AQA GCSE Physics | 8463

SPECIFICATION POINT 4.6.1.3

Reflection of waves (physics only)

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**16**
Available paper years	**2008–2024**

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.

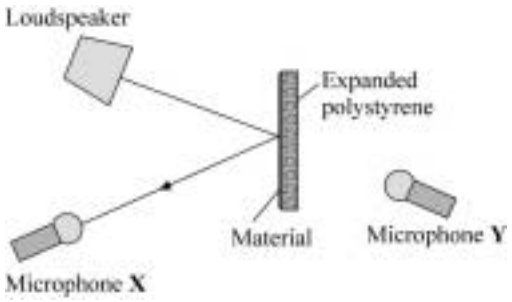
Name: _____ **Date:** _____

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

4.6.1.3 Reflection of waves (physics only)

Answer 01 · Mark scheme January 2008 | PHY3H | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
(a)	(mechanical) vibration(s)	**not** just 'particles knocking into each other' not reference to 'sound particles'	1
(b)	K		1
(c)(i)	reflected by the material from loudspeaker to microphone X shown by straight lines with angle of incidence = angle of reflection (by eye) **and** at least one arrow in the correct direction	 do **not** credit if the direction is contradicted by any incorrect arrow may be shown by waves / wavefronts in the direction of straight lines ignore any sound to Y or which 'misses' the material **example**  	1 1
(ii)	any **one** from: • so (the student) can compare results • so only one (independent) variable • to get reliable / accurate results • because (the expanded) polystyrene absorbs some of the sound	do **not** credit just 'so it's a fair test'	1

PHY3H

Question 2 continued

question	answers	extra information	mark
(iii)	**[A]** wood		1
	[B] either 0.25 **or** 1/4 **or** 25 % **or** 15/60 **or** 1: 3	do **not** credit 1 : 4	1
(d)	practical suggestion		1
	appropriate reason / explanation	**example** line / panel the walls with wood / plasterboard / increase the thickness of the plaster (on the walls) (1) (this) will absorb / reflect (back) (most / some of) the sound (1) credit legal suggestions for attempting to limit the noise made by the neighbours **example** ask the neighbours to make less noise (1) by limiting the time(s) music played (1) do **not** credit reference to 'sound particles' for second mark	1
total			9

continued

4.6.1.3 Reflection of waves (physics only)

Answer 01 · Mark scheme

January 2008 | PHY3H | Original Q2 | Legacy

PHY3H

4.6.1.3 Reflection of waves (physics only)

Answer 02 · Mark scheme

January 2009 | PHY1H | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
5(a)(i)	radio(waves)		1
5(a)(ii)	energy	correct answer only	1
5(b)(i)	0.0125 (m)	allow **1** mark for correct transformation and substitution	2
5(b)(ii)	make it hot(ter)	do **not** accept cook it accept (air) particles inside ball will move faster accept water in the ball gets hotter	1
5(b)(iii)	wavelength decreases frequency increases	ignore reference to speed	1 1
5(c)(i)	both variables are continuous	accept the data is continuous	1

Question 5 continues on the next page

PHY1H

Question 5 continued

question	answers	extra information	Mark
5(c)(ii)	digital data can be (easily) processed by a computer **or** digital analogue data cannot (easily) be processed by a computer	both parts needed do **not** accept answers in terms of interference / quality / clearer signals	1
5(c)(iii)	digital a signal that has only two states / discrete values analogue a signal that varies continuously	accept can only be on or off accept made up of 1 and 0 only allow both marks for two correct diagrams correctly labelled digital and analogue allow **1** mark for two correct diagrams but not labelled	1 1
Total			**11**

4.6.1.3 Reflection of waves (physics only)

Answer 03 · Mark scheme

June 2009 | PHY1BP | Original Q7 | Legacy

Seven	**4**	**1**	**3**	**4**

4.6.1.3 Reflection of waves (physics only)

Answer 04 · Mark scheme

January 2010 | PHY1H | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)(i)	microwaves		1
3(a)(ii)	can pass through the ionosphere	accept travels in a straight line accept atmosphere for ionosphere do **not** accept air for ionosphere	1
3(b)	any **two** from: • analogue is continuously varying • digital has only discrete values • digital is less prone to interference (than analogue) • digital can be processed more easily (than analogue) by a computer	 do **not** accept analogue has many values accept digital is on or off accept digital is 1 or 0 accept digital is binary accept digital is easier to restore	2
3(c)	higher the frequency, further the wave travels (into the atmosphere before reflection)		1
3(d)	15 000	allow **1** mark for correct transformation and substitution ie $\frac{300\,000\,000}{20}$ an answer of 15 000 000 only gains **1** mark allow both marks for an answer of 15 MHz (unit must be changed) an answer of 15 gains no credit	2
Total			**7**

4.6.1.3 Reflection of waves (physics only)

Answer 04 · Mark scheme

January 2010 | PHY1H | Original Q3 | Legacy

PHY1H

4.6.1.3 Reflection of waves (physics only)

Answer 05 · Mark scheme

Question 1

question	answers	extra information	mark
1(a)	higher frequency **or** shorter wavelength **or** greater energy	general properties / uses are neutral do **not** accept different frequency / wavelength / energy	1
1(b)	the same (speed)	accept they travel at the speed of light	1
1(c)	pass through / transmitted by the plastic / casing reflected by the metal / plates	 do **not** accept bounce / deflected etc for reflected if neither marking point scores an answer reflected (back to boat / from the device) scores **1** mark	1 1
1(d)(i)	waves are not reflected from the walls **or** only waves (reflected) from the device are detected	accept microwaves / radar for waves do **not** accept bounce / deflected etc for reflected accept to stop reflected waves affecting results	1

Question 1 continues on the next page . . .

