AQA GCSE Physics | 8463

SPECIFICATION POINT 4.4.4.2

Nuclear fusion

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**14**
Available paper years	**2006–2024**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

4.4.4.2 Nuclear fusion

Answer 01 · Mark scheme

November 2006 | PHY1A | Original Q6 | Legacy

Six	**A**	conclusion	**2**
	B	evidence	**4**
	C	reliable	**1**
	D	research	**3**

	A	B	C	D

4.4.4.2 Nuclear fusion

Answer 02 · Mark scheme

Question 1

question	answers	extra information	mark
1	**four** lines correct **List A** the nuclei of two atoms joining together the nucleus of an atom splitting into several pieces an atom losing an electron an electric charge moving through a metal **List B** gamma emission electric current ionisation nuclear fission nuclear fusion	allow **1** mark for each correct line if more than 1 line is drawn from a box in List A, mark each line incorrect	4
Total			**4**

4.4.4.2 Nuclear fusion

Answer 02 · Mark scheme

January 2009 | PHY2F | Original Q1 | Legacy

PHY2F

Answer 03 · Mark scheme

January 2009 | PHY3F | Original Q5 | Legacy

No matching mark scheme was available in the supplied archive for this question.

4.4.4.2 Nuclear fusion

Answer 04 · Mark scheme January 2010 | PHY2F | Original Q7 | Legacy

Question 7

question	answers	extra information	mark
7(a)(i)	(two) nuclei (of light elements) join forming a larger / heavier nucleus / one	accept hydrogen atoms for nuclei accept comparative term equivalent to larger accept forms a helium (nucleus / atom) this mark only scores if fusion is in terms of hydrogen atoms	1 1
7(a)(ii)	stars	accept a named star e.g. the Sun accept nebula mention of planets negates answer	1
7(b)(i)	any **one** from: • (currently) only experimental • reaction does not last long enough • use more energy than they produce	allow difficult to control do **not** allow inefficient on its own	1
7(b)(ii)	any **one** from: • will give another source of energy • unlimited fuel supplies / energy • would not produce any radioactive waste • want to show that it can be done	do **not** accept answers only in terms of fossil fuels or carbon dioxide accept unlimited hydrogen accept less radioactive waste accept nuclear for radioactive do **not** accept toxic waste accept any sensible suggestion	1

Question 7 continues on the next page . . .

4.4.4.2 Nuclear fusion

PHY2F

Question 7 continued . . .

question	answers	extra information	mark
7(c)(i)	any **one** from: • repeating did not produce the same results / data • experiments were not / may not be reproducible • data / experiments were not valid	accept could not be repeated accept has not been repeated do **not** accept answers in terms of scientists being biased	1
7(c)(ii)	any **one** from: • cannot trust journalists • newspaper journalist may not have a science background • newspaper may publish what people want to read • newspaper may simplify ideas • people believe / trust the scientists writing the journal • people have heard of the scientists writing in the journal • scientists writing in the journal are famous • journal only publishes the work of respected / famous scientists • data is checked by other scientists before published in the journal	bias is insufficient on its own accept any sensible suggestion, these are examples they do not constitute a full list	1
Total			**7**

4.4.4.2 Nuclear fusion

Answer 05 · Mark scheme

Question 1

question	answers	extra information	mark
1	**three** lines correct **List A**: fusion; chain reaction; alpha decay **List B**: in a star; in a nuclear reactor; in a smoke precipitator; in the nucleus of an atom	allow **1** mark for each correct line if more than 1 line is drawn from a box in **List A**, mark each line incorrect	3
Total			**3**

4.4.4.2 Nuclear fusion

Answer 05 · Mark scheme January 2011 | PHY2F | Original Q1 | Legacy

PHY2F

4.4.4.2 Nuclear fusion

Answer 06 · Mark scheme

January 2013 | PH2FP | Original Q9 | Legacy

Question 9

question	answers	extra information	mark
9(a)	forces (within the star) are balanced	if specific forces are mentioned they must be appropriate	1
9(b)(i)	bigger the mass (of the star) the shorter the 'main sequence' period	accept bigger the star the shorter the time	1
9(b)(ii)	any **one** from: • insufficient evidence • do not know (exact) amount of hydrogen in star • time too long (to measure directly) • may be other factors (not yet known) that determine length of 'main sequence' period • values are based on theory / calculation	accept do not know (exact) mass of star	1
9(b)(iii)	faster than		1
	larger stars have a shorter 'main sequence' period so they must have the faster (rate of) nuclear fusion	there must be a link between shorter 'main sequence' and nuclear fusion, this may be implied from the first marking point	1
	the end of 'main sequence' happens as the hydrogen in (the core of) a star is used up **or** (since) they use up hydrogen at a faster (rate)	accept more massive stars (are brighter so) release energy faster	1

Question 9 continues on the next page . . .

