AQA GCSE Physics | 8463

SPECIFICATION POINT 4.6.2.2

Properties of electromagnetic waves 1

Past-paper questions

Tier	**Higher**
Question groups	**19**
Available paper years	**2007–2024**

Using this booklet

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

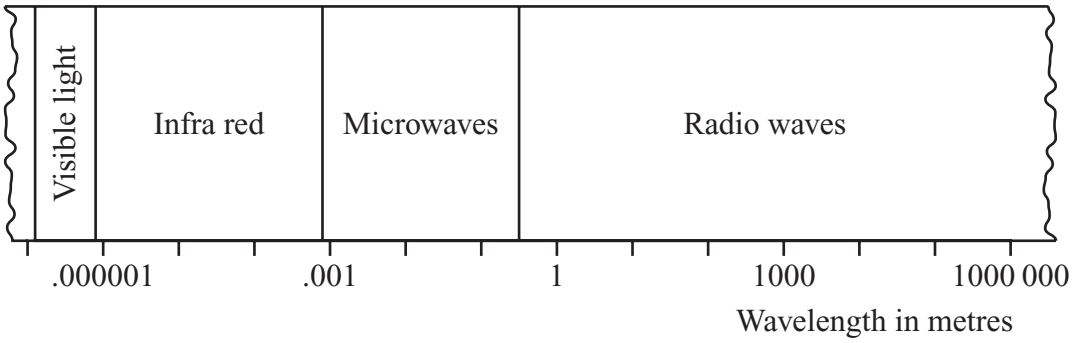
Name: _____ **Date:** _____

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

4.6.2.2 Properties of electromagnetic waves 1

Question 01

5 (a) The diagram represents part of the electromagnetic spectrum.



(i) Visible light travels through air at 300 000 000 m/s.

Why can we assume that radio waves travel through air at the same speed as light?

.....

(1 mark)

(ii) A radio station broadcasts at a frequency of 200 kHz.

Use the following equation to calculate the wavelength of the waves broadcast by this radio station. Show clearly how you work out your answer.

wave speed = frequency × wavelength

.....

.....

Wavelength = ... m

(2 marks)

(iii) Draw a vertical line on the diagram above to show the position of this radio wave in the electromagnetic spectrum.

(1 mark)

(b) Many radio stations now broadcast digital signals instead of *analogue* signals.

(i) What is an *analogue* signal?

.....

(1 mark)

4.6.2.2 Properties of electromagnetic waves 1

Question 01 · continued

BLANK

(ii) Give **one** reason why a radio station would broadcast digital signals instead of analogue signals.

.....

.....

(1 mark)

(c) A student thinks that because energy cannot be destroyed it is not possible to waste energy. So he leaves his radio, TV and computer on all the time, even when there is no one in the house.

Explain why he is wrong about not being able to waste energy.

.....

.....

.....

.....

(2 marks)

8

4.6.2.2 Properties of electromagnetic waves 1

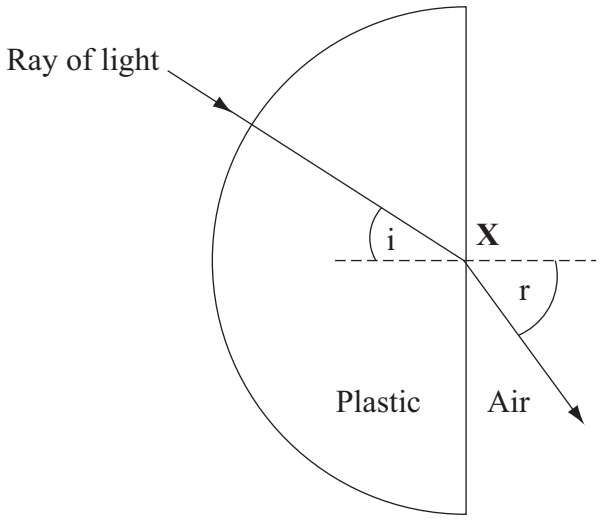
Question 02

June 2008 | PHY3H | Original Q1 | Legacy

1 (a) A student investigated the refraction of light as it passes out of a transparent plastic block.

