AQA GCSE Physics | 8463

SPECIFICATION POINT 4.6.2.2

Properties of electromagnetic waves 1

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**18**
Available paper years	**2007–2024**

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.

4.6.2.2 Properties of electromagnetic waves 1

Answer 01 · Mark scheme June 2007 | PHY1F | Original Q4 | Legacy

The full source mark scheme begins on page 34. Follow original question 4 in that document.

Answer 02 · Mark scheme June 2008 | PHY3F | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
(a)(i)	**A**, **C** and **D**	any order but all three required and no others	1
(a)(ii)	**D** and **E**	either order but both required and no others	1
(b)(i)	20000 (Hz) to 20 (Hz) **or** vice-versa	accept '19980 (Hz)'	1
(b)(ii)	frequency (of dog whistle) too high (for humans to hear) / frequency above 20000 Hz	accept 'it is ultrasound' accept 'sound from the whistle is ultrasonic'	1
(c)(i)	substance reflection	correct order essential	1 1
(c)(ii)	detector		1
total			7

4.6.2.2 Properties of electromagnetic waves 1

Answer 03 · Mark scheme

June 2008 | PHY3F | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
(a)(i)	(angle of) refraction	take care **not** to credit 'angle of reflection'	1
(a)(ii)	normal	do **not** credit 'horizontal'	1
(b)	**either** (photographic) film **or** CCD(s) (charge-coupled device(s)) / CMOS(s) (sensor(s)) / (active) pixel sensor(s)	 accept 'LDR(s)' / 'light dependent resistor(s)' **not** lux meter do **not** accept light sensor(s)	1
(c)(i)	converging	**or** 'convex'	1
(c)(ii)	 **either** (0).35 **or** (0).4(1…)	do **not** give any credit for an answer greater than 1 **or** 7 ÷ 20 for **1** mark **or** clear evidence that appropriate measuring / counting, has been made for **1** mark	2
(d)	otherwise it will have no effect on the light detector **or** otherwise no (real) light will fall on the light detector	**or** 'a virtual / imaginary image will have no effect on the light detector' allow error carried forwards for 'light detector' allow so it can be formed on the film	1
total			7

4.6.2.2 Properties of electromagnetic waves 1

Answer 03 · Mark scheme

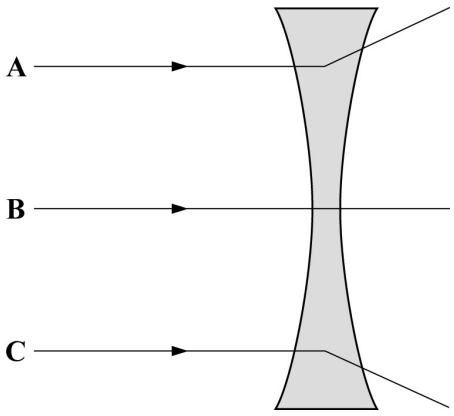
June 2008 | PHY3F | Original Q6 | Legacy

PHY3F

4.6.2.2 Properties of electromagnetic waves 1

Answer 04 · Mark scheme

Question 1

question	answers	extra information	mark
1(a)(i)	plane	accept any unambiguous indication	1
1(a)(ii)	normal		1
1(a)(iii)	incidence	accept any unambiguous indication	1
1(a)(iv)	be doubled	accept any unambiguous indication	1
1(b)(i)	diverging	accept any unambiguous indication	1
1(b)(ii)	**B** continues in a straight line (1) **A** refracted upwards and **C** refracted downwards (1)	accept any reasonable freehand attempt by eye ignore what happens in the lens **example** 	2
Total			**7**

4.6.2.2 Properties of electromagnetic waves 1

Answer 04 · Mark scheme

January 2010 | PHY3F | Original Q1 | Legacy

PHY3F

Answer 05 · Mark scheme

March 2011 | PHY1BP | Original Q8 | Legacy

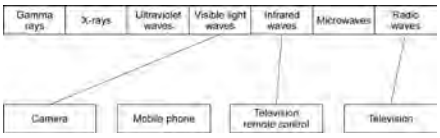
Eight	**1**	**3**	**2**	**1**

4.6.2.2 Properties of electromagnetic waves 1

Answer 06 · Mark scheme

June 2012 | PH1FP | Original Q2 | Legacy

Question 2

question	answers	extra information	mark
2(a)	3 lines drawn linking: camera to visible light television to radio waves remote control to infrared 	 if more than one line is drawn from any device all those lines are incorrect	 1 1 1
2(b)	300 000 km/s **or** 300 000 000 m/s	unit required accept the same (as light) accept the speed of light	1
2(c)	a longer wavelength than		1
2(d)(i)	refraction	 do **not** allow a misspelling that might be reflection	1
2(d)(ii)	travelling along the normal	accept light is at 90° to the surface / block light is not entering at an angle is insufficient	1
Total			**7**

