

GCSE Physics

Worksheet: Nuclear fission

TIME 30 min	TOTAL 29 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: Nuclear fission

NAME	CLASS	DATE
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- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

01

01.1

Which statement describes nuclear fission?
Tick (✓) **one** box.

A large, unstable nucleus splits into two smaller nuclei of similar size, releasing neutrons and energy

☐

Two small nuclei join together to form a larger nucleus, releasing energy

☐

A nucleus emits an alpha particle, becoming a smaller nucleus

☐

An electron is captured by a nucleus

☐

[1 mark]

01.2

State one thing, other than energy and two smaller nuclei, that is released when a large nucleus undergoes fission.

.....

.....

.....

.....

[1 mark]

0 2

0 2 . 1

What is nuclear fission?

Tick (✓) **one** box.

The splitting of a large, unstable nucleus into two smaller nuclei

☐

The joining of two light nuclei to form a heavier nucleus

☐

The emission of an alpha particle from a nucleus

☐

The absorption of an electron by a nucleus

☐

[1 mark]

0 2 . 2

Name **one** element used as a fuel in nuclear reactors.

.....

.....

.....

[1 mark]

0 2 . 3

What must usually be absorbed by a uranium-235 nucleus before it undergoes fission?

.....

.....

.....

[1 mark]

0 2 . 4

As well as two smaller nuclei, what else is released when a nucleus undergoes fission?

Tick (✓) **two** boxes.

Two or three neutrons

☐

Gamma rays

☐

Alpha particles

☐

Electrons from the atom

☐

[2 marks]

0 3

0 3 . 1

For a chain reaction to sustain itself, a minimum amount of fissionable material — called the critical mass — must be present.

Suggest why a very small piece of uranium-235 cannot sustain a chain reaction, even though each fission does release neutrons.

[2 marks]

0 4

0 4 . 1

Figure 1



In the box in Figure 1, draw a labelled diagram to show how a chain reaction develops in nuclear fission. Your diagram should start from a single neutron causing one fission, and show at least three generations of fission.

[4 marks]

0 5

One fission of a uranium-235 nucleus releases about 3.2×10^{-11} J of energy.

0 5 . 1

Calculate the number of fissions needed to release 1 J of energy.
Give your answer to 2 significant figures.

.....

.....

.....

.....

Number of fissions =

[2 marks]

0 6

Uranium-235 is used as the fuel in many nuclear power stations.

0 6 . 1

Describe what happens when a uranium-235 nucleus undergoes fission.

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.....

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.....

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.....

[4 marks]

0 6 . 2

Name the other element that is commonly used as a fuel for nuclear fission.

.....

.....

.....

.....

[1 mark]

0 6 . 3

Spontaneous fission is rare.

What does this tell you about how fission usually happens in a reactor?

.....

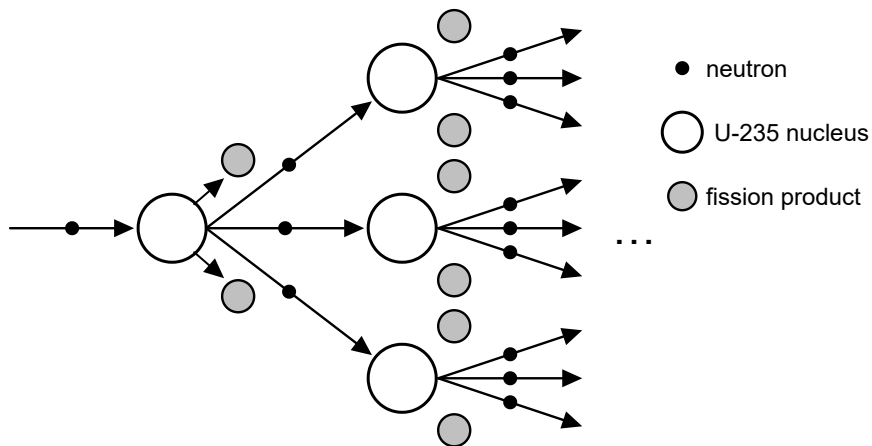
.....

[1 mark]

0 7

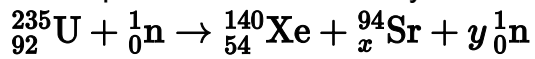
Figure 2 shows how the fission of uranium-235 can lead to a chain reaction.

Figure 2



0 7 . 1

The equation shows one way that a uranium-235 nucleus can undergo fission.



Determine the values of x and y.

.....

.....

.....

.....

[2 marks]

0 7 . 2

Use Figure 2 to explain how a chain reaction happens.

