

The Nuclear Model of the Atom

Question Paper

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

Time Allowed 50

Score /37

Percentage /100

Question 1a**Extended tier only**

Table 1.1 shows data about nine elements.

Table 1.1

proton number	element	symbol
2	helium	He
3	lithium	Li
4	beryllium	Be
5	boron	B
6	carbon	C
7	nitrogen	N
8	oxygen	O
9	fluorine	F
10	neon	Ne

Carbon-14 is a radioactive isotope with a nucleon number of 14. It decays by emitting β -particles.

Use data from Table 1.1 to write down the nuclide equation for this decay.

[4 marks]

Question 1b

A radioactive sample is placed close to a detector. The radioactive isotope in the sample has a long half-life. The detector records a count rate of 597 counts/s.

Fig. 11.2 shows the readings when different materials are placed between the radioactive sample and the detector.

Material	$\frac{\text{count rate}}{\text{counts / s}}$
a sheet of paper	602
a piece of thin aluminium	598
a piece of thin lead	510

Fig. 11.2

Explain whether any α -particles, β -particles or γ -rays are emitted by the radioactive sample.

[3 marks]

Question 2a

Fig. 10.1 represents a neutral atom of an isotope of element X.

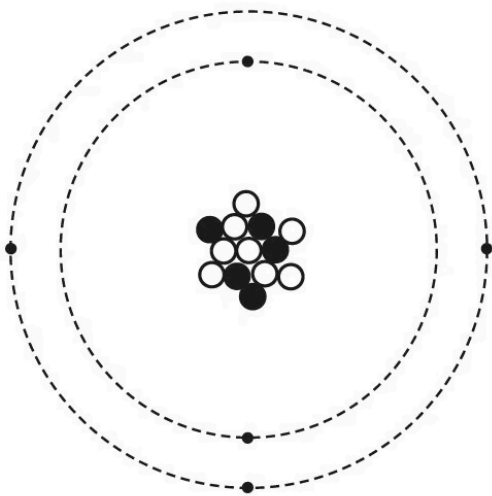


Fig. 10.1

State one similarity between this atom and a neutral atom of a different isotope of element X.

[1 mark]

Question 2b

The isotope of element X is radioactive. It decays to form an isotope of element Y by emitting a β -particle.

- (i) Using Fig. 10.1 deduce the nuclide notation for the isotope of Y produced by this decay.

nuclide notation: ${}^{\dots}_{\dots}\text{Y}$ [3]

- (ii) β -particles ionise the air they pass through less strongly than the same number of α -particles.

Suggest why this is so.

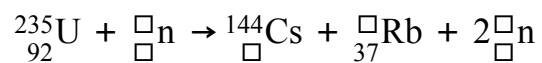
[3]

[6 marks]

Question 3a**Extended tier only**

When uranium-235 (${}^{235}_{92}\text{U}$) is bombarded with a neutron, it forms an isotope of caesium (Cs) and an isotope of rubidium (Rb).

Complete the nuclide notation for this reaction.

**[2 marks]****Question 3b****Extended tier only**

State and explain the process shown by the equation in **(a)**.

[3 marks]

Question 3c**Extended tier only**

- (i) Describe and give a reason for the difference between the mass of the products and the reactants in the reaction from part **(a)**.

[2]

- (ii) State the energy transfer that takes place in the products of the reaction from part **(a)**.

[1]

[3 marks]**Question 4a**

There are three naturally occurring isotopes of hydrogen: hydrogen-1, hydrogen-2 and hydrogen-3.

Hydrogen-1 is the simplest nuclide containing only one proton. Each isotope of hydrogen is represented by the symbol **H**.

Write down the symbols, using nuclide notation, for:

hydrogen-1

hydrogen-2

hydrogen-3

[1 mark]

Question 4b**Extended tier only**

In a fusion reactor, a nucleus of hydrogen-2 and a nucleus of hydrogen-3 undergo fusion.

- (i) State what is meant by nuclear fusion.
- (ii) The fusion reaction produces a free neutron and one other particle.

[2]

Write down, using nuclide notation, the equation that represents this reaction.

[3]

[5 marks]

Question 5a

Extended tier only

Fig 1.1 shows a neutron colliding with a nucleus of uranium-235, producing a number of products.

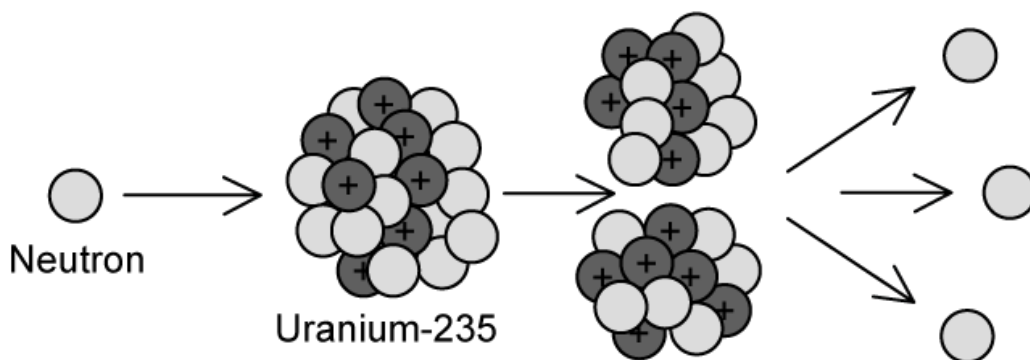
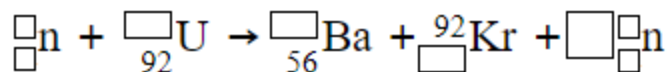


Fig. 1.1

- (i) Name the process shown in the diagram.
- (ii) Complete, using nuclide notation, the equation that represents the reaction shown in Fig 1.1.

[1]



[3]

[4 marks]

Question 5b**Extended tier only**

Explain how the process shown in Fig 1.1 can lead to a chain reaction.

[3 marks]

Question 5c**Extended tier only**

This process releases energy.

Explain the energy transfer taking place in this reaction.

[2 marks]