4.6.2.2 Properties of electromagnetic waves 1

Answer 06 · Mark scheme

June 2012 | PH1FP | Original Q2 | Legacy

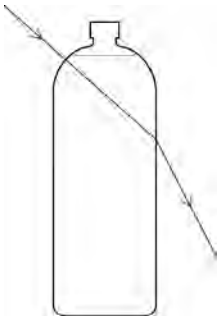
PH1FP

4.6.2.2 Properties of electromagnetic waves 1

Answer 07 · Mark scheme

January 2013 | PH1FP | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)	angle of refraction correctly identified	accept any correct indication	1
6(b)(i)	result at i = 25° identified		1
6(b)(ii)	measuring angle of refraction incorrectly	accept any practical suggestion that would lead to the angle r being incorrect eg placing the protractor in the wrong place not marking the refracted ray correctly / accurately / ray box has been moved do **not** accept measured angle i and angle r incorrectly do **not** accept plotted incorrectly	1
6(b)(iii)	greater than		1
6(c)	shown refracting out of the bottle with angle of refraction larger than angle of incidence 	allow **1** mark for refraction shown on correct side of normal with angle of refraction smaller than angle of incidence	2
6(d)(i)	People will have enough light to work inside their homes		1

Question 6 continues on the next page . . .

4.6.2.2 Properties of electromagnetic waves 1

PH1FP

Question 6 continued . . .

question	answers	extra information	mark
6(d)(ii)	accept any sensible suggestion eg does not work at night no control over light cannot switch on and off	do **not** accept roof leaks eg cannot control brightness	1
Total			**8**

4.6.2.2 Properties of electromagnetic waves 1

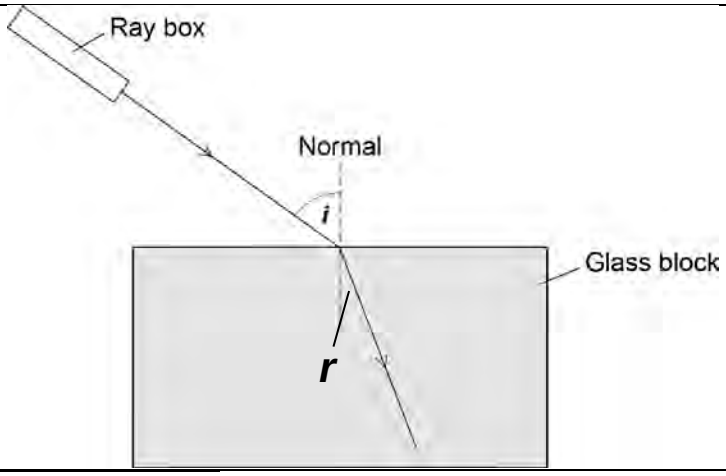
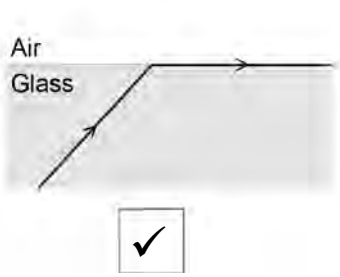
Answer 07 · Mark scheme

January 2013 | PH1FP | Original Q6 | Legacy

PH1FP

4.6.2.2 Properties of electromagnetic waves 1

Answer 08 · Mark scheme June 2015 | PH3FP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. ref.
5(a)(i)			1	AO1 P3.1.3c
5(a)(ii)	1 degree		1	AO3 P3.1.3c
5(a)(iii)	1.6	allow **1** mark for correct substitution, ie 0.80 / 0.5 provided no subsequent step shown working showing 1.59(9…..) scores zero	2	AO2 P3.1.3c
5(b)	2nd diagram ticked  ✓		1	AO1 P3.1.5a
5(c)(i)	any **one** correct description: • upright • virtual • diminished	treat multiple words as a list	1	AO1 P3.1.3d

Question 5 continued . . .