PHY1H

Question 1 continued . . .

question	answers	extra information	mark
1(d)(ii)	different types (of device) can be compared	fair test is insufficient accept idea that only one variable is then changed	1
1(d)(iii)	so (measurements / results / scientists) are not biased towards one type / manufacturer of device/s	accept to avoid bias accept so they are not biased	1
1(e)(i)	any **two** from: • (for any angle) **A** values < **B** values • **A** values increase with (increasing) angle • **B** values decrease with (increasing) angle • **A** values do not vary as much (as **B** values)	if temperature is mentioned rather than angle a maximum of **1** mark can be scored **or** converse eg **B** values are higher / better / stronger accept weakest at 0^{o} strongest at 15^{o} values go up is insufficient accept strongest at 0^{o} weakest at 15^{o} values go down is insufficient	2
1(e)(ii)	**D** values are always over 2(.0)	mark is for the reason reason cannot score if **D** is not chosen	1
Total			**10**

4.6.1.3 Reflection of waves (physics only)

Answer 05 · Mark scheme January 2011 | PHY1H | Original Q1 | Legacy

PHY1H

Answer 06 · Mark scheme March 2011 | PHY1BP | Original Q3 | Legacy

Three	**A**	bacteria	**3**
	B	cells	**2**
	C	isotopes	**1**
	D	particles	**4**

Answer 07 · Mark scheme June 2015 | PH1HP | Original Q4 | Legacy

The full source mark scheme begins on page 29. Follow original question 4 in that document.

Answer 08 · Mark scheme June 2015 | PH1HP | Original Q6 | Legacy

The full source mark scheme begins on page 29. Follow original question 6 in that document.

Answer 09 · Mark scheme June 2016 | PH1HP | Original Q1 | Legacy

The full source mark scheme begins on page 45. Follow original question 1 in that document.

4.6.1.3 Reflection of waves (physics only)

Answer 10 · Mark scheme

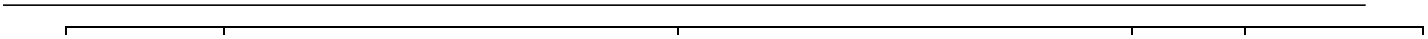
June 2017 | PH1HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)	Doppler		1	AO1 1.5.4a
4(b)(i)	A frequency has increased	 accept frequency is higher (compared to the emitted frequency) accept wavelength has decreased reason only scores if A is chosen	1 1	AO2 AO3 1.5.4a
4(b)(ii)	C greater change in frequency	 accept greater change in wavelength reason only scores if C chosen	1 1	AO2 AO3 1.5.4a
Total			**5**	

4.6.1.3 Reflection of waves (physics only)

Answer 10 · Mark scheme

June 2017 | PH1HP | Original Q4 | Legacy



4.6.1.3 Reflection of waves (physics only)

Answer 11 · Mark scheme

June 2018 | 8463/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	random	human error is insufficient	1	AO3 4.6.1.3
05.2	accept any practical suggestion that could cause a range of values eg misjudging the centre of the ray eg not replacing mirror / ray box in the same position	measuring the angle incorrectly is insufficient moving the mirror / ray box is insufficient	1	AO2 4.6.1.3
05.3	range = 10 **or** mean of 51 calculated 5(°)	an answer of 5(°) scores **2** marks	1 1	AO3 4.6.1.3
05.4	within experimental accuracy the angle of incidence and the angle of reflection are the same **or** the angle of reflection is usually different to the angle of incidence relevant use of data eg at 20° / 30° / 40° there is at least one measurement of angle of reflection that is exactly the same **or** at 50° there are big differences	allow the angle of incidence is nearly the same as the angle of reflection allow only a few of the values are the same / similar allow the idea of a range of values allow 50° includes anomalous results an answer in terms of calculated mean(s) may score both marks eg mean calculated for one or more angle of reflection (1) conclusion correctly stating angle i = / ≠ angle r (1)	1 1	AO3 4.6.1.3

4.6.1.3 Reflection of waves (physics only)

Answer 11 · Mark scheme

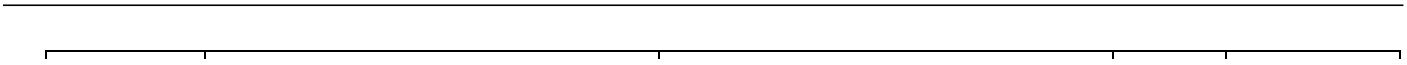
June 2018 | 8463/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	results could be collected for angles (of incidence) not yet measured	allow a stated angle of incidence eg 10º or 60º changing the mirror is insufficient ignore repeat the measurements	1	AO3 4.6.1.3
05.6	replace the mirror with an irregular reflecting surface	allow use an irregular reflecting surface replace mirror with paper is insufficient do **not** accept use a glass block	1	AO3 4.6.1.3
Total			**8**	

4.6.1.3 Reflection of waves (physics only)

Answer 11 · Mark scheme

June 2018 | 8463/2H | Original Q5



4.6.1.3 Reflection of waves (physics only)

Answer 12 · Mark scheme

June 2018 | 8463/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	an idea used to explain observations and data		1	AO1 key ideas
09.2	different models may be appropriate in different situations	allow one particular model may not be able to explain all observations	1	AO1 key ideas
09.3	new (experimental) evidence / data		1	AO1 key ideas
	evidence cannot be explained using an existing model **or** predictions made using old model are shown to be incorrect	allow old model based on data now shown to be incorrect	1	
	new model explains new evidence **or** predictions made with new model are shown to be correct		1	
	a suitable example given eg nuclear model of the atom replacing the plum pudding model	allow tectonic plates replacing static land masses	1	
	big bang theory replacing other theories for the creation of the universe	allow heliocentric model of solar system replacing geocentric model		
09.4	velocity / speed is slower in shallow water		1	AO2 4.6.2.2
	so edge of wave (front) entering shallow water slows down		1	
	but the part of the wave (front) in deeper water continues at a higher speed (leading to a change in direction of the wave fronts)	allow one part of the wave (front) changes speed before other parts allow an answer in terms of wave (front) travelling from shallow to deep water	1	