4.4.4.2 Nuclear fusion

Answer 06 · Mark scheme

question	answers	extra information	mark
9(c)	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best-fit' approach to the marking.		6

0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
No relevant content.	There is a basic description of what happens to a star much larger than the Sun after the 'main sequence' period. **OR** Two stages are correctly named and are in the correct sequence.	There is a clear description of what happens to a star much larger than the Sun after the 'main sequence' period. **AND** At least two stages are correctly named and are in the correct sequence.	There is a detailed description of what happens to a star much larger than the Sun after the 'main sequence' period. **AND** At least three stages are named, in the correct sequence. There are no additional incorrect stages given.

Examples of the points made in the response:	extra information
• (the core of the) star runs out of hydrogen • (the star) expands (to form) • (the star) cools (to form)	• the core shrinks • helium starts to fuse to form other elements
• a red supergiant	accept super red giant do **not** accept red giant
• (outer layers) explode	• fusion of lighter elements to form heavier elements (up to iron)
• as a supernova	accept heaviest elements are formed
• elements heavier than iron are formed • core shrinks	
• becoming a neutron star	
• if mass large enough (core collapses)	
• (to form) a black hole	if a correct description and sequence for a star the same size as the Sun and much bigger than the Sun given without clearly indicating which is which is limited to Level 2

Total			12

UMS Conversion Calculator: www.aqa.org.uk/umsconversion

4.4.4.2 Nuclear fusion

Answer 07 · Mark scheme

June 2015 | PH2FP | Original Q2 | Legacy

The full source mark scheme begins on page 25. Follow original question 2 in that document.

4.4.4.2 Nuclear fusion

Answer 08 · Mark scheme

June 2016 | PH2FP | Original Q1 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)	gas gravity protostar	correct order only accept correct word circled in box provided no answer given in answer space	1 1 1	AO1 2.6.2c
1(b)	the explosion of a massive star		1	AO1 2.6.2f
1(c)	The telescopes and measuring instruments were not sensitive enough.		1	AO3 2.6
Total			**5**	

4.4.4.2 Nuclear fusion

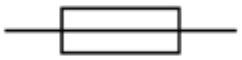
Answer 08 · Mark scheme

June 2016 | PH2FP | Original Q1 | Legacy



4.4.4.2 Nuclear fusion

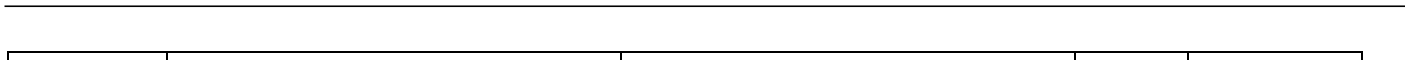
Answer 09 · Mark scheme June 2018 | 8463/1F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1			1	AO1 4.2.1.1
07.2	E = 13 × 230 E = 2990 (J)	an answer 2990 (J) scores **2** marks	1 1	AO2 4.2.4.2
07.3	charge flow = current x time	allow Q = It	1	AO1 4.2.1.2
07.4	1.52 = I × 0.40 $I = \frac{1.52}{0.40}$ I = 3.8 (A)	an answer of 3.8 (A) scores **3** marks	1 1 1	AO2 4.2.1.2
07.5	E = 0.00175 × 205 000 E = 359 (J)	an answer of 359 (J) scores **2** marks allow an answer that rounds to 360 (J) for **2** marks	1 1	AO2 4.3.2.3
Total			**9**	