4.6.2.2 Properties of electromagnetic waves 1

Answer 08 · Mark scheme

June 2015 | PH3FP | Original Q5 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. ref.
5(c)(ii)	0.25	allow **1** mark for correct substitution, ie 1 / 4 or 5/20 provided no subsequent step shown ignore any unit	2	AO2 P3.1.3i
5(c)(iii)	Correcting short sight		1	AO1 P3.1.4b
Total			9	

4.6.2.2 Properties of electromagnetic waves 1

Answer 08 · Mark scheme

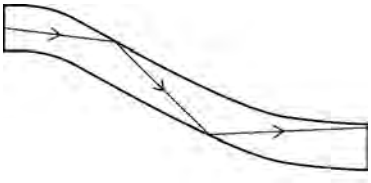
June 2015 | PH3FP | Original Q5 | Legacy



4.6.2.2 Properties of electromagnetic waves 1

Answer 09 · Mark scheme

June 2016 | PH3FP | Original Q7 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7(a)	to see inside the body or internal imaging	accept looking at an internal organ, e.g. stomach, appendix allow keyhole surgery	1	AO1 3.1.5b
7(b)	top diagram ticked 		1	AO1 3.1.5a
7(c)	1.5(2)	An answer that rounds to 1.5 gains **3** marks allow **2** marks for $\frac{0.978}{0.643}$ allow **1** mark for correct substitution $n = \frac{\sin(78)}{\sin(40)}$	3	AO2 3.1.3c
Total			5	

4.6.2.2 Properties of electromagnetic waves 1

Answer 09 · Mark scheme

June 2016 | PH3FP | Original Q7 | Legacy

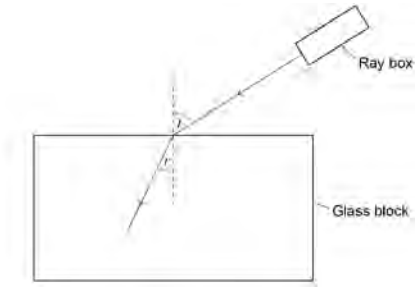
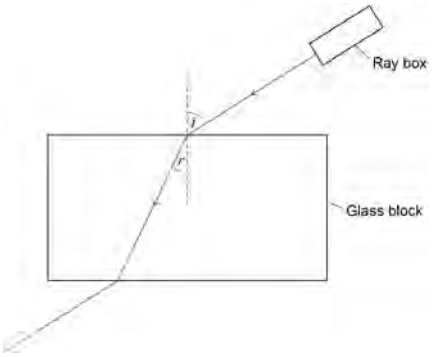


4.6.2.2 Properties of electromagnetic waves 1

Answer 10 · Mark scheme

June 2019 | 8463/2F | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5.1	correct angle labelled	answer must indicate the angle, the letter **r** on it's own is insufficient 	1	AO1/1 4.6.2.2
5.2	58 (degrees)	allow 57 to 59 inclusive	1	AO2/2 4.6.2.2
5.3	ray continues in a straight line to the edge of the block ray refracts away from the normal both rays in the air should be parallel	 judge by eye	1 1 1	AO1/1 4.6.2.2
5.4	random	allow a correct answer indicated in the box provided the answer space is blank	1	AO3/2a 4.6.1.3 WS3.7
5.5	25		1	AO2/2 4.6.1.3
5.6	less than	allow a correct answer indicated in the box provided the answer space is blank	1	AO3/2b 4.6.1.3 WS3.5
5.7	there is no data/results outside of that range	allow that is all the student measured	1	AO3/1b 4.6.1.3 WS2.7

4.6.2.2 Properties of electromagnetic waves 1

Answer 10 · Mark scheme

June 2019 | 8463/2F | Original Q5

5.8	light would not pass through an opaque block **or** light will pass through a transparent block	an answer which does not refer to either transparent or opaque should be taken as referring to transparent	1	AO1/1 4.6.2.6
5.9	The angles of incidence tested		1	AO3/3b 4.6.1.3 WS2.7
Total			**11**	

4.6.2.2 Properties of electromagnetic waves 1

Answer 11 · Mark scheme

June 2019 | 8463/2F | Original Q8

Question 8

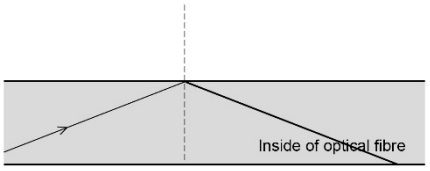
Question	Answers	Extra information	Mark	AO / Spec. Ref.
8.1	focal length	this answer only	1	AO1/1 4.6.2.5
8.2	one correct line drawn from the top of the object, passing through the lens and crossing or meeting given line inverted image drawn at the correct position and length	ignore any arrow drawn on the line if two lines are drawn, both must be correct arrowhead required	1 1	AO2/2 4.6.2.5
8.3	similarity (both are) diminished difference concave is <u>virtual</u> and convex is <u>real</u> **or** concave is upright and convex is inverted	 allow smaller for diminished a comparison must be made ignore reference to positions of images	1 1	AO3/2a 4.6.2.5
8.4	$6.0 = \frac{9.0}{\text{object height}}$ $\text{object height} = \frac{9.0}{6.0}$ object height = 1.5 (mm)	an answer of 1.5 (mm) scores **3** marks provided working can be seen, an attempt to convert 9.0 mm to cm or m with all other steps correct scores **2** marks	 1 1 1	AO2/1 4.6.2.5
Total			**8**	

