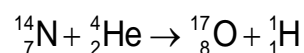


- 6 (a) When an  $\alpha$ -particle bombards a stationary nitrogen-14 nucleus, the following nuclear reaction may occur.



The rest masses of the nuclei are

${}^{14}_7\text{N}$  14.007525  $u$

${}^4_2\text{He}$  4.003860  $u$

${}^{17}_8\text{O}$  17.004507  $u$

${}^1_1\text{H}$  1.008142  $u$

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

[2]

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

.....  
 .....  
 ..... [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.

.....  
 .....  
 ..... [1]

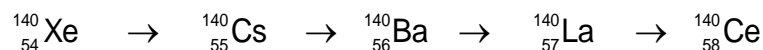
2. Describe the effect of this movement on your answer in (ii).

.....  
 .....  
 ..... [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 ( $^{140}_{54}\text{Xe}$ ), which eventually decays into cerium-140 ( $^{140}_{58}\text{Ce}$ ), which is stable.

The series of decay products is as follow:



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

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

**Fig. 6.1**

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

.....

.....

.....[1]

[Total: 10]