7 The discovery of the proton was credited to Ernest Rutherford. In 1917, he fired a beam of α particles into pure nitrogen gas which resulted in the production of oxygen and protons. The nuclear reaction is given by the equation

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

(a) State what is meant by the binding energy of a nucleus and how it is related to the mass defect.

……

……

……

……

…… [2]

(b) Data for some masses are given in Table 7.1.

		mass / u
proton	$^{1}_{1}\mathrm{H}$	1.007 276
neutron	$^{1}_{0}\mathrm{n}$	1.008 665
nitrogen-14	$^{14}_{7}\mathrm{N}$	14.003 074

Table 7.1

(i) Show that the energy equivalent of 1.00 *u* is 934 MeV.

[2]

(ii) Using data from Table 7.1, show that the binding energy per nucleon of nitrogen-14 is 7.24 MeV.

[2]

(c) The binding energy per nucleon for the other nuclides is shown in Table 7.2.

		binding energy per nucleon / MeV
helium	$^{4}_{2}He$	6.836
oxygen-17	$^{17}_{8}O$	7.530

Table 7.2

(i) Use data from Table 7.2 to determine, to three significant figures, the energy released in this reaction associated with the change in mass.

energy released = …….. MeV [2]

(ii) State and explain whether the reaction will take place if the incident α-particle has a kinetic energy of 0.300 MeV. You may assume that the nitrogen-14 nucleus is at rest.

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……..

……..

……..

…… [2]

[Total: 10 marks]