

GCSE Physics (9 – 1)

Nuclear Fission and Fusion

Name:

Group:



Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.

For markers use	
Question	Mark
1	/3
2	/10
3	/6
4	/8
5	/8
Total	/35
%	
Grade	

Information

- The maximum mark for this paper is 35 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. Nuclear fission and fusion are spectacular nuclear reactions where atoms are either deliberately split or violently smashed together to release absolutely massive amounts of energy.

For each of the following questions **circle** the letter of the correct answer.

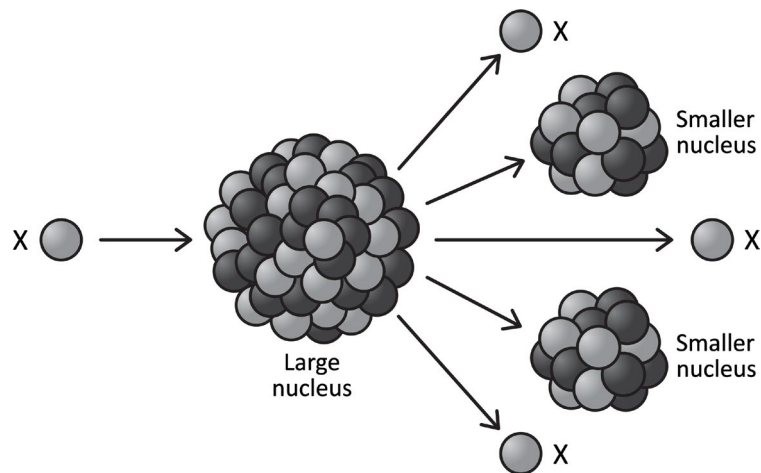
- a) Which of the following statements correctly describes the process of nuclear fusion?

- A** The splitting of a large, unstable nucleus into two smaller daughter nuclei.
- B** The joining of two light nuclei to form a single, heavier nucleus.
- C** The emission of a high-speed electron from an unstable isotope.
- D** The absorption of a slow-moving neutron by a uranium nucleus.

(1 mark)

- b) Look at the diagram showing a nuclear fission chain reaction.

What is the name of the particle labelled X that triggers the first reaction and is also released to start the next reactions?



- | | | | |
|----------|----------|----------|----------------|
| A | B | C | D |
| Proton | Electron | Neutron | Alpha particle |

(1 mark)

- c) Nuclear fusion is the process that powers the Sun and other stars.

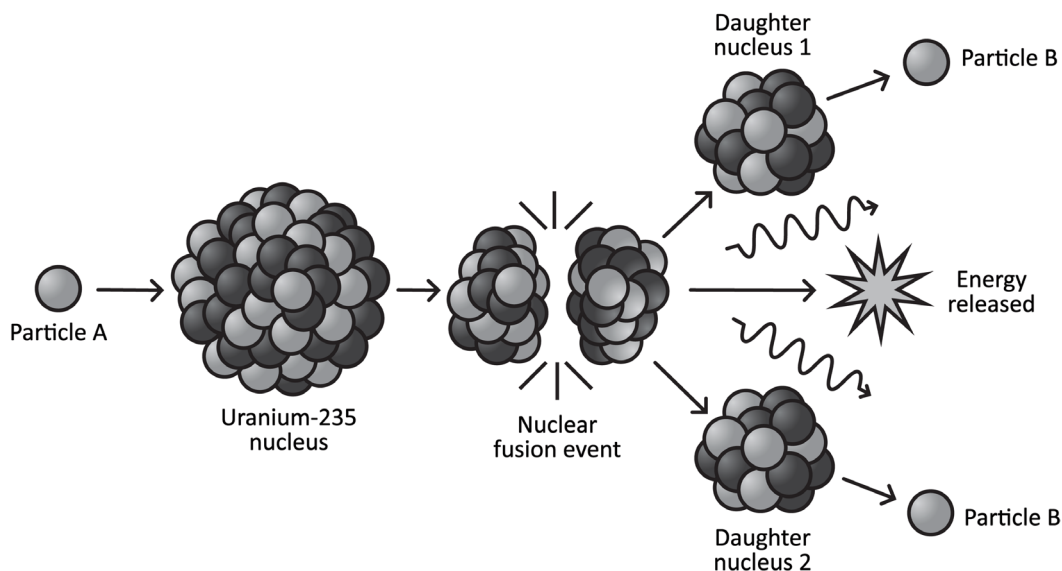
Why is it so difficult for scientists to build nuclear fusion reactors to generate electricity on Earth?

