AQA GCSE Physics | 8463

SPECIFICATION POINT 4.4.4.2

Nuclear fusion

Past-paper questions

Tier	**Higher**
Question groups	**12**
Available paper years	**2006–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.4.4.2 Nuclear fusion

Question 01

November 2006 | PHY1A | Original Q1 | Legacy

QUESTION ONE

Read this extract from a magazine article.

Cold fusion – energy for the future?

On 23rd March 1989, two scientists claimed to have discovered a process which they called cold fusion.

They thought that cold fusion might be a source of cheap energy.

All over the world, other scientists tried to copy the process but none of them had any success.

Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A conclusion

B evidence

C reliable

D research

Other scientists were not able to reproduce the results, so the evidence for cold fusion was not . . . **1** . . . .

These scientists came to the . . . **2** . . . that cold fusion did not happen.

So far, no one has achieved the dream of cold fusion.

Although further . . . **3** . . . has been carried out, no . . . **4** . . . supporting the existence of cold fusion has been found.

4.4.4.2 Nuclear fusion

Question 02

2 (a) The process of nuclear fusion results in the release of energy.

2 (a) (i) Describe the process of nuclear fusion.

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(2 marks)

2 (a) (ii) Where does nuclear fusion happen naturally?

.....

(1 mark)

2 (b) For many years, scientists have tried to produce a controlled nuclear fusion reaction that lasts long enough to be useful. However, the experimental fusion reactors use more energy than they produce.

2 (b) (i) From the information given, suggest **one** reason why nuclear fusion reactors are not used to produce energy in a nuclear power station.

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(1 mark)

2 (b) (ii) Suggest **one** reason why scientists continue to try to develop a practical nuclear fusion reactor.

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(1 mark)

4.4.4.2 Nuclear fusion

Question 02 · continued

for mark

2 (c) In 1989, two scientists claimed in a daily newspaper that they had produced nuclear fusion reactions in normal laboratory conditions. The process became known as 'cold fusion'. Other scientists thought that the evidence produced to support 'cold fusion' was unreliable.

2 (c) (i) Suggest **one** reason why other scientists thought that the evidence to support 'cold fusion' was unreliable.

.....

.....

(1 mark)

2 (c) (ii) In 2007, the results of a new 'cold fusion' research project were published in a respected scientific journal. This journal includes scientists such as Albert Einstein amongst its past authors.

Suggest why people may be more likely to believe an article published in a respected scientific journal than one published in a daily newspaper.

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(1 mark)

7

4.4.4.2 Nuclear fusion

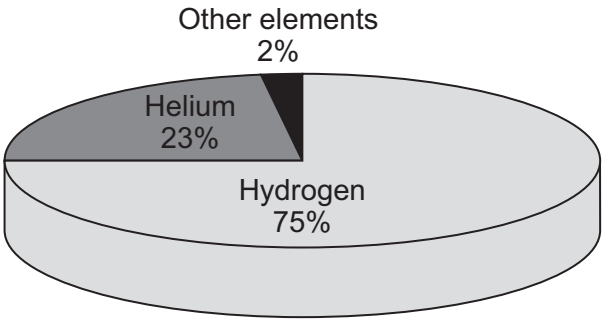
Question 03

June 2011 | PHY3H | Original Q6 | Legacy

6 This passage is from a web page.

Our nearest star, the Sun

The pie chart shows the proportions of chemical elements in the Sun.



Most of the Sun's helium has been produced from the Sun's hydrogen by the process of nuclear fusion. This process also produces vast quantities of energy. The process takes place in the core of the Sun at a temperature of about 15 million °C and has been going on for about 4.5 billion years. During this period of time, the Sun has remained stable and scientists think that it will remain stable for several billion years into the future.

6 (a) Explain why the Sun remains stable.

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(3 marks)

6 (b) A scientific opinion is expressed on this web page.

Identify this opinion and suggest how scientists could justify it.

