The Nuclear Model of the Atom

Question Paper

Course	CIE IGCSE Physics
Section	5. Nuclear Physics
Topic	The Nuclear Model of the Atom
Difficulty	Medium

Time Allowed 40

Score /33

Percentage /100

Question 1a

Extended tier only

A nucleus of americium-241 has the nuclide notation shown.

$$^{241}_{95}Am$$

(i) Determine the number of neutrons in a nucleus of americium-241.

number of neutrons = ... [1]

(ii) Determine the charge on a nucleus of americium-241.

charge = ... [2]

[3 marks]

Question 1b

Americium-241 decays by emitting α-particles.

Put a tick in the box next to each correct statement.

- ☐ α-particles are electromagnetic waves.
- ☐ α-particles are fast-moving electrons.
- ☐ α-particles are helium nuclei.
- ☐ α-particles are stopped by a sheet of paper.
- ☐ α-particles can pass through 3 cm of aluminium.

[2 marks]

Question 1c

Americium-241 has a half-life of 432 years.
A sample contains 16 mg of americium-241.

Calculate the time it takes until only 4.0 mg of americium-241 are left in the sample.

time = ... years

[2 marks]

Question 2a

This notation represents the nucleus of a neutral atom of carbon-14.

$$^{14}_{6}C$$

State the number of:

(i) protons in the nucleus of an atom of carbon-14

[1]

(ii) electrons orbiting the nucleus of an atom of carbon-14

[1]

(iii) neutrons in the nucleus of an atom of carbon-14.

[1]

[3 marks]

Question 2b

Carbon-14 is an isotope of carbon. Carbon-12 is another isotope of carbon.

Compare the nucleus of carbon-14 with the nucleus of carbon-12.

State the similarities and differences.

[3 marks]

Question 2c

Scientists use carbon-14 to estimate the age of wood that is very old.

A very old sample of wood contains 1.0×10^8 carbon-14 atoms.

When the sample was new, it contained 8.0×10^8 carbon-14 atoms. The half-life of carbon-14 is 5700 years.

Estimate the age of the sample of wood.

age of wood = ... years

[3 marks]

Question 3a

Use words from the box to complete the sentences about the charges in an atom. Words can be used once, more than once or not at all.

negative

neutral

positive

The charge on the nucleus of an atom is .....

The charge on a proton is .....

The charge on electrons orbiting the nucleus is .....

[3 marks]

Question 3b

A nucleus of radium-226 has the nuclide notation shown.

$$^{226}_{88}Ra$$

(i) Determine the number of protons in a nucleus of radium-226.

[1]

(ii) Determine the number of neutrons in a nucleus of radium-226.

[1]

(iii) Radium has another isotope, radium-223.

Write the nuclide notation for radium-223.

[1]

[3 marks]

Question 3c

Radium-226 has a half-life of 1600 years.

A sample contains 8.0 mg of radium-226.

Calculate the time for the sample to decay until only 1.0 mg of radium-226 remains.

time = ... years

[2 marks]

Question 4a

A nuclear power station uses uranium to generate thermal energy.

The fuel for the power station is an isotope of uranium.

Explain the meaning of the term isotope.

[2 marks]

Question 4b

When the nucleus of one particular isotope of uranium decays, it releases a β-particle. In the periodic table the entry for this isotope looks like this:

$$^{239}_{92}\mathrm{U}$$

State the proton number, the mass number and the neutron number of this isotope.

[2 marks]

Question 4c

A sample of rock includes some uranium-239.

The half-life of uranium-239 is 23 minutes.

Determine the fraction of the uranium-239 that remains after 46 minutes.

fraction remaining = ...

[2 marks]

Question 5

Extended tier only

The circles shown in Fig. 11.1 represent three gold nuclei. Three α-particles are approaching the gold nuclei.

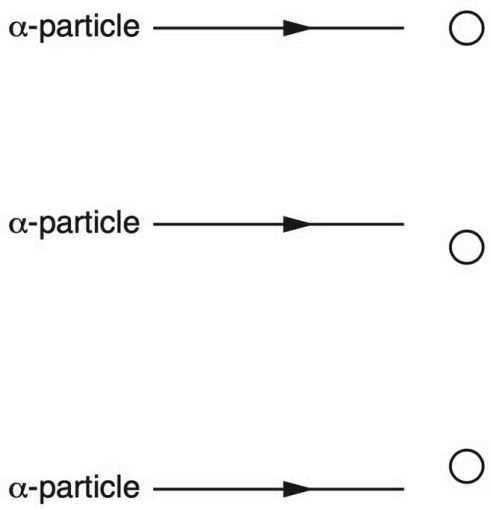

Fig. 11.1

On Fig. 11.1, complete the path of each α-particle.

[3 marks]