1 Fig. 11.1 shows a beam of radiation that contains α-particles, β-particles and γ-rays. The beam enters a very strong electric field between charged plates in a vacuum.

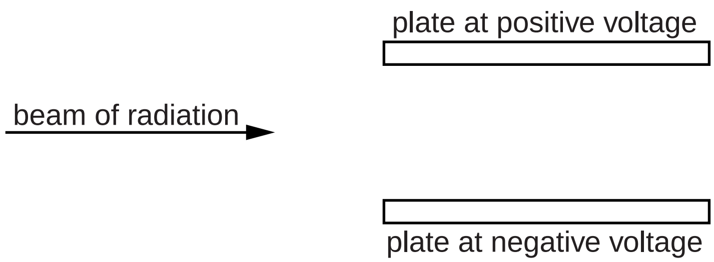

Fig. 11.1

(a) Indicate the deflection, if any, of the α-particles, β-particles and γ-rays, by placing **one** tick in **each** column of the table.

possible deflection	α-particles	β-particles	γ-rays
no deflection			
towards positive plate			
towards negative plate			
out of the paper			
into the paper			

[3]

(b) The radiation is said to be *ionising*. Explain what this means.

....

....[1]

(c) α-particles are more strongly ionising and have a shorter range in air than γ-rays.

Use your knowledge of the nature of these radiations to explain these differences.

....

....

....

.... [3]

[Total: 7]

2 A technician sets up a radiation detector in a university laboratory, for use in some experiments. Even before the radioactive source for the experiment is brought into the laboratory, the detector registers a low count rate.

(a) Suggest what causes this count rate.

....[1]

(b) A radioactive source that emits α-particles is placed on the laboratory bench and the source is gradually moved closer to the detector.

At first, the detector continues to register a low count rate sometimes slightly less than the count rate registered without the source. The count rate suddenly increases to a very high value when the source is very close to the detector.

Explain these changes in the count rate.

....

....

....

....

....[3]

(c) In a second experiment, α-particles pass between two parallel, horizontal metal plates in a vacuum.
They then continue to the detector as shown in Fig. 9.1.

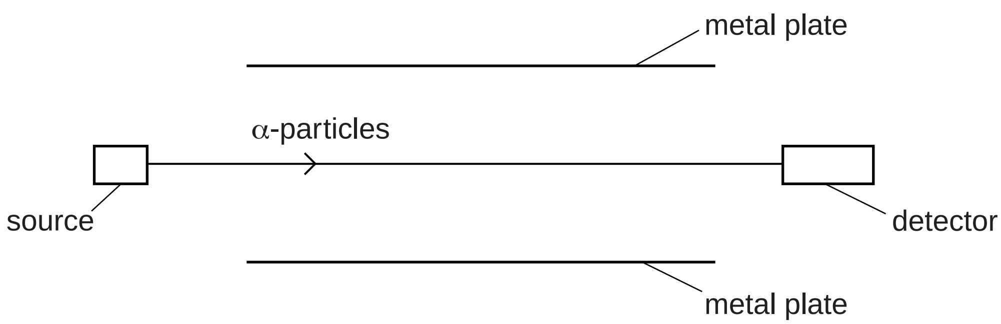

Fig. 9.1

A positive charge is established on the upper plate and a negative charge on the lower plate.

(i) On Fig. 9.1, sketch the new path of the α-particles. [2]

(ii) State what happens to the count rate registered by the detector.

....

....[1]

[Total: 7]

3 **(a)** A technician sets up a radiation detector in a university laboratory for use in a class experiment.

(i) A radioactive source that emits β-particles is placed on the laboratory bench, 10 cm from the detector. A small count rate is registered.

1. State the name of the particle, found in an atom, that is identical to a β-particle.

.... [1]

2. The technician sets up the same equipment in the same way every year. He notices that the count rate registered by the detector every year is slightly smaller than it was the previous year.

Suggest why this is so.

....

....

.... [2]

(ii) In a second experiment, the same equipment is set up but a radioactive source that emits α-particles is placed 10 cm from the detector. The same number of particles are emitted every second from this source as were emitted from the β-source in **(i)**.

Explain why the count rate obtained is much lower.

....

....

.... [2]

(b) In another experiment, β-particles pass between two parallel, horizontal metal plates in a vacuum. They then continue to the detector as shown in Fig. 10.1.

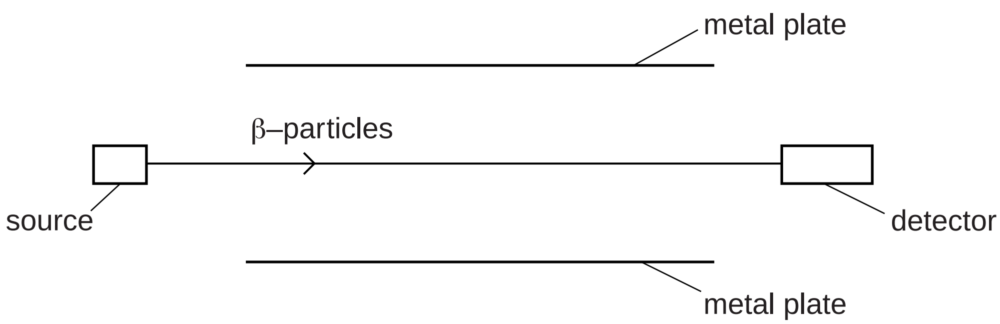

Fig. 10.1

A very high p.d. is connected between the plates, with the lower plate positive.

