8 **(a)** Explain why the mass of an α-particle is less than the total mass of two individual protons and two individual neutrons.

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..... [2]

(b) An equation for one possible nuclear reaction is

$$^{4}_{2}\text{He} + {}^{14}_{7}\text{N} \longrightarrow {}^{17}_{8}\text{O} + {}^{1}_{1}\text{p}.$$

Data for the masses of the nuclei are given in Fig. 8.1.

		mass/u
proton	$^{1}_{1}$p	1.00728
helium-4	$^{4}_{2}$He	4.00260
nitrogen-14	$^{14}_{7}$N	14.00307
oxygen-17	$^{17}_{8}$O	16.99913

Fig. 8.1

(i) Calculate the mass change, in u, associated with this reaction.

mass change = ... u [2]

(ii) Calculate the energy, in J, associated with the mass change in **(i)**.

energy = ... J [2]

(iii) Suggest and explain why, for this reaction to occur, the helium-4 nucleus must have a minimum speed.

For Examiner's Use

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..... [2]