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(2 marks)

5

4.4.4.2 Nuclear fusion

Question 04

January 2013 | PH2HP | Original Q3 | Legacy

3 Stars go through a life cycle. About 90% of all stars are in the 'main sequence' period of the life cycle.

3 (a) Stars are stable during the 'main sequence' period of the life cycle.

Why?

.....

.....

(1 mark)

3 (b) The table gives an estimated time for the number of years that three stars, **X**, **Y** and **Z**, will be in the 'main sequence' period of their life cycle.

Star	Relative mass of the star compared to the Sun	Estimated 'main sequence' period in millions of years
X	0.1	4 000 000
Y	1.0	9 000
Z	40.0	200

3 (b) (i) This data suggests that there is a pattern linking the mass of a star and the number of years the star is in the 'main sequence' period of its life cycle.

What is the pattern suggested by the data?

.....

.....

(1 mark)

3 (b) (ii) Scientists cannot give the exact number of years a star will be in the 'main sequence' period.

Suggest why.

.....

.....

(1 mark)

Question 3 continues on the next page

4.4.4.2 Nuclear fusion

Question 04 · continued

3 (b) (iii) Nuclear fusion is the process by which energy is released in stars.

Which **one** of the following can be concluded from the data in the table?

Draw a ring around the correct answer in the box to complete the sentence.

The rate of nuclear fusion in a large star is

faster than
the same as
slower than

in a small star.

Explain the reason for your answer.

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(3 marks)

4.4.4.2 Nuclear fusion

Question 04 · continued

3 (c) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Describe what happens to a star **much bigger** than the Sun, once the star reaches the end of the 'main sequence' period of its life cycle.

Your answer should include the names of the stages the star passes through.

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(6 marks)

12

4.4.4.2 Nuclear fusion

Question 05

June 2015 | PH2HP | Original Q3 | Legacy

3 Many countries use nuclear power stations to generate electricity.
Nuclear power stations use the process of nuclear fission to release energy.

3 (a) (i) What is nuclear fission?

[1 mark]

.....

.....

3 (a) (ii) Plutonium-239 is one substance used as a fuel in a nuclear reactor. For nuclear fission to happen, the nucleus must absorb a particle.

What type of particle must be absorbed?

[1 mark]

.....

3 (b) Nuclear **fusion** also releases energy.
Nuclear fusion happens at very high temperatures. A high temperature is needed to overcome the repulsion force between the nuclei.

3 (b) (i) Why is there a repulsion force between the nuclei of atoms?

[1 mark]

.....

.....

3 (b) (ii) Where does nuclear fusion happen naturally?

[1 mark]

.....

4.4.4.2 Nuclear fusion

Question 05 · continued

3 (c) In 1991, scientists produced the first controlled release of energy from an experimental nuclear **fusion** reactor. This was achieved by fusing the hydrogen isotopes, deuterium and tritium.

Deuterium is naturally occurring and can easily be extracted from seawater. Tritium can be produced from lithium. Lithium is also found in seawater.

Table 2 gives the energy released from 1 kg of fusion fuel and from 1 kg of fission fuel.

Table 2

Type of fuel	Energy released from 1 kg of fuel in joules
Fusion fuel	3.4×10^{14}
Fission fuel	8.8×10^{13}

3 (c) (i) Suggest **two** advantages of the fuel used in a fusion reactor compared with plutonium and the other substances used as fuel in a fission reactor.

[2 marks]

1 .....

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2 .....

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3 (c) (ii) Some scientists think that by the year 2050 a nuclear fusion power station capable of generating electricity on a large scale will have been developed.

Suggest **one** important consequence of developing nuclear fusion power stations to generate electricity.

[1 mark]

.....

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.....

Question 3 continues on the next page

4.4.4.2 Nuclear fusion

Question 05 · continued

3 (d) Tritium is radioactive.

After 36 years, only 10 g of tritium remains from an original sample of 80 g.

Calculate the half-life of tritium.

Show clearly how you work out your answer.

[2 marks]

.....

.....