4.6.2.2 Properties of electromagnetic waves 1

Answer 12 · Mark scheme

November 2020 | 8463/2F | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	Microwaves Radio waves		1 1	AO1 4.6.2.4
04.2	normal		1	AO1 4.6.1.3
04.3	reflected ray drawn to the right of the normal correct ray of light drawn using a ruler with i = r	ignore arrows  	1 1	AO2 4.6.1.3
04.4	they need to be flexible	ignore bendy / ductile / malleable / elastic	1	AO3 4.6.2.4
04.5	transmitted absorbed absorbed		1 1 1	AO1 4.6.2.6
Total			**9**	

4.6.2.2 Properties of electromagnetic waves 1

Answer 13 · Mark scheme

June 2022 | 8463/2F | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	ultraviolet travels at the same speed as visible light		1	AO1 4.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	D C	this order only	1 1	AO1 4.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	A 400 – 315 = 85 (nm) B 315 – 280 = 35 (nm) C 280 – 100 = 180 (nm) (ultraviolet) C (UVC)	three calculations correct 2 marks one or two calculations correct 1 mark mark dependent on all three calculations being made	2 1	AO2 4.6.2.1

4.6.2.2 Properties of electromagnetic waves 1

Answer 13 · Mark scheme

June 2022 | 8463/2F | Original Q5

Question	Answers	Mark	AO / Spec. Ref.
05.4	**Level 2:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	3–4	AO3 4.6.2.3
	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: • ozone absorbs all of the UVC • UVC is the most dangerous • ozone absorbs nearly all (95%) of the UVB • UVB has a medium risk • ozone does not absorb any UVA • ozone does not reduce risk from UVA • UVA is the least dangerous • the greater the ionising power the greater the absorption by ozone • the greater the ionising power the greater the risk • UV damages skin cells • can lead to skin cancer • can cause sunburn • UV can damage eyes • leads to problems with eyesight		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	our eyes detect visible light	allow it would be dark all the time allow specific effect ie plants couldn't grow	1	AO1 4.6.2.1

4.6.2.2 Properties of electromagnetic waves 1

Answer 13 · Mark scheme

June 2022 | 8463/2F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	transmitted absorbed	this order only	1 1	AO1 4.6.2.6

Total Question 5		**13**

4.6.2.2 Properties of electromagnetic waves 1

Answer 14 · Mark scheme

June 2022 | 8463/2F | Original Q9

Question 9

Question	Answers	Mark	AO / Spec. Ref.
09.1	**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		

4.6.2.2 Properties of electromagnetic waves 1

Answer 14 · Mark scheme

June 2022 | 8463/2F | Original Q9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.2	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.
09.3	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	

4.6.2.2 Properties of electromagnetic waves 1

Answer 14 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.4	(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 the 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 9		**16**

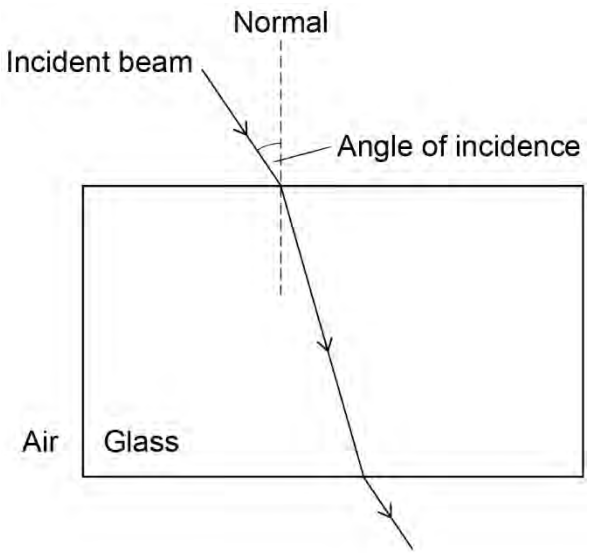
4.6.2.2 Properties of electromagnetic waves 1

Answer 15 · Mark scheme

June 2023 | 8463/2F | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	it is harder to judge where the centre of the beam is		1	AO3 4.6.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	ray shown refracted to the right of the normal as it enters the glass block refraction towards the normal emergent ray parallel to incident ray  	do **not** accept a continuation of the incident ray through the glass block ignore arrows	1 1 1	AO1 4.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	1 degree		1	AO2 4.6.1.3

4.6.2.2 Properties of electromagnetic waves 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	33 (°)		1	AO2 4.6.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	absorbed		1	AO1 4.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	wave speed = frequency × wavelength **or** $v = f\lambda$	allow correct re-arrangement	1	AO1 4.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.7	$3.0 \times 10^8 = 4.0 \times 10^{14} \times \lambda$ $\lambda = \frac{3.0 \times 10^8}{4.0 \times 10^{14}}$ $\lambda = 7.5 \times 10^{-7}$ (m)	 allow 0.000 000 75 (m)	1 1 1	AO2 4.6.1.2