4.4.4.2 Nuclear fusion

Answer 09 · Mark scheme

June 2018 | 8463/1F | Original Q7

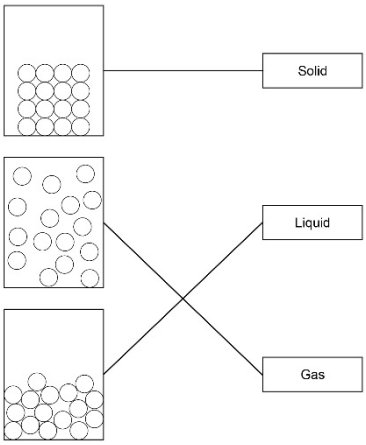


4.4.4.2 Nuclear fusion

Answer 10 · Mark scheme

November 2021 | 8463/1F | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1		2 marks for all correct 1 mark for 1 or 2 correct	2	AO1 4.3.1.1
01.2	**B**		1	AO1 4.3.2.3
01.3	**D**		1	AO1 4.3.2.3
01.4	the kinetic energy of the particles		1	AO1 4.3.2.1 4.3.3.1
01.5	E = 0.250 × 334 000 E = 83 500 (J)		1 1	AO2 4.3.2.3
01.6	sublimates		1	AO1 4.3.1.2
Total			**8**	

4.4.4.2 Nuclear fusion

Answer 11 · Mark scheme

November 2021 | 8463/1F | Original Q10

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	nuclei decreases	do not accept atoms	1 1	AO1 4.4.4.2
10.2	m = 0.004 (kg) E = 0.004 × 5200 × 50 000 000 E = 1.04 × 10^9 (J) **or** E = 1 040 000 000 (J)	 allow a correct substitution of an incorrectly/not converted value of m allow a correct calculation using an incorrectly/not converted value of m	1 1 1	AO2 4.3.2.2 4.1.1.3
10.3	any **two** from: • to make sure the fusion process is possible • to develop an understanding of the process • to make adaptations to the process • to assess the efficiency of the process • to make predictions • assess safety risks • to assess environmental impact • set-up cost is lower (for small scale experiments)		2	AO3 4.1.3

4.4.4.2 Nuclear fusion

10.4	releases carbon dioxide which causes global warming **OR** releases particulates which causes global dimming **or** which causes breathing problems **OR** releases sulfur dioxide which causes acid rain **OR** releases nitrogen oxides which causes breathing problems **or** which causes acid rain	allow releases greenhouse gases allow which causes climate change	1 1	AO1 4.1.3
Total			**9**	

4.4.4.2 Nuclear fusion

Answer 12 · Mark scheme

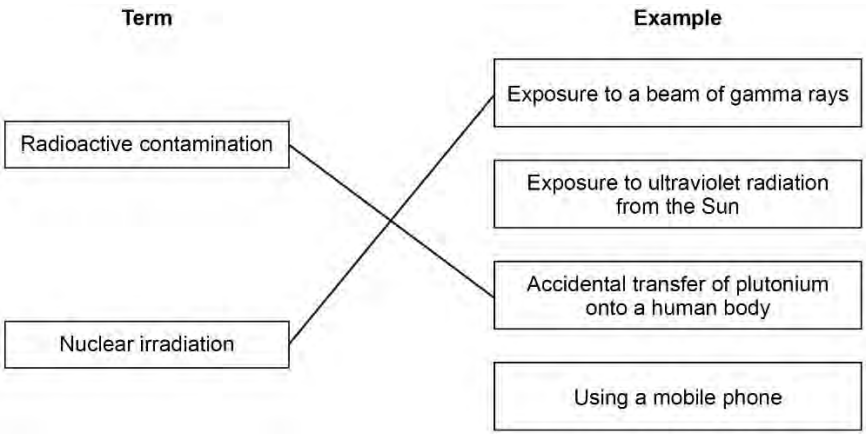
June 2023 | 8463/1F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	protons neutrons	this order only	1 1	AO1 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	the time taken for half the nuclei in a sample to decay		1	AO1 4.4.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	carbon-18		1	AO3 4.4.2.3

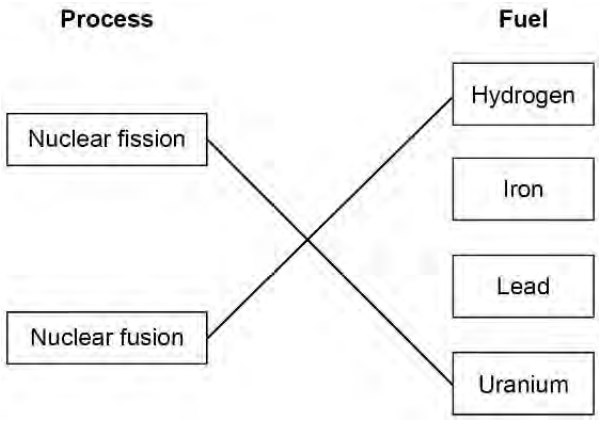
Question	Answers	Mark	AO / Spec. Ref.
03.4	 1 mark for each correct line additional line from a box on the left negates the mark for that box	1 1	AO1 4.4.2.4

