8 (a) In Rutherford's α-particle scattering experiment, α-particles from a radioactive source were directed towards a sheet of gold foil in a vacuum chamber as shown in Fig. 8.1.

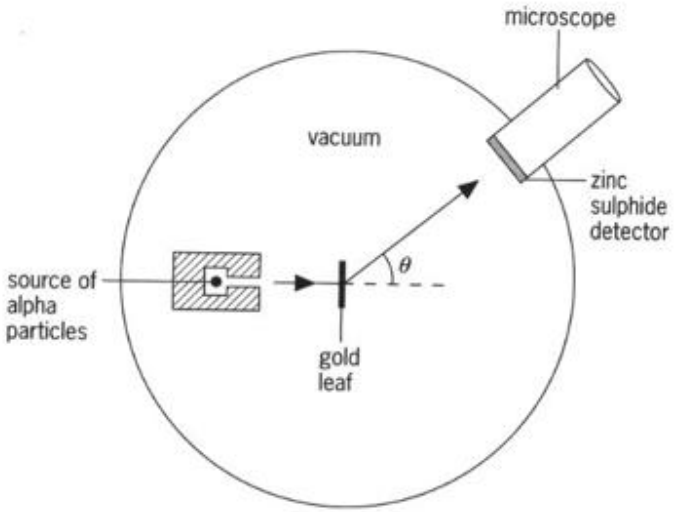

Fig. 8.1

(i) Explain why it is necessary for the radioactive source to be placed in vacuum.

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[1]

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(ii) State the experimental observation obtained from Rutherford's experiment which suggested that

1. the nucleus is small,

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……...

[1]

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……...

2. the nucleus is massive and charged.

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……...

[1
…….]
……...

(b) A common nuclear reaction that can be induced in a laboratory is represented by the following equation:

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

In this reaction, stationary nitrogen nuclei were bombarded with helium nuclei, forming oxygen and hydrogen.

The total rest masses of the reactant and the product nuclei are as follows:

$$^{14}_{7}N + ^{4}_{2}He = 18.00568 \text{ u}$$
$$^{17}_{8}O + ^{1}_{1}H = 18.00696 \text{ u}$$

(i) Deduce that the change in rest-mass energy in this reaction is 1.9×10^{-13} J.

[1]

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

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[1]

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(iii) In reality, more than 1.9×10^{-13} J of energy is required for the reaction to occur.

Suggest why this might be so.

……
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[1]

……
……

[Total: 6]

Section B

Answer **one** question from this Section in the space provided.