Total Question 6	11

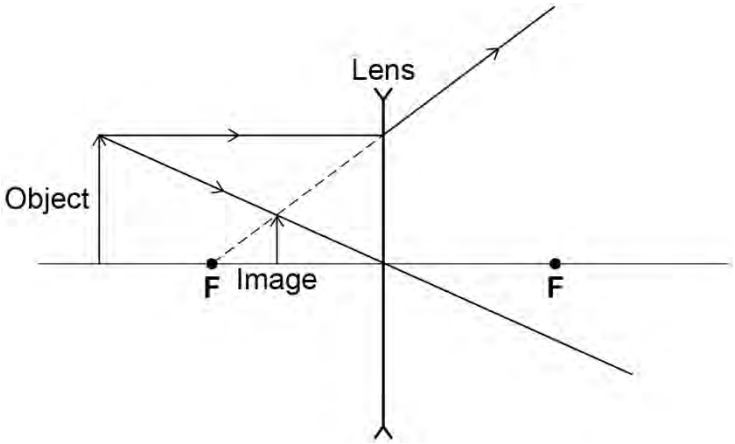
4.6.2.2 Properties of electromagnetic waves 1

Answer 16 · Mark scheme

June 2023 | 8463/2F | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	principal focus		1	AO1 4.6.2.5

Question	Answers	Mark	AO / Spec. Ref.
08.2	ray through the centre of the lens image in correct position and with correct orientation  	1 1	AO2 4.6.2.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	upright virtual	allow right way up ignore not real ignore it is on the same side of the lens	1 1	AO3 4.6.2.5

4.6.2.2 Properties of electromagnetic waves 1

Answer 16 · Mark scheme

June 2023 | 8463/2F | Original Q8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	$3.5 = \frac{\text{image height}}{1.6}$ image height = 3.5 × 1.6 image height = 5.6 (mm)		1 1 1	AO2 4.6.2.5

Total Question 8	**8**

4.6.2.2 Properties of electromagnetic waves 1

Answer 17 · Mark scheme

June 2024 | 8463/2F | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	infrared camera	allow thermometer, thermal imaging camera, night vision goggles	1	AO3 4.6.2.4 4.6.3.2 RPA10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	690 nm		1	AO3 4.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	bees cannot detect all the colours (a human can) bees can detect UV radiation (but humans can't)	allow bees cannot detect red (light but humans can)	1 1	AO3 4.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	reflected absorbed	this order only	1 1	AO1 4.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	black		1	AO1 4.6.2.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	diffuse		1	AO1 4.6.2.6

Total Question 6	**8**

4.6.2.2 Properties of electromagnetic waves 1

Answer 18 · Mark scheme

June 2024 | 8463/2F | Original Q8

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	1 (°)		1	AO3 4.6.1.3 RPA9

Question	Answers	Mark	AO / Spec. Ref.
08.2	**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		

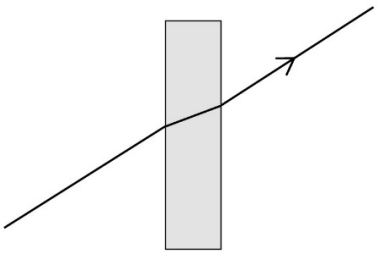
4.6.2.2 Properties of electromagnetic waves 1

Answer 18 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	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.
08.4	the line curves	allow the line is not straight allow line does not pass through the origin if consistent with their answer to question **08.3**	1	AO3 4.6.1.3 RPA9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	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.
08.6			1	AO1 4.6.2.2

Total Question 8	**13**

Version 1.0: 0707

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Science B 4462 / Physics 4451

PHY1F Unit Physics 1

Mark Scheme

2007 examination - June series

4.6.2.2 Properties of electromagnetic waves 1

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' 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 to download from the AQA Website: www.aqa.org.uk

Copyright © 2007 AQA and its licensors. All rights reserved.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales (company number 3644723) and a registered charity (registered charity number 1073334). Registered address: AQA, Devas Street, Manchester M15 6EX.
Dr Michael Cresswell, Director General.

4.6.2.2 Properties of electromagnetic waves 1

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 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 lines 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.)

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which candidates 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 error/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.