She aimed a ray of light at point **X**. She marked the position of the ray as it passed through the transparent plastic block and into the air.

The angle ***i*** is the angle of incidence.



1 (a) (i) What is the name of angle **r**?

.....

(1 mark)

1 (a) (ii) What is the name of the dashed line?

.....

(1 mark)

4.6.2.2 Properties of electromagnetic waves 1

Question 02 · continued

for mark

1 (b) A camera uses a lens to produce an image which falls on a light detector.



Name a light detecting device which may be used in a camera.

.....

(1 mark)

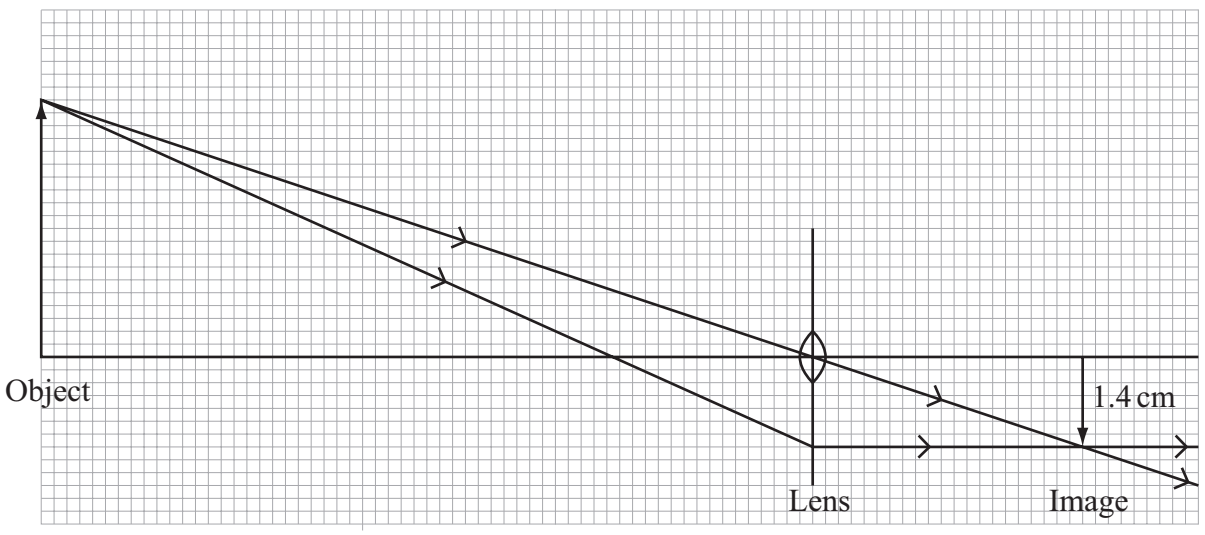
Question 1 continues on the next page

4.6.2.2 Properties of electromagnetic waves 1

Question 02 · continued

for mark

1 (c) The diagram shows the position of an image formed in a camera.



1 (c) (i) What type of lens is shown in the diagram?

.....

(1 mark)

1 (c) (ii) Use the equation in the box to calculate the magnification.

$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

Show clearly how you work out your answer.

.....

.....

Magnification = ... *(2 marks)*

1 (d) Why does the image formed in a camera have to be a real image?

.....

.....

(1 mark)

7

4.6.2.2 Properties of electromagnetic waves 1

Question 03

November 2008 | PHY1BP | Original Q5 | Legacy

QUESTION FIVE

This question is about the electromagnetic spectrum and its use in communications.

5A Which one of the following types of electromagnetic wave would **not** be suitable for communications?

1 infra red

2 microwave

3 gamma

4 visible light

5B Which types of electromagnetic waves can be used to send signals along optical fibres?