Half-life = ... years

9

4.4.4.2 Nuclear fusion

Question 06

June 2016 | PH2HP | Original Q6 | Legacy

6 (a) Brown dwarf stars are thought to have been formed in the same way as other stars.
They are too small for nuclear fusion reactions to take place in them.
Brown dwarf stars emit infrared radiation but are not hot enough to emit visible light.

6 (a) (i) Describe how a star is formed.

[2 marks]

6 (a) (ii) Describe the process of nuclear fusion.

[1 mark]

6 (a) (iii) Scientists predicted that brown dwarf stars existed before the first one was discovered in 1995.

Suggest **one** reason why scientists are now able to observe and identify brown dwarf stars.

[1 mark]

4.4.4.2 Nuclear fusion

Question 06 · continued

6 (b) In the 18th century some scientists suggested a theory about how the planets formed in the Solar System. The theory was that after the Sun formed, there were cool discs of matter rotating around the Sun. These cool discs of matter formed the planets. The scientists thought this must have happened around other stars too.

6 (b) (i) Thinking about this theory, what would the scientists have predicted to have been formed in other parts of the Universe?

[1 mark]

_____

_____

6 (b) (ii) Since the 1980s scientists studying young stars have shown the stars to be surrounded by cool discs of rotating matter.

What was the importance of these observations to the theory the scientists suggested in the 18th century?

[1 mark]

_____

_____

6 (c) The Earth contains elements heavier than iron.

Why is the presence of elements heavier than iron in the Earth evidence that the Solar System was formed from material produced after a massive star exploded?

[1 mark]

_____

_____

7

4.4.4.2 Nuclear fusion

Question 07

June 2019 | 8463/1H | Original Q8

0 8 A student investigated the thermal conductivity of different metals.

This is the method used:

1. Measure the mass of an ice cube.
2. Put the ice cube on a metal block which is at room temperature.
3. Measure the mass of the ice cube after one minute.
4. Repeat with other blocks of the same mass made from different metals.

Figure 10



Table 3 shows the student's results.

Table 3

Metal	Initial mass of ice cube in grams	Final mass of ice cube in grams	Change in mass of ice cube in grams
Aluminium	25.85	21.14	4.71
Copper	26.20	20.27	5.93
Lead	25.53	21.97	3.56
Steel	24.95	19.45	5.50

4.4.4.2 Nuclear fusion

Question 07 · continued

0 8 . 1 The initial temperature of each ice cube was –15 °C

Why was it important that the initial temperature of each ice cube was the same?

[1 mark]

Tick (✓) **one** box.

- Initial temperature was a continuous variable. ☐
- Initial temperature was a control variable. ☐
- Initial temperature was the dependent variable. ☐
- Initial temperature was the independent variable. ☐

0 8 . 2 Which metal had the highest thermal conductivity?

Give a reason for your answer.

[2 marks]

Metal: _____

Reason: _____

_____

_____

0 8 . 3 Suggest **one** source of random error in the student's investigation.

[1 mark]

_____

_____

_____

_____

4.4.4.2 Nuclear fusion

Question 07 · continued

0 8 . 4 An ice cube has a temperature of –15.0 °C

The total thermal energy needed to raise the temperature of this ice cube to 0.0 °C and completely melt the ice cube is 5848 J

specific heat capacity of ice = 2100 J/kg °C
specific latent heat of fusion of ice = 334 000 J/kg

Calculate the mass of the ice cube.

[5 marks]

Mass of ice cube = _____ kg

9

4.4.4.2 Nuclear fusion

Question 08

November 2020 | 8463/1H | Original Q5

0 5 Radioactive waste from nuclear power stations is a man-made source of background radiation.

0 5 . 1 Give **one** other man-made source of background radiation.

[1 mark]

Nuclear power stations use the energy released by nuclear fission to generate electricity.

0 5 . 2 Give the name of **one** nuclear fuel.

[1 mark]

0 5 . 3 Nuclear fission releases energy.

Describe the process of nuclear fission inside a nuclear reactor.

[4 marks]

4.4.4.2 Nuclear fusion

Question 08 · continued

0 5 . 4 A new type of power station is being developed that will generate electricity using nuclear fusion.