4.4.4.2 Nuclear fusion

Answer 12 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	to remove radioactive dust from their shoes		1	AO3 4.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	number of days = $\frac{0.072}{0.00050}$ number of days = 144		1 1	AO2 4.4.3.1

Question	Answers	Mark	AO / Spec. Ref.
03.7	 1 mark for each correct line additional line from a box on the left negates the mark for that box	1 1	AO1 4.4.4.1 4.4.4.2

Total Question 3	11

4.4.4.2 Nuclear fusion

Answer 13 · Mark scheme

June 2023 | 8463/1F | Original Q10

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	polarity of the potential difference doesn't change	allow direction of the potential difference doesn't change	1	AO1 4.2.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.2	$E = QV$		1	AO1 4.2.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.3	$5010 = Q \times 12$ $Q = \frac{5010}{12}$ $Q = 417.5$ (C)	 allow 418 (C)	1 1 1	AO2 4.2.4.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.4	$5010 = 0.015 \times L$ $L = \frac{5010}{0.015}$ $L = 334\,000$ (J/kg)		1 1 1	AO2 4.3.2.3

4.4.4.2 Nuclear fusion

Answer 13 · Mark scheme

June 2023 | 8463/1F | Original Q10

Question	Answers	Mark	AO / Spec. Ref.
10.5	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1 4.3.1.1 4.3.2.1
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content • particles in a solid are in a regular pattern • particles in a liquid are in a random arrangement • particles in a solid are vibrating about fixed positions • particles in a liquid are moving freely • as the ice changes to water the temperature remains constant • because as the ice changes to water the potential energy of the particles increases • as the water warms the particles move faster • so the kinetic energy of the particles increases • internal energy is the total kinetic and potential energy of all the particles ignore any references to density of ice vs liquid water ignore any references to spacing of particles		

Total Question 10	14

4.4.4.2 Nuclear fusion

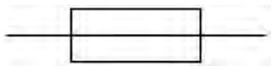
Answer 14 · Mark scheme

June 2024 | 8463/1F | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	brown		1	AO1 4.2.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	blue		1	AO1 4.2.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3			1	AO1 4.2.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	current = $\frac{2.0}{0.40}$ current = 5.0 (A)		1 1	AO2 4.2.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	m = 0.000016 (kg) **or** $m = 1.6 \times 10^{-5}$ (kg) E = 0.000016 × 60 000 E = 0.96 (J)	 allow a correct substitution using an incorrectly / not converted value of m allow an answer consistent with an incorrectly / not converted value of m	1 1 1	AO2 4.3.2.3

4.4.4.2 Nuclear fusion

Answer 14 · Mark scheme

June 2024 | 8463/1F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	the total energy will be greater		1	AO3 4.1.2.1 4.3.2.3

Total Question 7	**9**

4.4.4.2 Nuclear fusion

GCSE

Additional Science / Physics

PH2FP

Mark scheme

4408/4403
June 2015

Version/Stage: 1.0: Final

4.4.4.2 Nuclear fusion

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

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4.4.4.2 Nuclear fusion

Mark Scheme

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

4.4.4.2 Nuclear fusion

Example 1: What is the pH of an acidic solution? (1 mark)

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system. (2 marks)

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Full marks can be given for a correct numerical answer, without any working shown.

However, if the answer is incorrect, mark(s) can be gained by correct substitution / working and this is shown in the 'extra information' column or by each stage of a longer calculation.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation e.c.f. in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Accept / allow

Accept is used to indicate an equivalent answer to that given on the left-hand side of the mark scheme. Allow is used to denote lower-level responses that just gain credit.

3.9 Ignore / Insufficient / Do not allow

Ignore of insufficient is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

4. Quality of Communication and levels marking

In Question **8c** students are required to produce extended written material in English, and will be assessed on the quality of their communication as well as the standard of the scientific response.

Students will be required to:
- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

The following general criteria should be used to assign marks to a level:

Level 1: basic
- Knowledge of basic information
- Simple understanding
- The answer is poorly organised, with almost no specialist terms and their use demonstrating a general lack of understanding of their meaning, little or no detail
- The spelling, punctuation and grammar are very weak.