1 infra red and ultraviolet

2 infra red and visible light

3 infra red, ultraviolet and visible light

4 ultraviolet and visible light

5C By 2012, all TV signals in the UK will be digital.

This will be an improvement over analogue signals because . . .

1 digital signals are less prone to interference.

2 digital signals pick up interference and amplify it.

3 in an analogue signal, interference is treated as part of the original signal.

4 when analogue signals are amplified, interference is amplified.

4.6.2.2 Properties of electromagnetic waves 1

Question 03 · continued

5D Electromagnetic waves travel at a speed of 300 000 km/s.

wave speed (metre/second, m/s)	=	frequency (hertz, Hz)	×	wavelength (metre, m)

A radio station transmits signals at a wavelength of 1.5 km.

The frequency of the waves is . . .

1 200 Hz

2 200 kHz

3 450 000 Hz

4 450 000 kHz

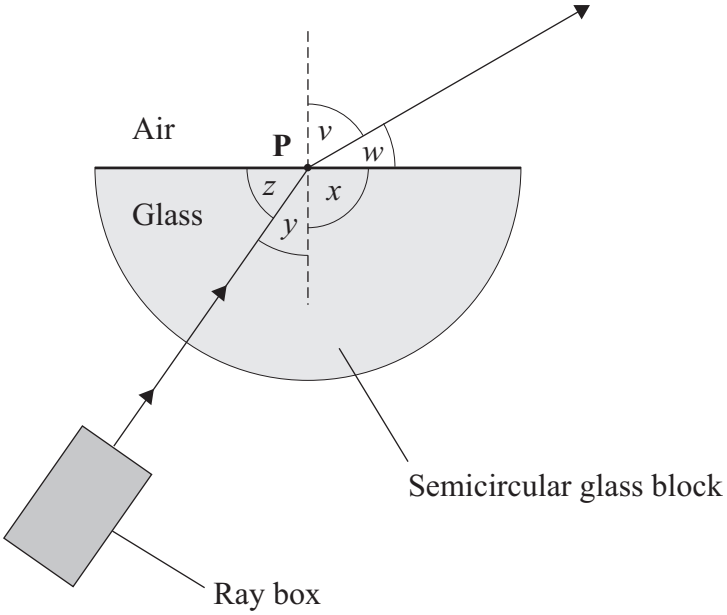
Turn over for the next question

4.6.2.2 Properties of electromagnetic waves 1

Question 04

June 2009 | PHY3H | Original Q3 | Legacy

3 A student uses a ray box and a semicircular glass block to investigate refraction.



3 (a) What is the vertical dashed line called?

.....

(1 mark)

3 (b) Which angle, *v*, *w*, *x*, *y* or *z*, is the angle of refraction?

.....

(1 mark)

3 (c) Why has refraction taken place?

.....

.....

(1 mark)

4.6.2.2 Properties of electromagnetic waves 1

Question 04 · continued

for mark

3 (d) In an investigation, a student always aims the light from the ray box at point **P**.
She moves the ray box to give different values of angle *v*.
She records angle *y* for each of these values. The table shows her results.

Angle *v* measured in degrees	Angle *y* measured in degrees
30	19
40	25
50	31
60	35
70	39
80	41

The student studies the data and comes to the following conclusion.

> Angle *y* is directly proportional to angle *v*.

Her friend says that this conclusion is **not** correct.

3 (d) (i) Use data from the table to explain why the conclusion is **not** correct.

.....

.....

(2 marks)

3 (d) (ii) Write a correct conclusion for the experiment.

.....

.....

(1 mark)

3 (d) (iii) Why is your conclusion only valid when angle *v* is between 30° and 80°?

.....

.....

