**8** **(a)** In the early 1900s, Geiger and Marsden (1909) fired a beam of alpha particles at a thin foil of gold. The experiment was conducted in a dark room.

A setup of this experiment is as shown in Fig. 8.1 below.

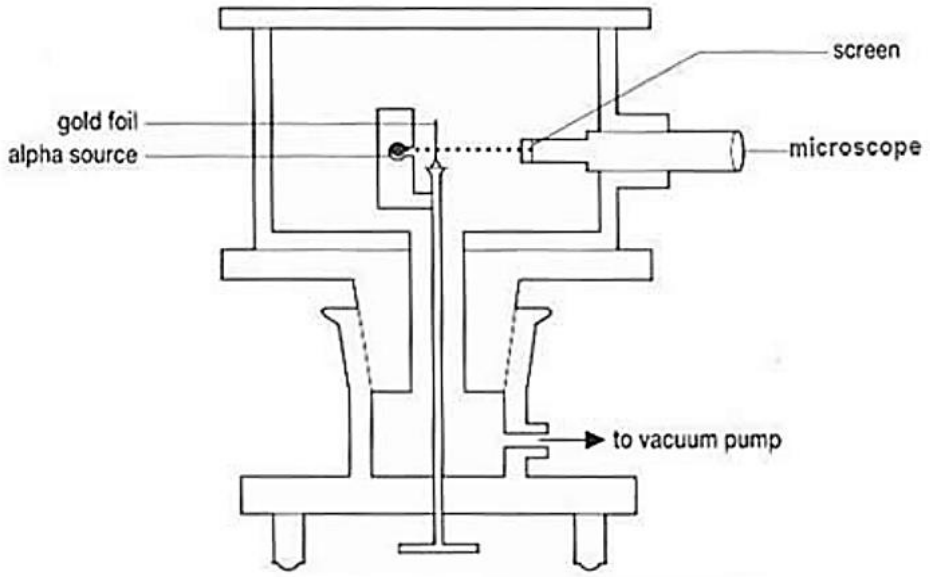


**Fig. 8.1**

**(i)** Explain the significance of the vacuum pump.

……

……

…… [2]

**(ii)** Suggest why the room is darkened.

……

……

…… [2]

**(iii)** State one of the experimental observations and corresponding implications on the understanding of the structure of the gold atom.

Observation:

……

……

……

Implication:

…….....

…….....

……..... [2]

**(iv)** Fig. 8.2 below shows two alpha particles approaching a gold nucleus inside the foil. Both will be deflected by the nucleus.

The arrows indicate the direction of the velocities at line A. Sketch their respective paths from line A to line B.

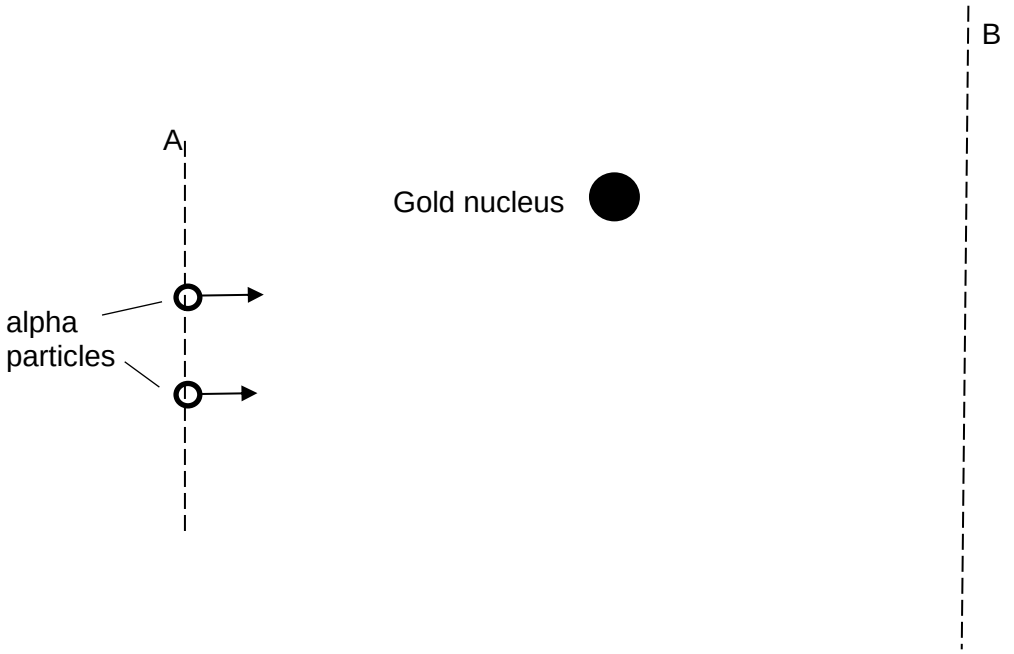


**Fig. 8.2**

[2]

**(b)** Data for the masses of some particles and nuclei are given in Fig. 8.3.

| | mass / u |
|---|---|
| proton | 1.0073 |
| neutron | 1.0087 |
| deuterium ($^{2}_{1}H$) | 2.0141 |
| zirconium ($^{97}_{40}Zr$) | 97.0980 |

**Fig. 8.3**

**(i)** Show that the energy equivalence of 1.0 u is 934 MeV.

[2]

**(ii)** State what is meant by the binding energy of a nucleus.

……

……

…… [2]

**(iii)** Determine the binding energy per nucleon of zirconium.

binding energy per nucleon = ..... MeV [3]

**(c)** The spontaneous and random decay of a radioactive substance involves the emission of one or more types of radiation.

**(i)** Explain what is meant by spontaneous decay.

……

……

…… [1]

**(ii)** Describe how the randomness of decay is manifested in a decay curve.

……

……

…… [1]

**(iii)** Fill up the table in Fig. 8.4 by stating the type of radiation emitted during decay, one in each case, that

**1.** is not affected by electric and magnetic fields,

**2.** produces the greatest number of ions per unit length along its path,

**3.** does not directly result in a change in the proton number of the nucleus,

**4.** has a range of energies, rather than discrete values.

| | Type of radiation |
|---|---|
| **1.** | |
| **2.** | |
| **3.** | |
| **4.** | |

**Fig. 8.4** [2]

**(iv)** Explain why the radiation in **(c)(iii)4**. has a range of energies.

……

……

…… [1]

[Total : 20]

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