4.6.2.2 Properties of electromagnetic waves 1

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

Candidate	Response	Marks awarded
1	4,8	0
2	green, 5	0
3	red*, 5	1
4	red*, 8	0

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

Candidate	Response	Marks awarded
1	Pluto, Mars, Moon	1
2	Pluto, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a candidate 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, as shown in the column 'answers', 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;

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 are 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 Unexpected Correct Answers not in the Mark Scheme

The Examiner should use professional judgement to award credit where a candidate has given an unexpected correct answer which is not covered by the mark scheme. The Examiner should consult with the Team Leader to confirm the judgement. The Team Leader should pass this answer on to the Principal Examiner with a view to informing all examiners.

4.6.2.2 Properties of electromagnetic waves 1

PHY1F Question 1

	answers	extra information	mark
(a)(i)	grid	accept any way of indicating correct answer	1
(ii)	increases voltage	accept any way of indicating correct answer	1
(iii)	230 V	accept any way of indicating correct answer	1
(iv)	reduce	accept any way of indicating correct answer	1
(b)(i)	increases the temperature	accept make it hotter / heat goes into the air accept convection currents accept sensible comment eg sound energy / it buzzes ignore pollutes the air	1
(ii)	less than 100%		1
total			6

4.6.2.2 Properties of electromagnetic waves 1

PHY1F Question 2

	answers	extra information	mark
(a)	coal		1
(b)	fossil fuels can be used to generate electricity at any time a few large power stations can generate the electricity for a million homes	if more than 2 boxes ticked, mark incorrect boxes first	1 1
(c)(i)	no fuel is burnt	accept a named fuel accept nothing is burnt accept does not use (fossil) fuel	1
(ii)	kinetic		1
(iii)	any **two** from: • cause <u>noise</u> pollution • cause <u>visual</u> pollution • need concrete for bases • new roads / infrastructure needed • may interfere with TV / radio / mobile phone signals • dangerous to birds • do not generate all of the time • need a lot of generators • high <u>initial</u> / <u>capital</u> costs • reduces house prices	accept causes pollution for **1** mark accept generates <u>only</u> when the wind blows do **not** accept 'generate when the wind blows' do **not** accept 'take up a lot of space / land'	2
total			7

4.6.2.2 Properties of electromagnetic waves 1

PHY1F Question 3

	answers	extra information	mark
(a)(i)	7pm	accept 19.00 / 1900	1
(ii)	8pm	accept 20.00 / 2000	1
	temperature drops more slowly	accept heat for temperature accept line is less steep	1
(b)	insulator		1
	conduction*	*answers can be either way around	1
	convection*		1
(c)(i)	4 (years)		1
(ii)	it is the cheapest / cheaper / cheap	do **not** accept answers in terms of heat rising or DIY	1
	has the shortest / shorter payback time	do **not** accept short payback time	1
total			9

4.6.2.2 Properties of electromagnetic waves 1

PHY1F Question 4

	answers	extra information	mark
(a)(i)	any **one** from: • gamma • X-rays • infra red • microwaves • radio	 accept correct symbol accept IR do **not** accept heat do **not** accept TV	1
(ii)	all the waves travel at the same speed		1
(b)(i)	(skin) cancer / melanoma	accept damage eyesight accept sunburn do **not** accept sun tan do **not** accept sunstroke	1
(ii)	higher levels of UV greater risk to health / risk of skin cancer / (more) protection needed / most likely to get burnt / damage skin	accept UV at its strongest / sun's rays are strongest ignore 'sun is at its hottest' ignore 'sun is at its highest' accept greater damage to / easier to damage cells / mutate cells ignore just 'affect your health' must be idea of greater adverse effect on health	1 1
total			5

4.6.2.2 Properties of electromagnetic waves 1

PHY1F Question 5

	answers	extra information	mark
(a)	C		1
(b)(i)	easy to maintain / access **or** (currently) cheaper than a space telescope **or** can modify (easily) an existing telescope **or** telescopes can be larger **or** can test new types of telescope (easily)	do **not** accept 'easier to use' do **not** accept easier to supply with power	1
(ii)	atmosphere does not block / distort the image	accept picture / data for image accept 'more detailed / clearer image / data / picture accept 'no light pollution' accept 'can look at the Earth' do **not** accept 'can see further' do **not** accept 'better view' do **not** accept 'clear view' do **not** accept 'can see more clearly'	1
total			3

4.6.2.2 Properties of electromagnetic waves 1

PHY1F Question 6

	answers	extra information	mark
(a)(i)	electromagnetic (wave / radiation)	accept em (wave / radiation) ignore reference to frequency	1
(ii)	gamma can penetrate the crate / box / packaging	accept converse (but must relate to both alpha and beta) ignore just gamma radiation kills bacteria accept can get through to food	1
(iii)	neutrons		1
(b)(i)	absorb gamma / radiation	accept it stops / reduces the radiation	1
(ii)	any **one** from: • slow down the conveyor belt • food does more than one circuit • stay on the conveyor belt longer • food closer to the source / radiation	ignore larger doses / use more of the source ignore thinner packaging	1