(1 mark)

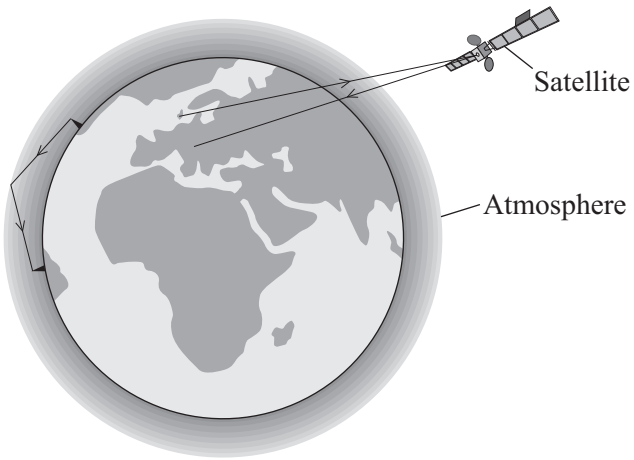
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4.6.2.2 Properties of electromagnetic waves 1

Question 05

January 2010 | PHY1H | Original Q3 | Legacy

3 (a) Electromagnetic waves have many uses. The diagram shows two ways of sending information using electromagnetic waves.



3 (a) (i) What type of wave is used to send information to and from satellites?

.....

(1 mark)

3 (a) (ii) What property of this type of wave makes it suitable for satellite communications?

.....

(1 mark)

3 (b) The diagram shows two types of signal that can be used to send information. One of the signals is an analogue signal. The other is a digital signal.



Describe the differences between an analogue signal and a digital signal.

.....

.....

.....

.....

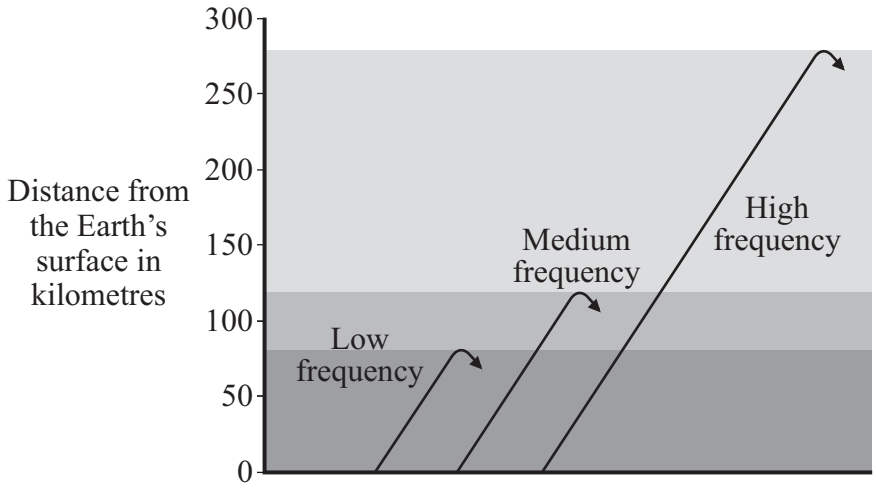
(2 marks)

4.6.2.2 Properties of electromagnetic waves 1

Question 05 · continued

for mark

3 (c) Different frequency radio waves travel different distances through the atmosphere before being reflected.



Use the information in the diagram to describe the connection between the frequency of a radio wave and the distance the radio wave travels through the atmosphere before it is reflected.

.....

.....

(1 mark)

3 (d) Electromagnetic waves travel at a speed of 300 000 000 m/s.

A radio station transmits waves with a wavelength of 20 metres.

Use the equation in the box to calculate the frequency, in kilohertz (kHz), of these waves.

wave speed = frequency × wavelength

Show clearly how you work out your answer.

.....

.....

.....