4.6.1.3 Reflection of waves (physics only)

Answer 12 · Mark scheme

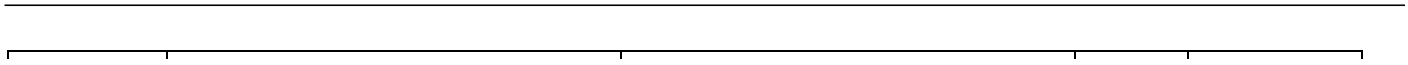
June 2018 | 8463/2H | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	every point on the wave (front) enters / hits the shallow water at the same time and so every point slows down at the same time	 allow changes speed for slows down allow an answer in terms of wave (front) travelling from shallow to deep water	1 1	AO2 4.6.2.2
Total			11	

4.6.1.3 Reflection of waves (physics only)

Answer 12 · Mark scheme

June 2018 | 8463/2H | Original Q9



4.6.1.3 Reflection of waves (physics only)

Answer 13 · Mark scheme

November 2021 | 8463/2H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	to reduce the effect of random errors	allow gives a more accurate mean ignore reference to anomalous results ignore measurements are more accurate	1	AO1 4.6.1.2
06.2	$\frac{(8.4+7.8+8.1)}{3}$ = 8.1 (s)		1	AO2 4.6.1.2
	$\frac{8.1}{10}$ = 0.81 (s)		1	
	frequency = $\frac{1}{0.81}$	allow a correct substitution of an incorrectly calculated value for time	1	
	frequency = 1.2345…	this mark may be awarded if the time is incorrectly calculated	1	
	frequency = 1.2 (Hz)	allow a calculated value correctly rounded to 2 sig figs	1	
06.3	measure the distance travelled by a wave using a metre rule	allow measure the length of the (ripple) tank using a metre rule	1	AO1 4.6.1.2
	measure the time taken (for the wave to travel the measured distance) with a timer / stopwatch		1	
	divide the distance by the time	dependant on scoring the first two mark points	1	
Total			**9**	

4.6.1.3 Reflection of waves (physics only)

Answer 14 · Mark scheme

June 2022 | 8463/2HR | Original Q2

Question 2

Question	Answers	Mark	AO / Spec. Ref.
02.1	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 4.6.1.3
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content Some indicative content could be indicated within a labelled diagram • place a glass block on a piece of paper • draw around the glass block • use the ray box to shine a ray of light through the glass block • mark the ray of light entering the glass block • mark the ray of light emerging from the glass block • join the points to show the path of the complete ray through the block • and draw a normal line at 90 degrees to the surface • use a protractor to measure the angle of incidence • use a protractor to measure the angle of refraction • use a ray box to shine a ray of light at a range of different angles (of incidence) • increase the angle of incidence in 10 degree intervals • from an angle of incidence of 10 degrees to an angle of incidence of 80 degrees Methods involving mirrors and reflection score zero		

4.6.1.3 Reflection of waves (physics only)

Answer 14 · Mark scheme

June 2022 | 8463/2HR | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	angle of incidence in degrees / ° on *x*-axis **and** angle of refraction in degrees / ° on *y*-axis		1	AO2 4.6.1.3
	all points plotted correctly	allow **1** mark if 3 or 4 points plotted correctly allow tolerance of half a small square	2	
	curved line of best fit	allow line of best fit from their incorrectly plotted points	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	normal drawn at 90° at the point where the incident ray strikes the mirror		1	AO2 4.6.1.3
	straight line drawn with a ruler **and** angle of incidence = angle of reflection	ignore any arrows	1	

4.6.1.3 Reflection of waves (physics only)

Answer 14 · Mark scheme

June 2022 | 8463/2HR | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	(the protractor drawn on the paper means you) do not have to move the mirror (to measure the angles)	allow do not have to mark the position of the rays of light allow protractor does not need to be repositioned	1	AO3 4.6.1.3
	(so) more likely to record the correct angle of incidence and / or reflection	allow reducing random error allow more accurate	1	
	ray in method A does not diverge	allow ray in method A is thin(ner)	1	
	(making it) easier to judge the centre (position) of the ray	allow more accurate if not already awarded allow converse answers in terms of method B being worse than method A	1	

Total Question 2		16

4.6.1.3 Reflection of waves (physics only)

Answer 15 · Mark scheme

June 2023 | 8463/2H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	specular (reflection)		1	AO1 4.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	the angle of incidence = the (mean) angle of reflection		1	AO3 4.6.1.3 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	random any **one** from: • the student's eye / head might not be in the same position each time • the centre of the ray may not have been marked correctly • the mirror / ray box may not have been (re)placed correctly	 allow parallax allow protractor not in the correct position incorrect measurement of the angle(s) is insufficient	1 1	AO3 4.6.1.3 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	all points on a wavefront enter the glass at the same time	allow incident ray (of light) is along the normal	1	AO1 4.6.1.3 RPA9