Level 2: clear
- Knowledge of accurate information
- Clear understanding
- The answer has some structure and organisation, use of specialist terms has been attempted but not always accurately, some detail is given
- There is reasonable accuracy in spelling, punctuation and grammar, although there may still be some errors.

Level 3: detailed
- Knowledge of accurate information appropriately contextualised
- Detailed understanding, supported by relevant evidence and examples
- Answer is coherent and in an organised, logical sequence, containing a wide range of appropriate or relevant specialist terms used accurately.
- The answer shows almost faultless spelling, punctuation and grammar.

4.4.4.2 Nuclear fusion

Question	Answers	Extra information	Mark	AO / Spec. ref.	ID
1(a)	increases	accept reaches highest value do **not** accept increases and decreases	1	AO2 2.3.2	**E**
1(b)(i)	increases		1	AO1 2.3.2m	**A**
1(b)(ii)	increases		1	AO1 2.3.2m	**A**
1(c)	18 watt	allow **1** mark for correct substitution i.e. 12 x 1.5 provided no subsequent step accept W answer may be indicated in the list	2 1	AO2 2.4.2c AO1 2.4.2c	**E**
Total			**6**		

4.4.4.2 Nuclear fusion

Question	Answers	Extra information	Mark	AO / Spec. ref.	ID
2(a)	inside the Sun		1	AO1 2.6.2b	**A**
2(b)	fusion		1	AO1 2.6.2a	**G**
2(c)	energy		1	AO1 2.6.2f	**A**
Total			**3**		

4.4.4.2 Nuclear fusion

Question	Answers	Extra information	Mark	AO / Spec. ref.	ID
3(a)	3 (.0)	allow **1** mark for correct substitution i.e. 25 x 0.12 provided no subsequent step	2	AO2 2.1.5d	**E**
3(b)(i)	elastic potential kinetic	correct order only	1 1	AO1 2.1.5c 2.2	**G**
3(b)(ii)	increases to 80(mm) (or more)	accept any number greater than 75 an answer 'it (more than) doubles' gains both marks	1 1	AO3 2.1.5a	**E**
3(c)(i)	weight		1	AO1 2.1	**A**
3(c)(ii)	Downward speed increases		1	AO1 2.1.1e	**A**
Total			**8**		

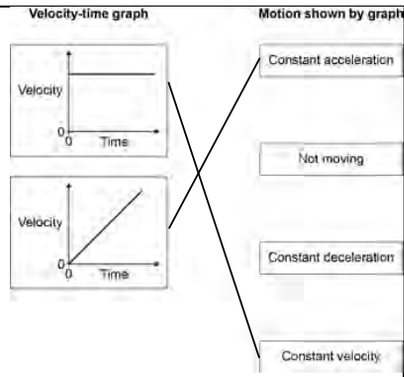
4.4.4.2 Nuclear fusion

PMT

MARK SCHEME – GCSE ADDITIONAL SCIENCE / PHYSICS – PH2FP– JUNE 2015

Question	Answers	Extra information	Mark	AO / Spec. ref.	ID
4(a)(i)	(3-pin) plug	do **not** accept plug socket	1	AO1 2.4.1d	**E**
4(a)(ii)	live and neutral		1	AO1 2.4.1e	**A**
4(a)(iii)	double		1	AO1 2.4.1j	**G**
4(b)	Direct current (d.c.) only		1	AO1 2.4.1a	**A**
4(c)(i)	live		1	AO1 2.4.1g	**G**
4(c)(ii)	too great a current flows	accept a surge of current accept too great a power accept an electrical fault do **not** accept voltage / energy / electricity too high	1	AO1 2.4.1g	**E**
4(c)(iii)	can be reset (disconnects circuit) faster	accept does not need replacing cheaper is insufficient does not melt is insufficient quicker to fix / replace is insufficient	1 1	AO2 2.4	**E**
Total			**8**		