[2]

On Fig. 10.1, sketch the new path of the β-particles.

[Total: 7]

4 A technician sets up a radiation detector in a university laboratory, for use in some experiments. Even before the radioactive source for the experiments is brought into the laboratory, the detector registers a small count rate due to background radiation.

(a) Suggest one source of this background radiation.

....

....[1]

(b) The radioactive source emits γ-rays. It is placed on the laboratory bench close to the detector.

(i) State what γ-rays are.

....

....

....[2]

(ii) A lead sheet of thickness 10 mm is positioned between the detector and the radioactive source.

State and explain what happens to the count rate on the detector.

....

....

....[2]

(c) In a second experiment, γ-rays pass through air to the detector, as shown in Fig. 10.1.

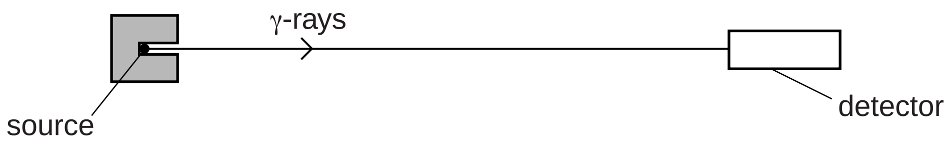

Fig. 10.1

One end of a bar magnet is brought close to the path of the γ-rays.

(i) Tick one box to indicate the effect on the path of the γ-rays. [1]

- ☐ deflected into the page
- ☐ deflected out of the page
- ☐ deflected downwards
- ☐ deflected upwards
- ☐ no deflection

(ii) Explain your answer to **(i)**.

....

....[1]

[Total: 7]

5 **(a)** Complete the following statements.

(i) An α-particle consists of ....

(ii) A β-particle consists of ....

[3]

(b) As α-particles and β-particles pass through a gas, molecules of the gas become ionised.

Explain what is meant by the *ionisation* of a gas molecule.

....

....[1]

(c) Fig. 11.1 shows a beam of α-particles and a beam of β-particles in a vacuum. The beams are about to enter a region in which a very strong magnetic field is acting. The direction of the magnetic field is into the page.

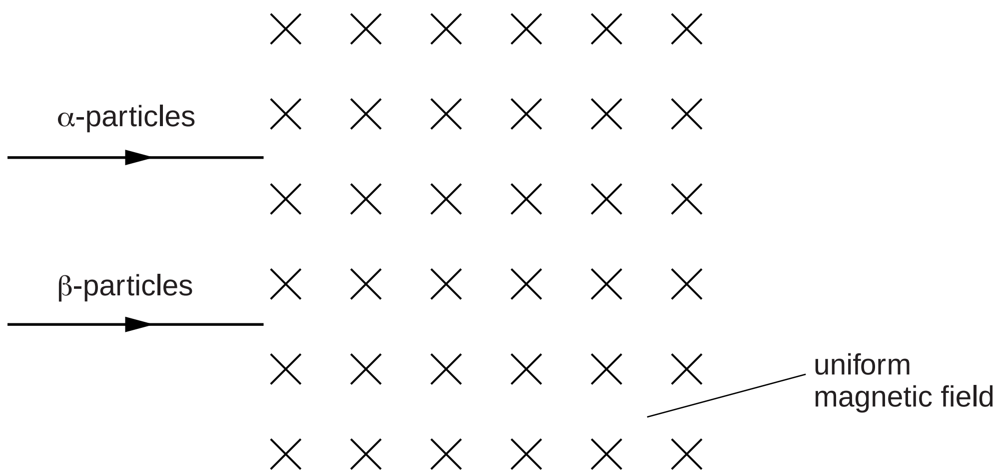

Fig. 11.1

(i) Suggest why the paths of the particles in the magnetic field are curved.

....[1]

(ii) Sketch the paths of both types of particle in the magnetic field. [3]

[Total: 8]

6 In a laboratory experiment, the isotope uranium-238 is used as a source of α-particles.

(a) State

(i) one feature of uranium-238 nuclei that is the same for the nuclei of other uranium isotopes,

.... [1]

(ii) one feature of uranium-238 nuclei that is different for the nuclei of other uranium isotopes.

.... [1]

(b) Fig. 9.1 shows the α-particles from the uranium source being directed at a very thin gold foil, in a vacuum.