.....

.....

.....

.....

[2 marks]

0 7 . 3

The explosion of a nuclear weapon is caused by a chain reaction.
Give **one** difference between the chain reaction in a nuclear weapon and the chain reaction in a nuclear reactor.

.....

.....

[1 mark]

0 8

The fission of all the nuclei in 1.0 kg of uranium-235 releases about 8.2×10^{13} J of energy. A large hydroelectric power station has a power output of 2.0×10^9 W.

0 8 . 1

Calculate how long the power station would need to run to transfer the same amount of energy as the fission of all the nuclei in 1.0 kg of uranium-235.
Give your answer in hours, to 2 significant figures.

.....

.....

.....

.....

.....

Time = hours

[3 marks]

END OF QUESTIONS

Original practice questions written to match the specification. Not produced by, affiliated with or endorsed by AQA.

Mark scheme

GCSE Physics · Worksheet: Nuclear fission · 29 marks

Question 1 (2 marks)

01.1 [1 mark]

Correct: A large, unstable nucleus splits into two smaller nuclei of similar size, releasing neutrons and energy

01.2 [1 mark]

Answer: Two or three neutrons (or gamma rays).

- (two or three) neutrons / gamma rays (1)
-
-

Question 2 (5 marks)

02.1 [1 mark]

Correct: The splitting of a large, unstable nucleus into two smaller nuclei

02.2 [1 mark]

Answer: Uranium

- uranium / plutonium (1)
-

02.3 [1 mark]

Answer: A neutron

- a neutron (1)
-

02.4 [2 marks]

Correct: Two or three neutrons; Gamma rays

Question 3 (2 marks)

03.1 [2 marks]

Answer: Too many neutrons escape from the surface of a small piece before hitting another nucleus, so on average fewer than one fission is caused per fission, and the reaction dies out.

- in a small piece, a large fraction of the neutrons released escape from the surface without hitting another nucleus, because a small piece has a large surface area relative to its volume (1)
 - so, on average, less than one neutron from each fission goes on to cause another fission, and the chain reaction dies out rather than sustaining itself (1)
-

Question 4 (4 marks)

04.1 [4 marks]

- the first neutron causes one nucleus to undergo fission, releasing two or three more neutrons (1)
 - these neutrons go on to cause further fissions — at least two shown in the second generation, each releasing more neutrons (1)
 - the number of fissions increases with each generation, correctly shown growing across at least three generations (1)
 - each fission event correctly shows a nucleus splitting into two smaller nuclei plus two or three neutrons (1)
-

Question 5 (2 marks)

05.1 [2 marks]

Answer: 3.1×10^{10}

- $n = 1 \div (3.2 \times 10^{-11})$ (1)
 - 3.1×10^{10} (1)
-

Question 6 (6 marks)

06.1 [4 marks]

Answer: The nucleus absorbs a neutron and splits into two smaller nuclei of roughly equal size, releasing two or three neutrons, gamma rays and energy; the products have kinetic energy.

- the nucleus absorbs a neutron (1)
- it splits into two smaller nuclei (of roughly equal size) (1)
- two or three neutrons are released (1)
- gamma rays are emitted / energy is released (1)
- the fission products have kinetic energy (1)

Any 4 of the points above.

06.2 [1 mark]

Answer: Plutonium

- plutonium (1)

06.3 [1 mark]

Answer: Nuclei usually split only after absorbing a neutron.

- fission usually happens only after the nucleus has absorbed a neutron (so neutrons are needed to start / keep the reaction going) (1)

Question 7 (5 marks)

07.1 [2 marks]

Answer: $x = 38$, $y = 2$

- $x = 38$ (1)
- $y = 2$ (1)

07.2 [2 marks]

Answer: Each fission releases neutrons that go on to cause more fissions, which release more neutrons, and so on.

- each fission releases (two or three) neutrons (1)
- these neutrons can be absorbed by other uranium-235 nuclei, causing them to undergo fission and release more neutrons (1)

07.3 [1 mark]

Answer: In a weapon it is uncontrolled; in a reactor it is controlled.

- in a weapon the chain reaction is uncontrolled (the number of fissions increases very rapidly); in a reactor it is controlled (the rate of fission is kept steady) (1)
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Question 8 (3 marks)

08.1 [3 marks]

Answer: 11 hours

- $t = 8.2 \times 10^{13} \div 2.0 \times 10^9 = 4.1 \times 10^4$ (s) (1)
 - $4.1 \times 10^4 \div 3600 = 11.4$ (1)
 - 11 (hours) (1)
-