Continued on next page

4.6.2.2 Properties of electromagnetic waves 1

Question 6 continued

	answers	extra information	mark
(c)(i)	idea of testing food on humans / animals		1
	no (measured) ill effects **or** monitor their health	accept monitor people that have eaten the food accept a measurement / comparison for **1** mark eg measure the amount of radiation in treated food comparison plus a reason for the comparison would get **2** marks eg idea of measuring level of radiation in treated food **with** no measurable increase in level = **2** marks **or** comparing it to untreated food = **2** marks	1
(ii)	so can make own decision about eating or not eating treated food	accept may be against their religious / moral views accept some people prefer food that hasn't been tampered with ignore in case they don't like the idea of eating treated food accept don't want to eat treated food ignore might be allergic to the food eg think it will give them cancer = **0** marks think it will give you cancer so I need to know so that I can choose = **1** mark	1
total			8

4.6.2.2 Properties of electromagnetic waves 1

PHY1F Question 7

	answers	extra information	mark
(a)	the outside colour of the cans		1
(b)(i)	18 (°C) **or** 88 to 70	ignore negative sign	1
(ii)	8 (°C) **or** 70 to 62	ignore negative sign	1
(c)	greater temperature difference between water and surroundings (at start)	must mention temperature difference ignore just water hotter accept energy used to heat cans initially	1
(d)	black		1
	temperature falls the fastest (in L)	accept (can L) loses more heat / cools quicker accept heat for temperature	1
	black is a good / the best / better emitter (of heat / radiation)	accept converse ignore black is best absorber	1
total			7

4.6.2.2 Properties of electromagnetic waves 1

Answer 10 · Examiner comments

June 2019 | 8463/2F | Original Q5

Question 5 (Low demand)

05.1 Nearly 7% of the students did not attempt this question. Whilst angles were often incorrectly labelled ‘r’ a significant number of students labelled the refracted ray ‘r’ rather than the angle of refraction.

05.2 Over half of the students were unable to use a protractor to measure the angle of incidence.

05.3 Just over 8% of students did not attempt this question. About 67% of the students scored at least one mark for continuing the ray through the block with about 30% drawing the refracted ray in the correct direction.

05.4 About 57% of the students made the correct choice.

05.5 About 87% of the students were able to correctly calculate the value of **X**.

05.6 About three quarters of the students gave the correct answer.

05.7 58% of the students scored zero. A further 10% did not attempt the question. Correct answers were usually well expressed.

05.8 Answers were often too vague to gain credit. The easiest way to score the mark was to state that light would not go through an opaque block.

05.9 Just over 50% of the students scored this mark.

4.6.2.2 Properties of electromagnetic waves 1

Answer 11 · Examiner comments

June 2019 | 8463/2F | Original Q8

Question 8 (Standard demand)

08.1 About 10% of the students did not attempt this question with a further 84% giving an incorrect answer.

08.2 Nearly 13% of the students did not attempt this question. Few of the students drew a second ray to produce the image position. Rays started from all positions in front or behind the lens, not passing through the focus or incorrectly refracting at the lens. Even when a correct ray was drawn the image was often not drawn in, or if drawn had the wrong size or orientation.

08.3 Most of students scored zero or did not attempt this question. Answers for similarity included ‘both produce an image’ and ‘the images are the same size’. Answers for difference often did not include a comparison and gave only one part of the required answer.

08.4 About 57% of the students picked the correct equation and completed the calculation to score all 3 marks. However, a significant number of students that identified the equation then substituted incorrectly or simply multiplied 9 and 6 to give an answer of 54.

4.6.2.2 Properties of electromagnetic waves 1

Answer 13 · Examiner comments June 2022 | 8463/2F | Original Q5

Question 5 (Low and standard demand)

05.1 Very few of the students seemed to know that all electromagnetic waves travel at the same speed in a vacuum.

05.2 The order of the waves in the electromagnetic spectrum was not well known with only about 40% of the students scoring both marks.

05.3 The majority of the students demonstrated an understanding of ‘range’. About 10% of students did not attempt the question.

05.4 Very few of the students related the information in Table 4 and Figure 10 to the relative risk of harm to people. Few of the students scored more than 1 mark with about 13% of the students not attempting the question. Most of the students that scored 1 mark did so for giving a general trend or stating that UV can cause skin cancer.

05.5 Many of the students tried to give a more complex answer than required, which were commonly incorrect. The most common correct answers involved being able to see or the idea that if light did not get through it would be dark all the time.

05.6 Nearly three quarters of the students scored at least one mark, often for completing the second blank space correctly.