4.6.1.3 Reflection of waves (physics only)

Answer 15 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	the resolution (of the protractor) is 1(°)		1	AO3 4.6.1.3 RPA9
	(so) could not be used to measure the difference between the results	allow (so) could not be used to measure to 1 decimal place	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	different parts of the wavefront enter the glass at different times		1	AO1 4.6.2.2
	the velocity / speed (of light) is less in glass		1	
	(so) one part of the wave front changes speed before other parts		1	

Total Question 7	10

4.6.1.3 Reflection of waves (physics only)

Answer 16 · Mark scheme

June 2024 | 8463/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	1 (°)		1	AO3 4.6.1.3 RPA9

Question	Answers	Mark	AO / Spec. Ref.
01.2	**Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 4.6.1.3 RPA9
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content Some indicative content could be indicated within a labelled diagram • place a glass block on a piece of paper • draw around the glass block • use the ray box to shine a ray of light through the glass block • mark the ray of light entering the glass block • mark the ray of light emerging from the glass block • join the points to show the path of the complete ray through the block • and draw a normal line at 90 degrees to the surface • use a protractor to measure the angle of incidence • use a protractor to measure the angle of refraction • use a ray box to shine a ray of light at a range of different angles (of incidence) • increase the angle of incidence in 10 degree intervals • from an angle of incidence of 10 degrees to an angle of incidence of 60 degrees Methods involving mirrors **and** reflection score zero		

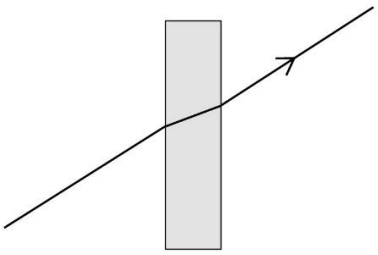
4.6.1.3 Reflection of waves (physics only)

Answer 16 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	points plotted correctly curve drawn passing through points	allow tolerance of ± half a small square allow a line starting at the origin	1 1	AO2 4.6.1.3 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	the line curves	allow the line is not straight allow line does not pass through the origin if consistent with their answer to question **01.3**	1	AO3 4.6.1.3 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	normal drawn ray reflected so $i = r$	 judge by eye	1 1	AO2 4.6.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6			1	AO1 4.6.2.2

Total Question 1	**13**

4.6.1.3 Reflection of waves (physics only)

AQA

GCSE

Science A / Physics

PH1HP

Mark scheme

4405/4403
June 2015

Version/Stage: 1.0 Final

4.6.1.3 Reflection of waves (physics only)

PMT

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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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.

4.6.1.3 Reflection of waves (physics only)

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

3.1 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.

3.2 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.

3.3 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.

3.4 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.

3.5 Phonetic spelling

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

3.6 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.

3.2 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 **2a** 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

4.6.1.3 Reflection of waves (physics only)

Question	Answers	Extra information	Mark	AO / Spec. ref.
1(a)	chemical kinetic sound	correct order only	1 1 1	AO1 P1.2.1a
1(b)	37.5% or 0.375	an answer rounded to 0.38 or 38% scores both marks an answer of 0.375 with a unit gains **1** mark an answer of 0.375% gains **1** mark an answer of 37.5 with or without a unit gains **1** mark allow **1** mark for an answer 3/8 3/8 with a unit scores 0	2	AO2 P1.2.1d
Total			**5**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
2 (a)	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 4 and apply a 'best-fit' approach to the marking.		6	AO2 AO3 P1.2 HSW	E

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant information	There is a relevant statement about an energy saving method	There is at least one clear comparison of energy saving methods and their cost effectiveness with an appropriate calculation	There is a comparison of energy saving methods and their cost effectiveness with appropriate calculations. Comparison to include further detail.

examples of physics points made in the response	extra information
examples of relevant statements • energy efficient boiler saves the most (energy / money) per year • loft insulation costs the least to install • double-glazing costs the most to install **examples of statements that include cost effectiveness** • loft insulation is the most cost effective in the long term • double-glazing is the least cost effective • loft insulation has the shortest payback time • double-glazing has the longest payback time • payback time calculated for any method **examples of further detail** • for cost effectiveness install in the following order: loft, cavity wall, boiler, double-glazing • for reducing energy use install in the following order: boiler, loft, cavity wall, double glazing • don't install double-glazing for insulation purposes • double-glazing won't pay for itself in your lifetime • justified choice of best / worst method	payback times: energy efficient boiler: 6.25 years loft insulation: 2 years double glazing: 100 years cavity wall insulation: 2.86 years

4.6.1.3 Reflection of waves (physics only)

Question 2 continued . . .

Question	Answers	Extra information	Mark	AO / Spec. ref.
2(b)(i)	how effective a material is as an insulator	accept 'heat' for energy accept how effective a material is at keeping energy in accept the lower the U-value the better the insulator accept the lower the U-value the lower the rate of energy transfer	1	AO1 P1.1.4a
2(b)(ii)	(the U-value) decreases		1	AO1 P1.1.4b
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec. ref.
3(a)(i)	0.5 °C		1	AO3 P1.1
3(a)(ii)	data is continuous **or** both variables are continuous **or** independent variable is continuous **or** time is continuous	accept results / measurements for data accept data is not categoric one variable is continuous is insufficient air temperature is continuous is insufficient	1	AO3 P1.1
3(b)(i)	20.5 (°C)		1	AO2 P1.1
3(b)(ii)	60 (minutes)	accept 1 hour	1	AO2 P1.1
3(c)(i)	so a comparison can be made **or** outside temperature is a control variable	accept: (outside) temperature would affect energy required (to maintain temperature of the house) **or** (outside) temperature would affect internal temperature (of the house) **or** heat loss will be faster on a cold day outside temperature will affect the results is insufficient fair test is insufficient	1	AO3 P1.1