4.4.4.2 Nuclear fusion

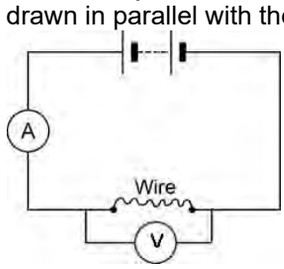
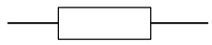
Question	Answers	Extra information	Mark	AO / Spec. ref.	ID
5(a)		if more than one line is drawn from a graph then all those lines are wrong allow **1** mark for 1 correct line	2	AO1 2.1.2f	**G**
5(b)	speed		1	AO1 2.1.2d	**G**
5(c)(i)	2.25	allow **1** mark for correct substitution i.e. $a = \frac{9-0}{4}$ or $a = \frac{9}{4}$ provided no subsequent step	2	AO2 2.1.2e	**E**
5(c)(ii)	The air resistance increases		1	AO1 2.1.4a	**A**
5(d)	2000 J mass is half **or** kinetic energy depends on mass	 do **not** accept weight for mass	1 1	AO2 2.2.1g	**E**
Total			**8**		

4.4.4.2 Nuclear fusion

Question	Answers	Extra information	Mark	AO / Spec. ref.	ID
6(a)	cell damage *or* cancer	accept kills/mutates cells radiation poisoning is insufficient ionising is insufficient	1	AO3 2.5.2g	**E**
6(b)(i)	any **one** from: • use tongs to pick up source • wear gloves • use (lead) shielding • minimise time (of exposure) • maximise distance (between source and teacher)	accept any other sensible and practical suggestion ignore reference to increasing / decreasing the number / thickness of lead sheets	1	AO3 2.5	**E**
6(b)(ii)	<u>background</u>		1	AO1 2.5.2b	**E**
6(c)(i)	curve drawn *from point 2,160*	do **not** accept straight lines drawn from dot to dot	1	AO2 2.5	**E**
6(c)(ii)	(also) increases	less radiation passes through is insufficient	1	AO3 2.5	**E**
6(c)(iii)	50	accept any value from 40 to 56 inclusive	1	AO3 2.5	**E**
6(d)	gamma only gamma (radiation) can pass through lead	 accept alpha **and** beta cannot pass through lead a general property of gamma radiation is insufficient	1 1	AO2 2.5.2e	**E**
Total			**8**		

4.4.4.2 Nuclear fusion

Question	Answers	Extra information	Mark	AO / Spec. ref.	ID
7(a)(i)	p.d. is (directly) proportional to current **or** gradient/slope is constant ***or*** the lines show constant resistance	accept lines are straight / diagonal	1	AO2 2.3.2d/e/g	**E**
7(a)(ii)	C for the same p.d. the current is the smallest	reason only scores if C is chosen accept lowest gradient **and** the gradient = 1/R	1 1	AO2 2.3.2i	**E**
7(b)(i) clip with table 1	ohm	accept correct symbol Ω accept an answer written in Table 1 if not given in answer space	1	AO1 2.3.2h	**E**
7(b)(ii)	K and L only length varies	reason only scores if both K and L are chosen accept type of metal and the diameter are the same	1 1	AO3 2.3.2	**E**
7(b)(iii)	measure the resistance of more wires made from different metals	accept test more (types of) metals measure the resistance of more wires is insufficient they only use two metals is insufficient	1	AO3 2.3.2	**E**

7(c)(i)	voltmeter symbol correct and drawn in parallel with the wire 	accept voltmeter symbol correct and drawn in parallel with the battery	1	AO1 2.3.2c/f	**E**
7(c)(ii)	correct symbol drawn 	symbol must be rectangular	1	AO1 2.3.2c	**E**
Total			**9**		

Question	**Answers**	**Extra information**	**Mark**	**AO / Spec. ref.**	**ID**
8(a)	(an equal amount of) positive charge	do **not** accept charge on the atom / nucleus is positive	1	AO3 2.5.1	**E**
8(b)(i)	a (significant) number of alpha particles were scattered by more than 4° **or** alpha particles deflected backwards measurements / results could not be explained by 'plum pudding' model **or** measurements / results did not support predictions	accept (some) measurements / results were unexpected can be explained by the nuclear model is insufficient accept measurements / results did not support hypothesis	1 1	AO1 2.5 AO1	**E**
8(b)(ii)	many/(over)100 000 measurements / results taken	accept Rutherford(and Marsden) were respected scientists **or** scientists were respected accept measurements / results taken over several months the experiment was repeated many times is insufficient	1	AO3 2.5	**E**

4.4.4.2 Nuclear fusion

PMT

MARK SCHEME – GCSE ADDITIONAL SCIENCE / PHYSICS – PH2FP– JUNE 2015

Question 8 continues on the next page . . .