4.6.2.2 Properties of electromagnetic waves 1

Answer 14 · Examiner comments

June 2022 | 8463/2F | Original Q9

Question 9 (Standard demand)

09.1 Many of the students did not appear to know which experiment to describe. A significant number described a reflection experiment using a mirror whilst others described how the data would be displayed rather than how it would be obtained. Approximately 30% of the students did not attempt the question.

09.2 Many students failed to label the axes and / or draw a line of best fit. Students should also be aware that lines of best fit are not always straight.

09.3 Many of the students did not appear to have a protractor or chose not to use one. A less common error was to show the incident ray being refracted by the mirror. The normal line was often not drawn.

09.4 Most of the students that scored 1 mark did so for realising that Method A would give more accurate results. However, few of the students were able to link ideas to give clear explanations. The more common correct responses were in terms of the protractor not having to be moved and the laser producing a thinner ray of light. The idea of the mirror not having to be moved or repositioned was rarely seen.

4.6.2.2 Properties of electromagnetic waves 1

Answer 14 · Examiner comments

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

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

4.6.2.2 Properties of electromagnetic waves 1

Answer 15 · Examiner comments June 2023 | 8463/2F | Original Q6

06.1

50% of students knew that a wide beam of light makes it more difficult to judge where the centre of the beam is.

06.2

Many students found completing the path taken by the ray through the block very difficult very difficult, with many scoring no marks. Some treated the normal line as mirror and drew a reflected ray either inside the block or against the edge of it.

06.3

21% of students were able to identify the resolution of the protractor.

06.4

The vast majority of students were able to calculate the mean.

06.5

Only 25% of students gave the correct word ‘absorbed’. Common incorrect answers included blocked, emitted, filtered, reflected and refracted.

06.6

The vast majority of students gave the correct equation. For those few that didn’t score, it was most frequently because they did not attempt the question, in spite of having the formula sheet.

06.7

A significant number of students scored 2 marks because they could not calculate the powers of ten correctly, giving an answer of 7.5×10^{21}. A number of students scored no marks because they showed an incorrect rearrangement but omitted to show the substitution step first.

Answer 16 · Examiner comments June 2023 | 8463/2F | Original Q8

08.1

Only 12% of students could name the principal focus. The most common wrong answer was focus point.

08.2

The vast majority of students did not attempt to complete the ray diagram or scored zero. Many student drew multiple rays from various parts of the diagram in all directions. Even fewer identified where to draw the correct image. X % of students scored 2 marks, while X % of students scored 1 mark.

08.3

Most students gave similarities of the ray diagrams rather than the images.

08.76% of students obtained all 3 marks. Of those who didn’t, some started with an incorrectly rearranged equation and thus scored zero. The most common error was dividing the magnification by the object height, instead of multiplying, to get the image height.

4.6.2.2 Properties of electromagnetic waves 1

Answer 17 · Examiner comments June 2024 | 8463/2F | Original Q6

06.1
Many responses for this question were too vague. The questions asked for equipment that can be used to detect infrared waves, so responses that involved emitters of IR waves were incorrect. A significant number focussed on the word radiation and gave their response as a Geiger counter.

06.2
23% of students interpreted the information correctly and chose the correct wavelength.

© 2024 AQA and its licensors. All rights reserved.

Answer 17 · Examiner comments June 2024 | 8463/2F | Original Q6

06.3
A correct response required the use of the information given to identify differences between the sight of bees and humans. Simply quoting wavelengths that could and could not be detected was not sufficient. A minority of students gained marks.

06.4
This question was about white light shining onto a coloured flower. A significant number of students chose the correct words but not always in the incorrect order.

06.5
60% of students were aware of the affect a filter has on the appearance of a coloured object.

06.6
Less than 2% of students were able to name diffuse reflection.

4.6.2.2 Properties of electromagnetic waves 1

Answer 18 · Examiner comments June 2024 | 8463/2F | Original Q8

08.2
Only 41% of students gained any marks for this description of a practical investigation about the refraction of light. There was confusion, or lack of detail, when describing the angles to measure. Many forgot to include a normal line. A small number of students had not read the question carefully and described reflection by a mirror.

08.3
47% of students plotted points on the graph correctly, and drew a curve, to show the relationship between the angles of incidence and refraction. 40% of students drew a straight line of best fit. This is connected to the misconception that a line of best fit is always straight.

08.4
Many students stated that the line was curved even though they drew a straight line in **08.3** or said that the points don't go through the line of best fit. This was incorrect, but was because they had drawn an incorrect line of best fit.

08.5
Many students tried to draw the path of the reflected ray of light by eye rather than using a protractor to measure the required angles. Very few drew the normal line, as directed in the question, those that did tended to do it correctly. 9% of students scored both marks and 23% gained 1 mark.

08.6
50% of students were able to identify the correct pathway for a ray of light being refracted through a denser medium.