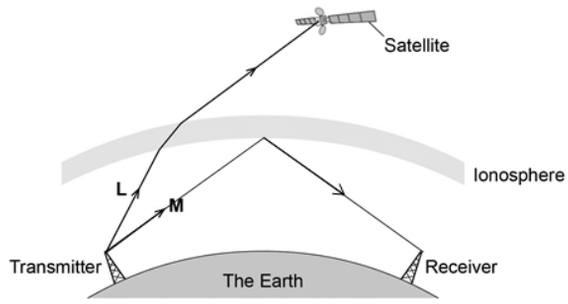
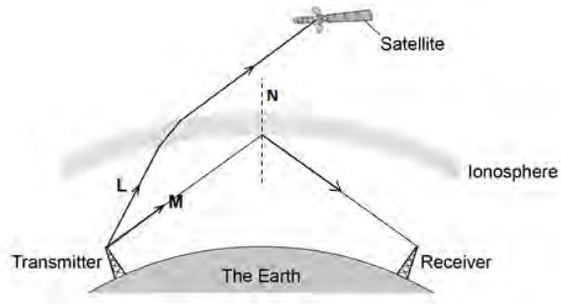
Question 3 continues on the next page . . .

4.6.1.3 Reflection of waves (physics only)

Question	Answers	Extra information	Mark	AO / Spec. ref.
3(c)(ii)	the cost is equal to the number of kWh x the cost per kWh calculation 0.8 / 8.0 = 0.1 or 10%	accept (heating) bill depends on (number of) kWh used accept energy for kWh allow 7.2 / 8.0 = 0.9 or 90%	1 1	AO3 AO2 P1.1
3(c)(iii)	heating is on for more / less time (than anticipated) because some days it is cooler / warmer (than anticipated)	 accept other sensible suggestions an answer giving two sensible situations gains **2** marks possible examples: • some houses have different amounts of insulation • there are different styles of house temperature (inside / outside) is always changing is insufficient	1 1	AO3 P1.1
Total			**9**	

4.6.1.3 Reflection of waves (physics only)

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP – JUNE 2015

Question	Answers	Extra information	Mark	AO / Spec. ref.
4(a)(i)	microwave		1	AO1 P1.5.1k
4(a)(ii)	refraction		1	AO1 P1.5.1g
4(b)(i)	wave M continues as a straight line to the ionosphere and shown reflected correctly reflected wave shown as a straight line reaching the top of the receiver  	accept reflection at or within the ionosphere if more than 2 rays shown 1 mark maximum ignore arrows	1 1	AO2 P1.5.2b
4(b)(ii)	normal drawn at point where their **M** meets the ionosphere  		1	AO1 P1.5.2a

Question 4 continues on the next page. . .

4.6.1.3 Reflection of waves (physics only)

Question 4 continued…

Question	Answers	Extra information	Mark	AO / Spec. ref.
4(c)	any **two** from: • transverse • same speed (through air) • can be reflected • can be refracted • can be diffracted • can be absorbed • transfer energy • can travel through a vacuum • can be polarised • show interference	accept speed of light **or** 3×10^8 m/s an answer travel at the same speed though a vacuum scores **2** marks travel in straight lines is insufficient	2	AO1 P1.5.1a,bc, d,g
Total			**7**	

4.6.1.3 Reflection of waves (physics only)

Question	Answers	Extra information	Mark	AO / Spec. ref.
5(a)(i)	infrared (radiation)	accept IR (radiation)	1	AO1 P1.1.1b
5(a)(ii)	(heated) water turns to steam steam turns a turbine turbine turns a generator	ignore reference to fossil fuels do **not** accept water evaporates to steam accept turbine connected to a generator	1 1 1	AO1 P1.4.1a
5(b)(i)	(so the molten salts) can store large amounts of energy	accept there is a small temperature change for a large energy transfer accept heat for energy	1	AO2 P1.1.4d
5(b)(ii)	16 (hours)	an answer that rounds to 16 gains **2** marks eg 15.71 allow **1** mark for a correct substitution ie 2 200 000 = 140 000 x t	3	AO2 AO1 P1.3.1c
5(b)(iii)	the number of daylight hours varies the (mean) power (received from the Sun per square metre) varies	less sunlight is insufficient accept an answer in terms of maximum possible electrical output only possible during Summer for **1** mark	1 1	AO2 AO3 P1.4

Question 5 continues on the next page . . .

4.6.1.3 Reflection of waves (physics only)

Question 5 continued . . .

Question	Answers	Extra information	Mark	AO / Spec. ref.
5(c)(i)	non-renewable power stations have higher Capacity Factors than renewable power stations		1	AO1 AO3 P1.4
	fuel (for non-renewable power stations) is always available	reference to non-renewable power stations operating all the time is insufficient non-renewable energy sources are reliable is insufficient	1	
	(most) renewable energy sources are unpredictable / unreliable	accept (most) renewable energy sources depend on the weather	1	
5(c)(ii)	the (proportion of) time that solar storage power stations can generate electricity is greater (than for other renewable energy sources)		1	AO1 P1.4
Total			**14**	

4.6.1.3 Reflection of waves (physics only)

Question	Answers	Extra information	Mark	AO/Spec ref.
6(a)	Doppler (effect)		1	AO1 P1.5.4a
6(b)	(reflected microwaves) wavelength decreased (reflected microwaves) frequency increased (reflected microwaves) have same speed		1 1 1	AO1 P1.5.4a P1.5.1d
Total			4	

