

5 Atomic Physics

5.1 The Nuclear Atom

Syllabus points

5.1.1 Atomic Model

5.1.2 Nucleus

book p227-230

- Rutherford Scattering Experiment
- Radioactive Isotopes
- Nuclear Fission & Fusion

(1) 11 (a) A radioactive source emits α -, β - and γ -radiation.

Which of these radiations

- (i) has the shortest range in air,
- (ii) has a negative charge,
- (iii) is not deflected in a magnetic field?

[2]

(b) In a famous experiment, carried out in a vacuum, a very thin sheet of gold was placed in the path of alpha particles.

It was found that a large number of the alpha particles passed through the sheet with little or no deflection from their original path. A very small number of the alpha particles were reflected back towards the source.

(i) Explain, in terms of the force acting, why the direction of motion of an alpha particle changes when it comes close to the nucleus of a gold atom.

.....

 [2]

(ii) State **two** conclusions, about the nuclei of atoms, that were made from the results of this experiment.

1.

 2.
 [2]

[Total: 6]

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(2)₁₀ There are two stable, naturally occurring isotopes of hydrogen.

Common hydrogen (hydrogen-1) has a proton number of 1 and a nucleon number of 1.

Hydrogen-2 (deuterium) has a nucleon number of 2.

There is also a radioactive isotope of hydrogen called tritium (hydrogen-3), with a nucleon number of 3.

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(a) Complete the table for neutral atoms of these isotopes.

| | hydrogen-1 | hydrogen-2 (deuterium) | hydrogen-3 (tritium) |
|---------------------|------------|---------------------------|-------------------------|
| number of protons | | | |
| number of neutrons | | | |
| number of electrons | | | |

[3]

(b) Two samples of tritium are stored in aluminium containers of different thickness.

Sample 1 is in a container of thickness 0.5 mm and radiation can be detected coming through the container.

Sample 2 is in a container of thickness 5 mm and no radiation comes through.

(i) State the type of radiation coming through the container of Sample 1.

..... [1]

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

.....

 [2]

(c) Under conditions of extremely high temperature and pressure, as in the interior of the Sun, hydrogen nuclei can join together.

(i) Name this process.

..... [1]

(ii) State whether energy is released, absorbed or neither released nor absorbed during this reaction.

..... [1]

- (d) When a nucleus of a certain isotope of uranium is bombarded by a suitable neutron, it splits into two smaller nuclei and energy is released.

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Name this process.

..... [1]

[Total: 9]

Turn over for Question 11

(3)₉ In a laboratory experiment, the isotope uranium-238 is used as a source of α -particles.

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(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.

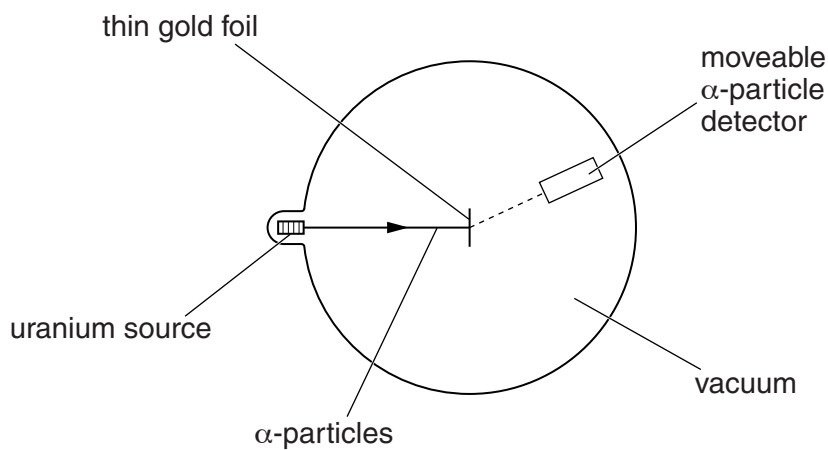


Fig. 9.1

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.

.....

.....

.....

.....

.....

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.....

.....

..... [4]

[Total: 6]

(4) 11 Uranium-238 and uranium-234 are radioactive isotopes of the element uranium.

A uranium-238 nucleus is different from a uranium-234 nucleus but both decay by the emission of an α -particle.

(a) (i) In terms of the particles in each, state how a nucleus of uranium-238 differs from a nucleus of uranium-234.

.....
 [2]

(ii) Although the two nuclei are different, they are both nuclei of uranium.

State a property that makes these isotopes the same element.

.....
 [1]

(b) When α -particles pass through air, they are more strongly ionising than β -particles.

Suggest **two** reasons why this is so.

.....
 [2]

(c) In an experiment, α -particles are allowed to strike a thin gold foil in a vacuum.

Almost all the α -particles pass straight through the gold undeflected. Only a very small number of α -particles are deflected from their original path.

This result reveals certain features of the atoms of the gold.

State what is shown about atoms by the fact that

(i) most α -particles pass straight through the gold undeflected,

.....
 [1]

(ii) some α -particles are deflected back the way they came.

.....
 [1]

[Total: 7]