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
8(c)			6	AO1 2.5.1a/b/c	**E**

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
no relevant content	A brief description is given with some particles correctly named	A description is given with all three particles named **plus either** the polarity of charge associated with the three particles **or** the relative mass of the three particles **or** the relative mass for one particle and the relative charge for one particle given	A more detailed description is given, naming the particles and polarity of charge **and either** the relative mass is given for at least two particles **or** the relative charge is given for at least two particles

4.4.4.2 Nuclear fusion

examples of the points made in the response	extra information		
brief description contains protons, neutrons and electrons protons are positive electrons are negative neutrons are uncharged has a nucleus **relative charge** proton +1 electron – 1 neutron 0 **relative mass** proton 1 neutron 1 electron (about) 1/2000 **more detailed description** protons and neutrons make up the nucleus electrons orbit the nucleus electrons are in shells most of the atom is empty space nucleus occupies a very small fraction of the volume of the atom electrons orbit at a relatively large distance from the nucleus most of the mass of the atom is contained in the nucleus the nucleus as a whole is positively charged total number of protons in the nucleus equals the total number of electrons orbiting it in an atom	accept protons and neutrons have the same mass accept electrons have tiny / negligible mass zero mass is neutral		

Total		**10**

4.4.4.2 Nuclear fusion

Answer 12 · Examiner comments

June 2023 | 8463/1F | Original Q3

Question 3 (Low and Standard Demand)

03.1 29% of students scored 2 marks, while 27 % of students scored 1 mark for this question about isotopes..

03.2 51% of students knew what half-life means.

03.3 77 % of students correctly identified the least stable isoptope.

03.4 Students found this question difficult with only 38% scoring 2 marks and 21% scoring 1 mark for this question about irradiation and contamination.

03.5 68% of students identified the purpose of the sticky floor.

03.6 72% of students scored 2 marks on this calculation question.

03.7 This question discriminated well with 46 % of students scoring 2 marks and 20 % of students scoring 1 mark for this question about fission and fusion

4.4.4.2 Nuclear fusion

Answer 13 · Examiner comments

June 2023 | 8463/1F | Original Q10

Question 10 (Standard Demand)

10.1 Very few correct answers, only 2% of students scored a mark. Many students gave answers in terms of charge flow and current which were insufficient. The specification does not mention alternating or direct current, only alternating or direct p.d. Answers like ' the potential difference flows in one direction' were insufficient to score.
. Saying the potential difference only travels/goes in one direction was insufficient, as this suggested charge flow. Saying that 'the potential difference is always positive' or 'the potential difference doesn't go negative' were creditworthy. 'The potential difference is in one direction' was creditworthy. 'The potential difference isn't alternating' was insufficient.

10.2 95% of students scored this mark. The equations sheet was provided for this exam series.

10.3 74% of students scored 3 marks. The most common mistake was to multiply the energy and the pd, which scored zero.

10.4 64% of students scored 3 marks. Students should appreciate that the first mark in a calculation is for the substitution, not the rearrangement. The substitution into an incorrectly rearranged equation scores zero. A substitution into an equation could score one mark even if the next step was an incorrect rearrangement.

10.5 Students made simple statements about the particle movement or particle arrangement, but usually made mistakes which stopped them scoring marks in Level 2. To score in Level 2, students needed to make comparisons of the movement and arrangement of particles in ice and liquid water. In addition to this, for students to score in Level 3, they needed to discuss either the change of state at constant temperature increasing the potential energy of the particles or how the warming of liquid water increased the kinetic energy of the particles. For 6 marks, both these aspects needed discussion. Students found this question difficult with less than 1% scoring 5 or 6 marks and14% scoring 3 or 4 marks.

4.4.4.2 Nuclear fusion

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

4.4.4.2 Nuclear fusion

Answer 14 · Examiner comments June 2024 | 8463/1F | Original Q7

Question 7 (Low / Standard demand)

07.1 42% of students answered this question correctly, identifying the colour of the insulation around the live wire.

07.2 Students were slightly more successful answering this question, with 48% correctly identifying the colour of the insulation around the neutral wire.

07.3 64% of students were able to identify the circuit symbol for a fuse.

07.4 92% of students scored 2 marks for this question. For low demand calculations the equation is provided in the rearrangement needed to answer the question.

07.5 72% of students multiplied numbers given in this standard demand calculation and scored 2 marks. Very few students attempted the unit conversion. Only 8% of students scored 3 marks for the correct final answer.

07.6 43% of students realised that the total energy would be greater.