Frequency = ... kHz

(2 marks)

7

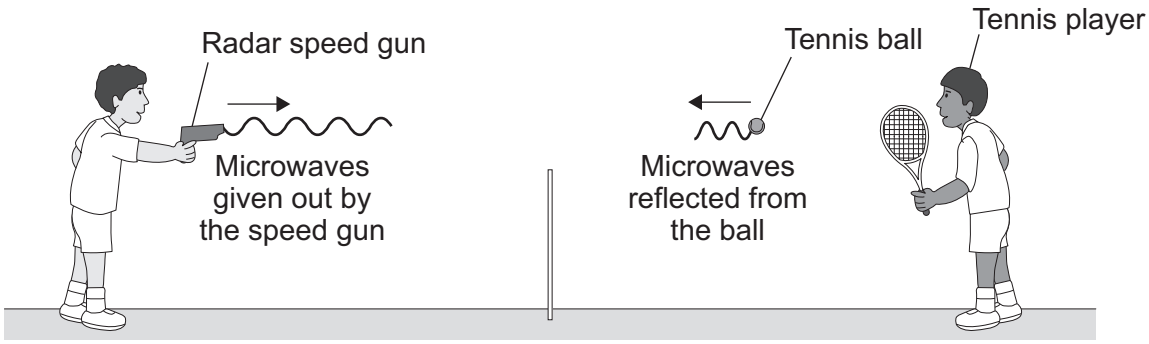
4.6.2.2 Properties of electromagnetic waves 1

Question 06

March 2011 | PHY1BP | Original Q3 | Legacy

QUESTION THREE

The picture shows a radar speed gun being used to measure how fast a tennis player hits the ball.



Some of the microwaves from the radar speed gun are absorbed by the ball and some are reflected by the ball.

3A What effect will the absorbed microwaves have on the ball?

1 The temperature of the ball will increase slightly.

2 The ball will go faster.

3 The temperature of the ball will decrease slightly.

4 The ball will go slower.

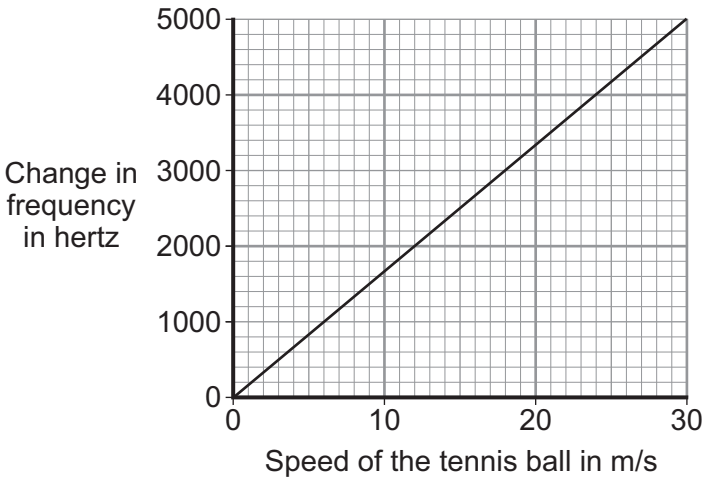
3B Which row in the table describes how the frequency and wavelength of the reflected microwaves are different from the microwaves given out by the speed gun?

	Frequency of reflected waves	Wavelength of reflected waves
1	higher	longer
2	lower	shorter
3	higher	shorter
4	lower	longer

4.6.2.2 Properties of electromagnetic waves 1

Question 06 · continued

The graph shows how the change in frequency of the microwaves depends on the speed of the ball.



3C The data has been drawn as a line graph because . . .

1 frequency and speed are both categoric variables.

2 frequency and speed are both continuous variables.

3 frequency is a categoric variable and speed is a continuous variable.

4 frequency is a continuous variable and speed is a categoric variable.

3D The speed gun measures the change in frequency as 3000 Hz.

What is the speed of the ball?