4.6.1.3 Reflection of waves (physics only)

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP – JUNE 2015

Question	Answers	Extra information	Mark	AO / Spec. ref.
7(a)	4200	allow **2** marks for correct substitution ie 6930 = 0.330 x c x 5.0 answers of 1050 **or** 840 **or** correctly calculated answer from correct substitution of incorrect temperature change **or** identification of temperature change ie 5 ˚C gain **1** mark	3	AO2 AO1 P1.1.4d
	J/kg˚C	accept J/kg K	1	
7(b)	(in a metal) free electrons	to gain full credit the answer must be in terms of free electrons	1	AO1 P1.1.3a
	gain kinetic energy	accept move faster	1	
	(free electrons) transfer energy to other electrons / ions / atoms	do **not** accept particles	1	
	by collision		1	
		allow a maximum of **2** marks for answers in terms of atoms / ions / particles • gaining kinetic energy or vibrating faster / more • transferring energy by collisions		
7(c)	(air) particles spread out		1	AO1 P1.1.3a
	(which causes the) air to become less dense / expand	do **not** accept particles become less dense	1	
	(so the) warm air rises	do **not** accept heat rises particles rise is insufficient	1	
7(d)	large surface area	ignore references to type of metal or external conditions	1	AO1 P1.1.3c
	black / dark (colour)		1	
Total			**13**	

4.6.1.3 Reflection of waves (physics only)

PMT

AQA

GCSE

Science A / Physics

PH1HP

Mark scheme

4405/4403
June 2016

Version 1.0: Final Mark Scheme

4.6.1.3 Reflection of waves (physics only)

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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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.

4.6.1.3 Reflection of waves (physics only)

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 **2(b)** 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.

4.6.1.3 Reflection of waves (physics only)

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1(a)	frequency		1	AO1 1.5.3b
1(b)	echo(es)		1	AO1 1.5.3c
1(c)	spreading (out)	changing direction is insufficient moving apart is insufficient bending is insufficient	1	AO1 1.5.1g
	equal to	accept: similar to same (order of magnitude) as slightly smaller than slightly larger than	1	
1(d)	340 (m/s)	allow **1** mark for correct substitution ie 25 000 x 0.0136 provided no subsequent step **or** allow **1** mark for a correct calculation showing an incorrect value from conversion to hertz x 0.0136 an answer of 0.34 gains **1** mark	2	AO2 1.5.1j
1(e)		both marking points may appear as labels on a diagram		AO1 1.5.1b
	(a wave where the) oscillations are parallel to the direction of energy transfer	accept vibrations for oscillations accept in same direction as for parallel to allow direction of wave (motion) for direction of energy transfer	1	
	causing (areas of) compression and rarefaction	accept correct description in terms of particles mechanical wave is insufficient needs a medium to travel through is insufficient	1	
Total			**8**	

4.6.1.3 Reflection of waves (physics only)

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(a)	any **one** from: • high cost of installing overhead power lines or underground cables or pylons • high cost as (very) long cables needed • amount of electricity required is too low	allow not enough (surplus) electricity would be generated	1	AO1 1.4.1e

Question 2 continues on the next page . . .

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2(b)	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	3 AO1 2 AO2 1 AO3 1.4.1b

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant information	at least **one** advantage **or one** disadvantage of either method	at least **one** advantage **and one** disadvantage is stated for **one** method **and** a different advantage **or** disadvantage is stated for the other method	clear comparison of advantages **and** disadvantages of **each** method

examples of physics points made in the response	extra information
Advantages of both methods:	
• both renewable sources of energy	
• both have no fuel (cost)	accept carbon neutral
• both have very small (allow 'no') running costs	accept no greenhouse gases
• no carbon dioxide produced	accept doesn't contribute to global warming
Advantages of wind:	
• higher average power output	produces more energy is insufficient
Advantages of hydroelectric:	
• constant / reliable power (output)	
• lower (installation) cost	
Disadvantages of wind:	
• higher (installation) cost	
• variable / unreliable power output	
• (may) kill birds / bats	
Disadvantages of hydroelectric:	
• lower power output	
• (may) kill fish or (may) damage habitats	
• more difficult to set up (within river)	
Disadvantages of both methods	
• (may be) noisy	
• visual pollution	ignore payback time unless no other relevant points made ignore time to build for both

Total			7

4.6.1.3 Reflection of waves (physics only)

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3(a)	a proportion / percentage of the energy is wasted	allow heat for energy allow some energy is wasted	1	AO2 1.2.1b 1.2.1c
	(wasted) energy is transferred to surroundings **or** energy is needed to heat pan (before food is heated)		1	
3(b)	(fins have a) large(r) surface area	accept fins increase the surface area	1	AO1 1.1.1c 1.1.1e 1.1.3c
	(black metal surface is a) good / better absorber of infrared radiation	allow 'heat' or 'energy' for infrared radiation ignore good emitter of infrared radiation not a good reflector is insufficient	1	
3(c)	the higher the temperature (of the saucepan) the greater the rate at which infrared radiation is emitted	accept converse answer allow the higher the temperature the more infrared radiation is emitted allow there is a positive correlation	1	AO2 1.1.1b
Total			**5**	

4.6.1.3 Reflection of waves (physics only)

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)(i)	**use of infrared:** remote controls fibre optic (communications) **use of microwaves:** mobile/cell phones satellite (communications/TV) wi-fi Bluetooth	 accept mobiles accept phone signals	1 1	AO1 1.5.1k
4(a)(ii)	any **two** from • same speed **or** travel at the speed of light (in a vacuum) • transverse • transfer energy (from one place to another) • can be reflected • can be refracted • can be diffracted • can be absorbed / transmitted • can travel through a vacuum/space • can be polarised	 accept a full description of a transverse wave travels in straight lines is insufficient	2	AO1 1.5.1c 1.5.1d 1.5.1e 1.5.1g
4(b)(i)	Cosmic Microwave Background (Radiation)	accept CMBR	1	AO1 1.5.4d
4(b)(ii)	 the Big Bang (theory) predicted the existence of CMBR **or** only the Big Bang (theory) supports the existence of CMBR	allow microwave radiation for CMBR throughout allow it supports / proves the Big Bang (theory) accept CMBR disproved other theories, eg steady state	 1	AO1 1.5.4e
Total			**6**	