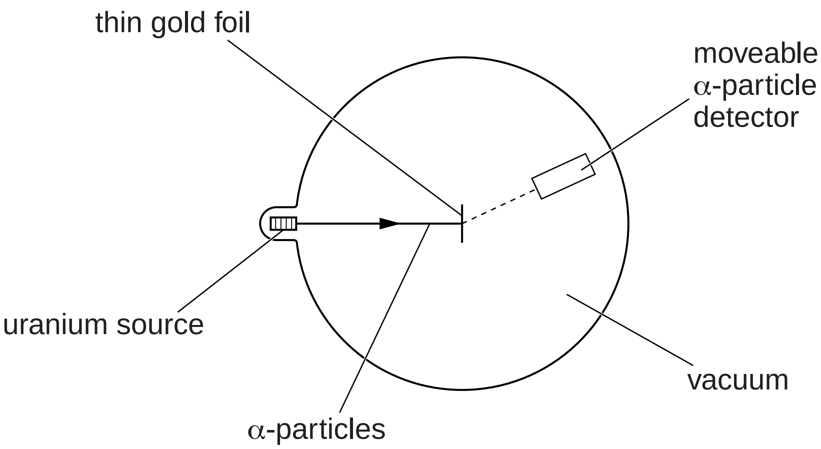

Fig. 9.1

To investigate the scattering of α-particles, a detector is moved to different positions around the very thin gold foil and measurements are recorded.

Describe the results from this scattering experiment and explain what they show about the structure of atoms.

....

....

....

....

....

....

.... [4]

[Total: 6]

7 In a laboratory at a nuclear power station, a radiation detector is connected to a computer. The readings recorded are displayed on the computer screen.

The detector is switched on. Ten minutes later, at time t = 10 minutes, a small sample of radioactive material is removed from a nuclear reactor and placed near to the detector. Readings are recorded for a further 40 minutes. Fig. 11.1 shows the display.

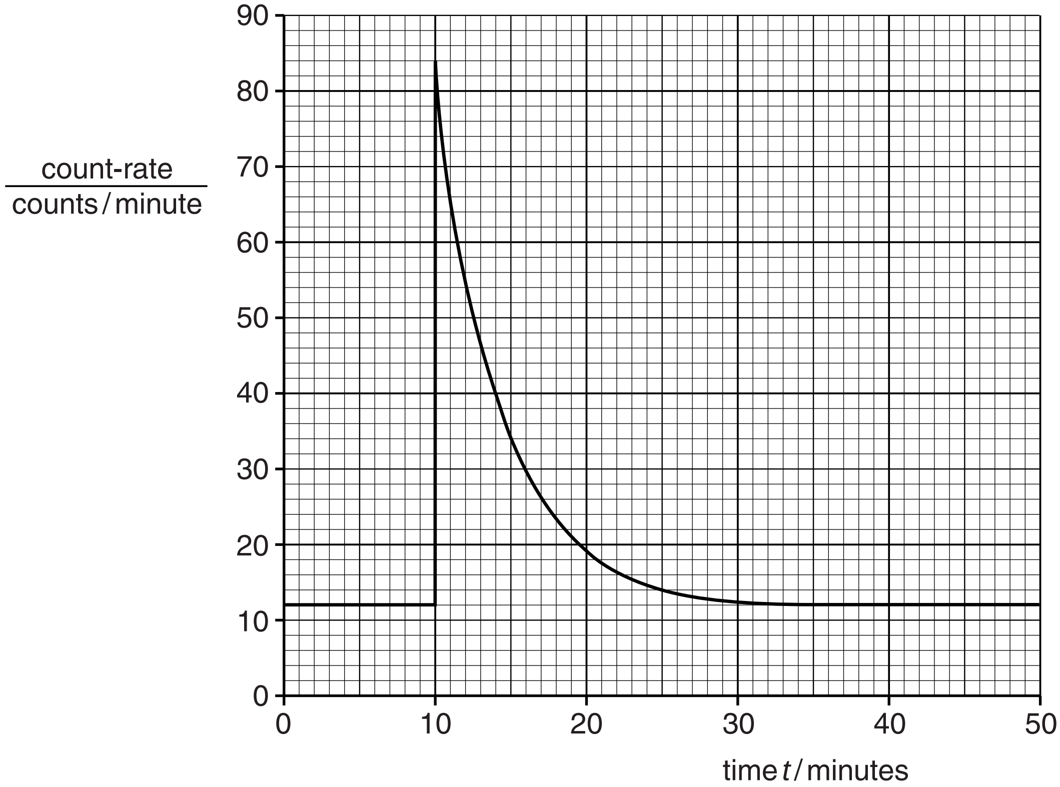

Fig. 11.1

(a) Use Fig. 11.1 to determine the background count-rate in the laboratory.

background count-rate = ... [1]

(b) Use Fig. 11.1 to determine the count-rate due to the radioactive sample

(i) at t = 10 minutes,

count-rate due to sample = ...

(ii) at t = 19 minutes.

count-rate due to sample = ...
[2]

(c) Use the values obtained in **(b)** to estimate the half-life of the radioactive sample.

half-life = ... [2]

[Total: 5]