9 **(a)** State what is meant by

- *radioactive decay*,

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- *nuclear fission*,

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- *nuclear fusion*.

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[4]

(b) When an α-particle bombards a stationary nitrogen nucleus, a nuclear reaction that can take place is given by the equation

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

Data for the nuclei in the reaction are given in Fig. 9.1.

nucleus	mass / u
α-particle $^{4}_{2}$He	4.002604
hydrogen $^{1}_{1}$H	1.007825
nitrogen $^{14}_{7}$N	14.003074
oxygen $^{17}_{8}$O	16.999130

Fig. 9.1

(i) Use data from Fig. 9.1 to determine, to three significant figures, the energy associated with the change in mass in this reaction.

energy = ... J [4]

(ii) The incident α-particle has a kinetic energy of 1.76×10^{-13} J.

State and explain whether the reaction will take place.

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..... [2]

(c) A stationary nucleus emits a γ-ray photon of energy 1.16 MeV.

For the γ-ray photon, calculate, to three significant figures,

(i) its wavelength,

wavelength = ... m [3]

(ii) its momentum.

momentum = ... Ns [2]

(d) (i) The stationary nucleus in **(c)** has a mass of 60 u.

Use your answer in **(c)(ii)** to determine the recoil kinetic energy of this nucleus. Explain your working.

energy = ... J [4]

(ii) Suggest why the energy in **(d)(i)** is not usually thought to be an important factor when considering mass-energy for the emission of the γ-ray photon.

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..... [1]

[Total: 20]