1 18 m/s

2 20 m/s

3 21 m/s

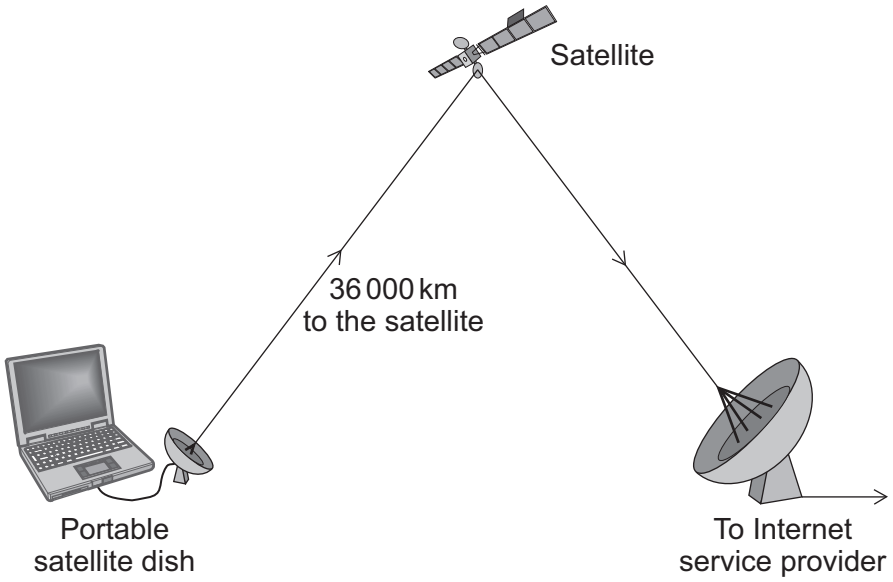
4 22 m/s

4.6.2.2 Properties of electromagnetic waves 1

Question 07

June 2011 | PHY1H | Original Q3 | Legacy

3 (a) The diagram shows a computer connected to the Internet using a satellite link.



3 (a) (i) Name the type of electromagnetic wave used to send information to and from the satellite.

.....

(1 mark)

3 (a) (ii) The information is sent to and from the satellite using a *digital signal*.

Describe a *digital signal*.

You may draw a diagram to help you answer.

.....

.....

(1 mark)

4.6.2.2 Properties of electromagnetic waves 1

Question 07 · continued

3 (a) (iii) Give **one** advantage of sending information as a digital signal rather than as an analogue signal.

.....

.....

(1 mark)

3 (b) Electromagnetic waves travel at a speed of 300 000 000 m/s.
The waves travelling to and from the satellite have a wavelength of 15 cm.

Use the equation in the box to calculate the frequency of these waves.

wave speed = frequency × wavelength

Show clearly how you work out your answer and give the unit.

.....

.....

Frequency = ...

(3 marks)

3 (c) In 2009, parts of the African country Kenya, were linked to the Internet by a super-fast optical fibre. Before that, all Internet connections had to be made via a satellite link.

3 (c) (i) Complete the following sentence.

Signals can be sent along an optical fibre using either visible light or

..... .

(1 mark)

3 (c) (ii) Suggest a reason why signals sent through the optical fibre arrive faster than signals sent via a satellite link.

.....

.....

(1 mark)