4.6.1.3 Reflection of waves (physics only)

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5(a)	no particles (in a vacuum) (so) no / reduced conduction and no / reduced convection	 both energy transfer methods needed for the mark	1 1	AO1 1.1.3a
5(b)(i)	78 (°C)	allow **2** marks for correct temperature change ie 22 ˚C allow **1** mark for correct substitution ie 46 200 = 0.5 x 4200 x θ **or** $\frac{46200}{0.5\times4200}=\theta$	3	AO2 1.1.4d
5(b)(ii)	6.4 (W)	allow **2** marks for an answer that rounds to 6.4 allow **1** mark for correct substitution ie 46 200 = P x 7200 an answer of 23 000 or 23 100 or 385 gains 1 mark	2	AO2 1.3.1c
Total			**7**	

4.6.1.3 Reflection of waves (physics only)

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6(a)	any **two** from: • cost per kWh is lower (than all other energy resources) • infrastructure for nuclear power already exists • more reliable (than renewable energy resources)	allow it is cheaper ignore fuel cost ignore energy released per kg of nuclear fuel accept cost of setting up renewable energy resources is high accept many renewable power stations would be needed to replace one nuclear power station accept (France in 2011 already had a) surplus of nuclear energy, so less need to develop more renewable capacity for increased demand in the future accept France benefits economically from selling electricity accept (nuclear) fuel is readily available ignore destruction of habitats for renewables	2	AO1 AO2 1.4
6(b)	any **two** from: • non-renewable • high decommissioning costs • produces radioactive / nuclear waste • long start-up time • nuclear accidents have widespread implications	allow nuclear fuel is running out accept high commissioning costs allow waste has a long half-life allow for nuclear accident a named nuclear accident eg Fukushima, Chernobyl ignore visual pollution	2	AO1 1.4.1f

Question 6 continues on the next page . . .

4.6.1.3 Reflection of waves (physics only)

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6(c)	0.48 (kW)	allow **1** mark for correct substitution ie 0.15 = P / 3.2 an answer of 480 W gains **2** marks an answer of 48 or 480 scores **1** mark	2	AO2 1.2.1d
6(d)	the higher the efficiency, the higher the cost (per m^2 to manufacture)	accept a specific numerical example	1	AO2 AO3 1.4.1c
	more electricity could be generated for the same (manufacturing) cost using lower efficiency solar panels **or** (reducing the cost) allows more solar panels to be bought	accept a specific numerical example	1	
Total			**8**	

4.6.1.3 Reflection of waves (physics only)

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7(a)	surface area **or** duration of experiment	accept shape of beaker size of beaker is insufficient	1	AO3 1.1.3b
7(b)	any **two** from: • takes readings automatically • takes readings more frequently • reduces / no instrument reading error • higher resolution • don't need to remove probe to take reading • more accurate	ignore easier **or** takes readings for you ignore human error allow better resolution	2	AO3 1.1.3
7(c)(i)	0.07 (°C/s)	allow **1** mark for obtaining a temperature drop of 7(ºC) allow **1** mark for an answer between 0.068 and 0.069 (°C/s)	2	AO2 1.1.3d
7(c)(ii)	rate of temperature change is greater at the start **or** rate of temperature change decreases	accept rate of evaporation is greater at the start allow rate of evaporation decreases allow temperature decreases faster at the start	1	AO3 1.1.3b

Question 7 continues on the next page . . .

4.6.1.3 Reflection of waves (physics only)

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7(c)(iii)	A lower temperature decrease (over 200 seconds)	reason only scores if A is chosen accept lower gradient	 1	AO3 1.1.3b
7(c)(iv)	no effect (as rate of evaporation is unchanged)	allow larger temperature change (per second as mass of liquid is lower)	1	AO3 1.1.3b
7(d)	particles with more energy leave the (surface of the) liquid (which) reduces the average (kinetic) energy (of the remaining particles)	accept particles with higher speeds allow reference to the total energy of the liquid reducing	1 1 1	AO1 1.1.3b
Total			11	

4.6.1.3 Reflection of waves (physics only)

MARK SCHEME – GCSE SCIENCE A / PHYSICS – PH1HP– JUNE 2016

Question	Answers	Extra information	Mark	AO / Spec. Ref.
8(a)	any **two** factors: • surface area (of mug in contact with cup warmer) • thickness of mug • temperature of heater / coffee • power of the heater	 accept temperature difference (between heater and coffee) accept power of the laptop ignore efficiency of the heater	2	AO3 1.1.3c
8(b)	atoms (gain kinetic energy and) vibrate faster / more energy is passed on from atom to atom by collision	allow particles / molecules for atoms allow bigger / faster vibrations do not accept start to vibrate accept vibrations for energy an answer in terms of free electrons scores zero	1 1	AO1 1.1.3a
8(c)	the particles spread out (so) coffee becomes less dense (so) the heated coffee rises (and) cooler / denser coffee falls	allow fluid / liquid / water for coffee throughout answer allow particles move further apart allow (coffee) expands particles rise is insufficient particles fall is insufficient	1 1 1 1	AO1 1.1.3a
Total			8	

4.6.1.3 Reflection of waves (physics only)

Answer 11 · Examiner comments

June 2018 | 8463/2H | Original Q5

Question 5 (Standard/high demand)

05.1 There were very few correct answers. Most answers described a specific error rather than a type of error. Many students incorrectly think that 'human error' is an acceptable answer.