Explain how the process of nuclear fusion leads to the release of energy.

[2 marks]

0 5 . 5 Nuclear fusion power stations will produce radioactive waste. This waste will have a much shorter half-life than the radioactive waste from a nuclear fission power station.

Explain the advantage of the radioactive waste having a shorter half-life.

[2 marks]

10

4.4.4.2 Nuclear fusion

Question 09

0 2 Energy from the Sun is released by nuclear fusion.

0 2 . 1 Complete the sentences.

[2 marks]

Nuclear fusion is the joining together of _____.

During nuclear fusion the total mass of the particles _____.

0 2 . 2 Nuclear fusion of deuterium is difficult to achieve on Earth because of the high temperature needed.

Electricity is used to increase the temperature of 4.0 g of deuterium by 50 000 000 °C.

specific heat capacity of deuterium = 5200 J/kg °C

Calculate the energy needed to increase the temperature of the deuterium by 50 000 000 °C.

Use the Physics Equation Sheet.

[3 marks]

Energy = _____ J

4.4.4.2 Nuclear fusion

Question 09 · continued

0 2 . 3 The idea of obtaining power from nuclear fusion was investigated using models.

The models were tested before starting to build the first commercial nuclear fusion power station.

Suggest **two** reasons why models were tested.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

0 2 . 4 Generating electricity using nuclear fusion will have fewer environmental effects than generating electricity using fossil fuels.

Explain **one** environmental effect of generating electricity using fossil fuels.

[2 marks]

_____

_____

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9

4.4.4.2 Nuclear fusion

Question 10

November 2021 | 8463/1H | Original Q11

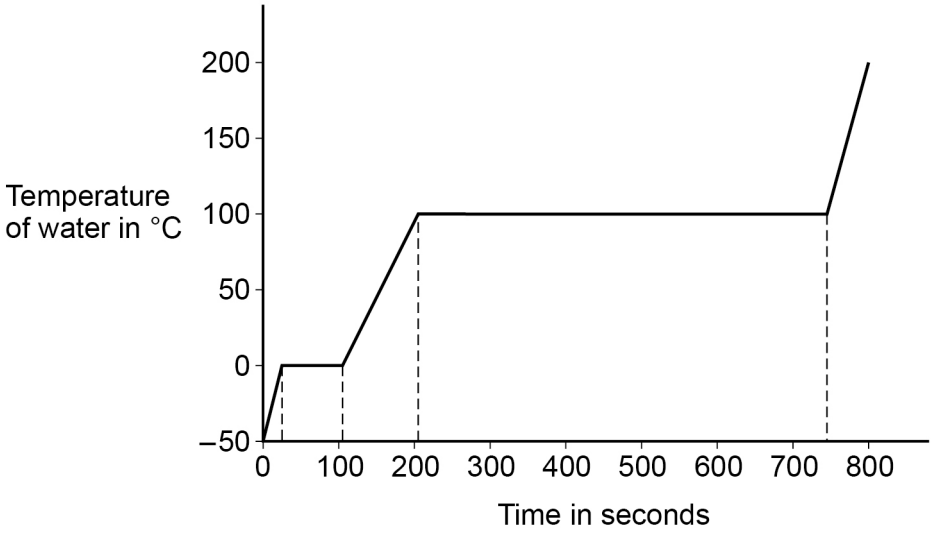
1 1 A student investigated how the temperature of a lump of ice varied as the ice was heated.

The student recorded the temperature until the ice melted and then the water produced boiled.

Figure 17 shows the student's results.

The power output of the heater was constant.

Figure 17



1 1 . 1 The specific heat capacity of ice is less than the specific heat capacity of water.

Explain how **Figure 17** shows this.

[2 marks]

4.4.4.2 Nuclear fusion

Question 10 · continued

1 1 . 2 The specific latent heat of fusion of ice is less than the specific latent heat of vaporisation of water.

Explain how **Figure 17** shows this.

