AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.6.2.2

Properties of electromagnetic waves 1

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**2**
Available paper years	**2019–2025**

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.

6.6.2.2 Properties of electromagnetic waves 1

Answer 01 · Mark scheme June 2019 | 8464/P/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
7.1	speed / velocity in the glass is lower	speed / velocity changes is insufficient allow the refractive index of glass is higher than that of air allow glass has a higher optical density than air	1	AO1 6.6.2.2	E
	so the edge of the wave(front) entering the glass slows down		1		
	but the part of the wave(front) in the air continues at the higher speed / velocity (causing a change in direction)		1		
7.2	correct ray in the prism bent towards the normal		1	AO1 6.2.2.2	E
	second normal at 90° at the point the ray emerges		1		
	correct emergent ray bent away from the normal	this mark can be awarded without a normal line drawn	1		
7.3	violet has the shortest wavelength (400 nm)		1	AO3 6.2.2.2	E
	violet light travels the slowest in water		1		
	violet light undergoes the greatest change in speed (and direction)		1		
Total			**9**		

6.6.2.2 Properties of electromagnetic waves 1

Answer 02 · Mark scheme

June 2025 | 8464/P/2H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	oscillations / vibrations are perpendicular to the direction of energy transfer	allow oscillations / vibrations are perpendicular to the direction of wave travel allow **1** mark for oscillations/ vibrations are perpendicular	2	AO1 6.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	skin cancer **or** causes skin to age (prematurely)	allow skin cell mutation ignore cancer unqualified	1	AO1 6.6.2.3

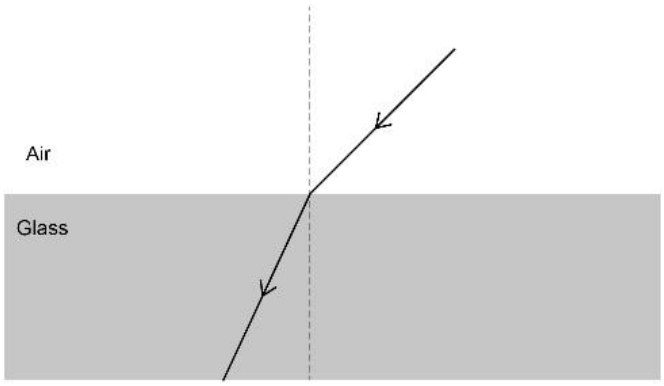
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	shorter		1	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	$3.00 \times 10^{8} = 6.25 \times 10^{14} \times \lambda$ $\lambda = \frac{3.00 \times 10^{8}}{6.25 \times 10^{14}}$ $\lambda = 4.80 \times 10^{-7}$ (m) $\lambda = 480$ (nm)	 allow a correct conversion to nm of their incorrectly calculated value of λ using the numbers from the question	1 1 1 1	AO2 6.6.1.2

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Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	the speed of the light / waves / wavefronts decreases (when entering the lens) (so) one end of the wavefront slows before the other end	allow the speed of light / waves / wavefronts is less in the lens (than in air) ignore lens has a higher density than air ignore references to refractive index	1 1	AO1 6.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	normal line drawn ray drawn with an angle of refraction of 28°  ignore ray below the glass	allow a normal line that only extends from the boundary into the glass	1 1	AO2 6.6.2.2

Total Question 3	12

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Answer 02 · Examiner comments June 2025 | 8464/P/2H | Original Q3

Question 3 (Standard, standard/high and high demand)

03.1 About a quarter of students were able to give a complete and correct definition of a transverse wave, with just under a fifth giving a definition that gained partial credit.

03.2 Nearly two thirds were able to give another risk caused by exposure to ultraviolet.

03.3 Just over 60% identified that ultraviolet has a shorter wavelength than visible light.

03.4 Giving an answer in nm proved to be very challenging, with just under 10% managing to work out the correct final answer.

A surprisingly large proportion of students struggled to calculate the correct power of ten to their answer, with working such as $\frac{3\times10^{8}\ \text{m/s}}{6.25\times10^{14}\ \text{Hz}} = 4.8\times10^{21}\ \text{m}$ being relatively common. Students who did this could then go on to convert their calculated value into nm and gain the final mark, but it was very common for students to multiply their answer by 10^{-9} instead of dividing by 10^{-9}, so the final mark was not often gained. Many students who attempted the conversion to nm thought that nano referred to 10^{-3} or 10^{-6}.

0 3 . 4 A wave of visible light has a frequency of 6.25×10^{14} Hz.

speed of light = 3.00×10^{8} m/s

Calculate the wavelength of this light.

Use the Physics Equations Sheet.

Give your answer in nanometres (nm).

[4 marks]

wave speed = frequency x wavelength.

wave speed / frequency = wavelength.

$3.00\times10^{8} / 6.25\times10^{14} = 4.8\times10^{21}$ m

$4.8\times10^{21} / 1000 = 4.8\times10^{18}$ nm

Wavelength = 4.8×10^{18} nm

This student correctly substituted into and rearranged the equation but made errors when calculating the wavelength in metres. This answer also illustrates the difficulties many students had in converting a value from metres to nanometres.

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Answer 02 · Examiner comments

03.5 Students struggled to explain why refraction occurs using the idea of wavefronts. It was very common for students to refer to the density of the glass, and sometimes to optical density. All of these references were ignored. Some students recalled that the wave speed changes but did not make it clear whether they thought the waves were increasing or decreasing in speed, so did not score any marks. Only about a fifth of students gained any credit in this question.

03.6 About four in ten students gained at least one mark, with approximately 20% giving a fully correct answer. The refracted rays drawn were in many different directions, but those who were able to draw the ray in the correct direction usually did so with accuracy and gained the second mark, and those that did not score the second mark tended to draw their refracted rays in completely the wrong direction. Some students gained the mark for drawing the refracted ray without having drawn a normal.

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