- A** It need extremely high temperatures and pressures to overcome the repulsion between nuclei.
- B** The radioactive uranium fuel required for fusion is too rare and expensive.
- C** It produces too much carbon dioxide, contributing to global warming.
- D** It is impossible to stop the chain reaction once it has started.

(1 mark)

(Total for Question 1 is 3 marks)

2. Nuclear power stations use the nuclear fission of Uranium-235 to generate electricity.



a) Name the particle labelled A that is fired at the Uranium-235 nucleus to start the reaction.

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(1 mark)

b) Describe the process of nuclear fission as shown in the diagram.

In your answer, you should refer to what happens to the Uranium-235 nucleus.

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(3 marks)

c) The particles labelled B are exactly the same as particle A.

Explain how the release of particles B can lead to a chain reaction.

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(2 marks)

d) Inside a nuclear reactor, the chain reaction must be carefully controlled.

Explain how control rods are used to prevent the chain reaction from growing out of control and causing a meltdown.

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(2 marks)

e) A different part of the nuclear reactor is called the moderator. Its job is to slow down the neutrons released during fission.

Suggest why it is important to slow the neutrons down.

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(2 marks)

(Total for Question 2 is 10 marks)

3. Nuclear fission and nuclear fusion are two different types of nuclear reaction that both release massive amounts of energy.

Compare the processes of nuclear fission and nuclear fusion.

In your answer, you should include:

- what happens to the nuclei during each process
- the conditions required for each process to occur
- the waste products generated by each process.

(6 marks)

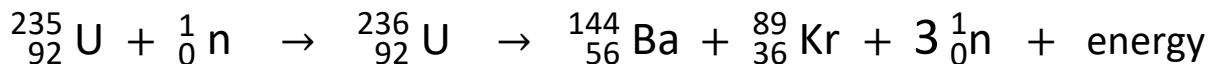
(Total for Question 3 is 6 marks)

4. This question is about nuclear fission.

a) State where nuclear fission takes place on earth.

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(1 mark)

b) The nuclear equation below shows the fission of uranium-235.



Use the information in the equation to describe the process of nuclear fission.

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(4 marks)

c) The fission reaction must be carefully controlled to prevent a meltdown.

Explain how control rods are used to control the rate of the reaction.

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.....
(2 marks)

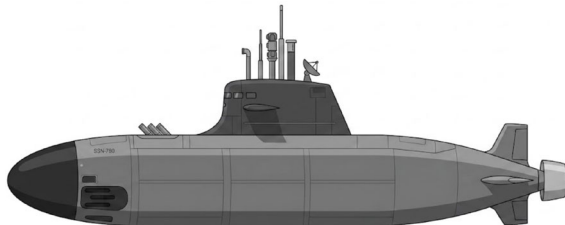
d) If you measured the particles before and after the reaction, the total mass of the products is slightly less than the total mass of the reactants.

State what happens to this 'missing' mass.

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(1 mark)

(Total for Question 4 is 8 marks)

5. A nuclear submarine uses a reactor powered by the fission of Plutonium-239 ($^{239}_{94}\text{Pu}$).



During one fission event, a Plutonium-239 nucleus absorbs a neutron. It splits into Tellurium-137 ($^{137}_{52}\text{Te}$), an unknown nucleus **X**, and three spare neutrons.

- a) Determine the mass number and atomic number of nucleus **X**.
Show your working.

Mass number of **X** = ...

Atomic number of **X** = ...

(3 marks)

- b) A single fission of a Plutonium-239 nucleus releases 3.0×10^{-11} J of energy.
The submarine's reactor has a useful power output of **12 MW**. The reactor has an efficiency of **40%**.

Calculate the total number of fission reactions that must occur in the reactor in **one minute**.
Give your answer in standard form.

Number of fission reactions = ...

(5 marks)

(Total for Question 5 is 8 marks)