[2 marks]

1 1 . 3 A second student did the same investigation and recorded the temperature until the water produced boiled.

In the second student's investigation more thermal energy was transferred to the surroundings.

Describe **two** ways the results of the experiment in **Figure 17** would have been different.

[2 marks]

1

2

Question 11 continues on the next page

4.4.4.2 Nuclear fusion

Question 10 · continued

11.4 When the water was boiling, 0.030 kg of water turned into steam.

The energy transferred to the water was 69 kJ.

Calculate the specific latent heat of vaporisation of water.

Give the unit.

[5 marks]

Specific latent heat of vaporisation = _____

Unit _____

11

4.4.4.2 Nuclear fusion

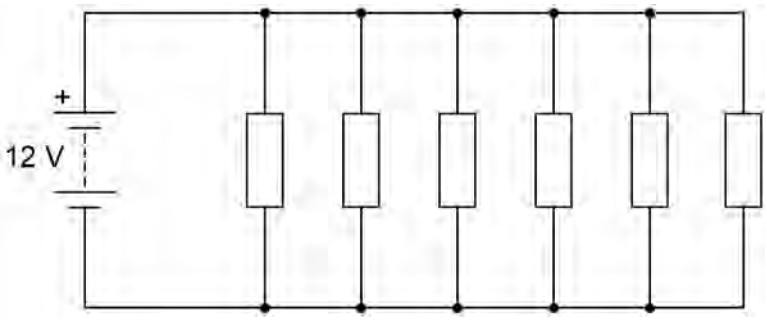
Question 11

June 2023 | 8463/1H | Original Q3

0 3 **Figure 4** shows an electrical circuit used to heat the windscreen of a car.

Each resistor in the circuit represents a heating element.

Figure 4



0 3 . 1 The 12 V battery supplies direct potential difference.

What is meant by 'direct potential difference'?

[1 mark]

Use the Physics Equations Sheet to answer questions **03.2** and **03.3**.

0 3 . 2 Which equation links charge flow (Q), energy (E) and potential difference (V)?

[1 mark]

Tick (✓) **one** box.

$E = \frac{V}{Q}$ ☐

$E = QV$ ☐

$E = \frac{Q}{V}$ ☐

$E = \frac{V^2}{Q}$ ☐

4.4.4.2 Nuclear fusion

Question 11 · continued

0 3 . 3 Calculate the charge flow through the 12 V battery when the battery transfers 5010 J of energy.

[3 marks]

Charge flow = _____ C

0 3 . 4 Ice forms on the windscreen at a temperature of 0 °C.

The electrical circuit transfers 5010 J of energy to the ice.

A mass of 0.015 kg of ice melts.

Calculate the specific latent heat of fusion of water.

Use the Physics Equations Sheet.

[3 marks]

Specific latent heat of fusion of water = _____ J/kg

4.4.4.2 Nuclear fusion

Question 11 · continued

0 3 . 5 The electrical circuit was left switched on while the ice changed from a solid to a liquid and increased in temperature to 5 °C.

Explain the changes in the arrangement **and** movement of the particles as the ice melted and the temperature increased to 5 °C.

[6 marks]

14

4.4.4.2 Nuclear fusion

Question 12

June 2025 | 8463/1H | Original Q5

0 5 Scientists have used lasers to start a nuclear **fusion** reaction.

The scientists used the lasers to heat a small amount of an isotope of hydrogen.

0 5 . 1 Describe what is meant by 'isotopes' of an element.

[2 marks]

0 5 . 2 Explain how nuclear **fusion** releases energy.

[3 marks]

4.4.4.2 Nuclear fusion

Question 12 · continued

0 5 . 3 The fusion reaction releases large amounts of energy.

The fusion reaction takes place in a reactor.

Explain why the walls of the reactor should be made from a material with a very high specific heat capacity.

[2 marks]

0 5 . 4 Nuclear fusion is safer than nuclear fission.

Nuclear **fission** can lead to an uncontrolled chain reaction.

Give **one** consequence of an uncontrolled chain reaction.

[1 mark]

8