05.2 There were many vague answers such as; ‘knocked the ray box’ that were not worthy of credit. Many students simply stated that there was a measuring error without further detail. Few students took the hint from Figure 7 that the rays were wide and so there would be difficulty in marking the exact position of each ray.

05.3 Nearly 70% of the students scored at least one mark for either calculating the mean or for calculating the range. Around 33% then calculated the uncertainty correctly.

05.4 Over 90% of the students scored at least one mark for either writing ‘I agree / disagree’ and quoting relevant data but not identifying the trend or for doing the converse.

05.5 About 23% of the students realised that the extra evidence would come from using a larger number of angles of incidence. Most answered in terms of repeating the same angles or comparing with another student’s results.

05.6 Many students simply wrote ‘change the mirror’ but did not say for what. Others suggested’ replacing the mirror but with a non-reflecting surface or a glass block. In this question it was important to realise that the replacement was in the context of an investigation and not simply recalling the meaning of diffuse reflection.

4.6.1.3 Reflection of waves (physics only)

Answer 12 · Examiner comments June 2018 | 8463/2H | Original Q9

Question 9 (Standard/high and High demand)

09.1 Nearly 80% of the students chose the correct description for a model.

09.2 This part was not answered well. Some students appeared to answer the question 'why do scientists use models?'.

09.3 Most students scored either one or two marks. The idea of new evidence or data was often expressed although not always very clearly. When giving an example many students did describe a model and what replaced it but a significant number only mentioned one of the models.

09.4 Nearly 80% of the students scored zero on this question. Some students were aware that the waves changed speed but did not state what the change was. There were many answers in terms of the refraction of light at a boundary and references to water having different density depending on its depth.

09.5 80% of students scored zero. Many answers were simply descriptions of Figure 17.
A common error was to state that the wavefronts did not cross the boundary.

Answer 13 · Examiner comments November 2021 | 8463/2H | Original Q6

Question 6

Although it was frequently seen, an answer only in terms of removing anomalous results was insufficient. The reason being that the question asked not only the advantage of repeating but also taking a mean. Very few of the students gave a precise answer in terms of reducing the effect of random errors. The calculation produced a full range of marks with most of the students scoring 2 or less. For part **06.3** there were a number of very good answers covering all three marking points. However, most of the students failed to answer the question asked as they simply described a way that the teacher could have measured the wavelength.

4.6.1.3 Reflection of waves (physics only)

Answer 15 · Examiner comments June 2023 | 8463/2H | Original Q7

wavelength than that emitted by the Sun.

07.1

28% of students were able to identify this as specular reflection.

07.2

64% of students gave the correct conclusion regarding the angle of incidence and the angle of reflection. There were a number of students who did not analyse the data in detail and failed to consider the magnitude of the angles. These students looked only for a trend and gave increasing angle of incidence resulted in an increase in the angle of reflection, or similar, as their conclusion.

07.3

11% of students gained both marks. Some students are not aware that 'human error' is not an acceptable answer. Others are unable to classify errors correctly. Many responses identifying the cause of the error were not consistent with the error given. Misreading the protractor was a common, but insufficient response.

Answer 15 · Examiner comments June 2023 | 8463/2H | Original Q7

07.4

36% of students gained this mark. Responses often referred to irrelevant factors, such asdensity, transparency of glass and the thickness of the block. 'Not hitting at an angle' was a popular response and a significant number of students seemed to have an idea of the reason but were unable to express themselves with clarity.

07.5

11% of students scored both marks. A significant number of students thought that the results were for angles of reflection, not refraction. There were many students who considered the construction of the protractor and offered various reasons for there being issues with the results.

07.6

8% of students scored all 3 marks on this question. Very few answers recognised the significance of parts of the wavefront reaching the boundary at different times and hence changing speed at different times. Students, generally, only gained credit for appreciating that the velocity/speed of light was less in glass than in air and these students were in a minority. Some students were aware that change in speed was involved but were unable to put together a coherent argument that matched the second marking point. There were many simplistic answers that referred to variation in optical density and light rays rather than wavefronts.

4.6.1.3 Reflection of waves (physics only)

Answer 16 · Examiner comments June 2024 | 8463/2H | Original Q1

01.1
69% of students correctly gave the resolution of the protractor. Answers of 10, 90 and 180 degrees were frequently seen.

01.2
Answers to this level of response question about the refraction of light included details, such as drawing round the block, that suggested that most students were familiar with this practical. Most students were aware of the need to incorporate the drawing of a normal into their account and described the need to measure the angles of incidence and refraction. Many students, however, described a method that would not necessarily lead to a valid outcome because they did not clearly identify the location of the angles or describe a method to mark the path of the ray of light through the glass block. Most students failed to describe the range and interval of angle of incidence that should be used to obtain the results recorded in the table reproduced in the question. A small number had not read the question carefully and described reflection at a mirror. 38% of responses were level 2 and16% level 3.

01.3
Very few errors were made in the plotting of the 2 points on the graph of angle of incidence against angle of refraction, but many students drew a straight line of best fit. This is connected to the misconception that a line of best fit is always straight.

01.4
74% of students were able to answer this question about the relationship in the graph correctly. Of those who drew a straight line of best fit in **01.3**, a large number described the points as not lying on the line of best fit.

01.5
Students did not always take sufficient care in drawing the reflected ray to show that i = r. A significant number of students appeared to have only read the first part of the question and, consequently, had not drawn a normal. 61% scored both marks, 21% scored one.

01.6
73% of students identified the correct ray diagram for refraction of light.