei are

$^{14}_{7}N$ 14.007525*u*

$^{4}_{2}He$ 4.003860*u*

$^{17}_{8}O$ 17.004507*u*

$^{1}_{1}H$ 1.008142*u*

(i) Deduce that the energy associated with the change in mass in this reaction is approximately 1.9 x 10^{-13} J.

[2]

(ii) By reference to energy, suggest how it is possible for this reaction to occur.

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....[2]

(iii) The oxygen−17 nucleus and the hydrogen nucleus move apart after the reaction.

1. Explain why the oxygen−17 nucleus and the hydrogen nucleus move after the reaction.

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.... [1]

2. Describe the effect of this movement on your answer in **(ii)**.

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.... [1]

(b) Products of a radioactive decay can be radioactive as well and give rise to a series of radioactive decay products. Each decay product has its own half-life, but eventually a stable nuclide is reached.

One such nuclide is xenon−140 ($^{140}_{54}Xe$), which eventually decays into cerium−140 ($^{140}_{58}Ce$), which is stable.

The series of decay products is as follow:

$$^{140}_{54}Xe \rightarrow {}^{140}_{55}Cs \rightarrow {}^{140}_{56}Ba \rightarrow {}^{140}_{57}La \rightarrow {}^{140}_{58}Ce$$

The half-lives of the radioactive nuclides are given in Fig. 6.1.

Nuclide	Half-life
xenon–140 $^{140}_{54}Xe$	16 s
caesium–140 $^{140}_{55}Cs$	1.1 minute
barium–140 $^{140}_{56}Ba$	13 days
lanthanum–140 $^{140}_{57}La$	40 hours

Fig. 6.1

(i) Initially, the total mass of undecayed xenon−140 in a radioactive sample is 5.7×10^{-12} kg.

Calculate the activity of the undecayed xenon−140 in the sample after 60 s.

activity = …………………………….Bq [3]

(ii) The activity of the sample after 1 minute is higher than the value calculated in **(b)(i)**. Suggest a reason for the difference using the given data.

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....[1]

[Total: 10]