8

4.6.2.2 Properties of electromagnetic waves 1

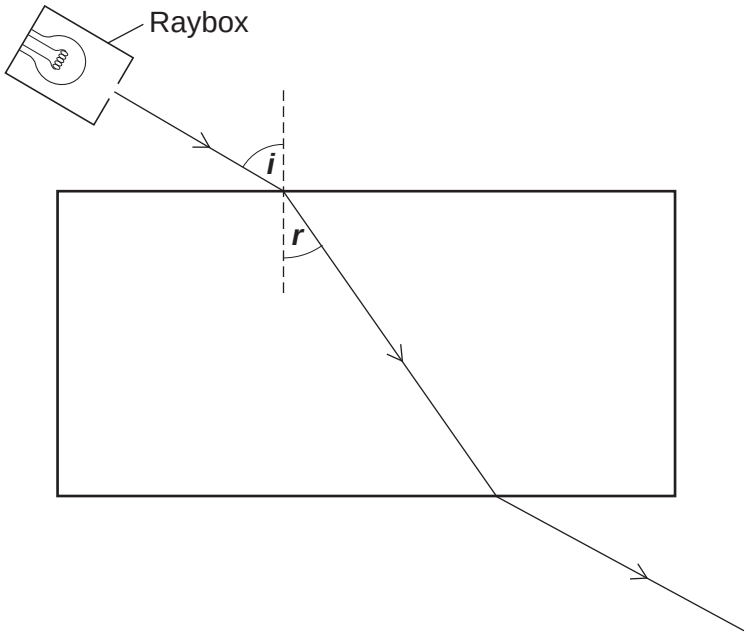
Question 08

January 2013 | PH1HP | Original Q4 | Legacy

4 A student investigated the refraction of light as it passes into and out of a clear plastic block.

Diagram 1 shows the apparatus the student used.

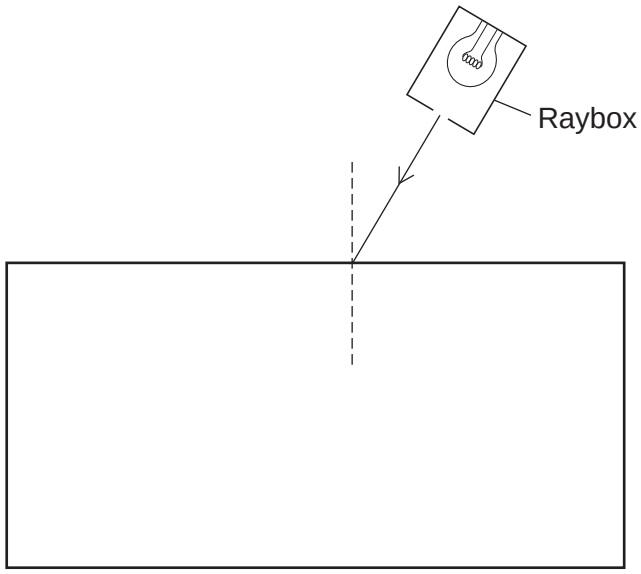
Diagram 1



4 (a) **Diagram 2** shows the same apparatus.

Use a ruler to draw on **Diagram 2** the path of the light ray.

Diagram 2



(2 marks)

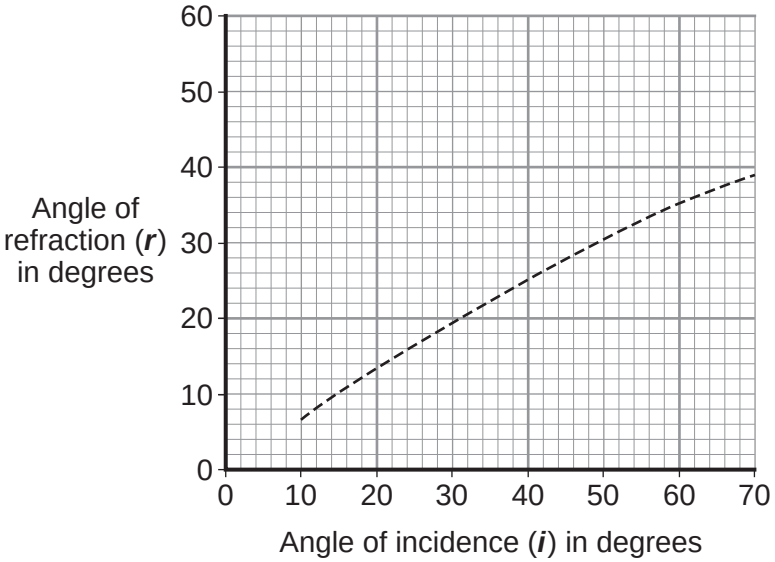
4.6.2.2 Properties of electromagnetic waves 1

Question 08 · continued

4 (b) The student measured the angle of refraction (***r***) for different angles of incidence (***i***) for light entering the plastic block.

The results are shown in **Graph 1**.

Graph 1



4 (b) (i) What **two** conclusions can be made about the relationship between the angle of incidence and the angle of refraction from **Graph 1**?

1 .....

.....

2 .....

.....

(2 marks)

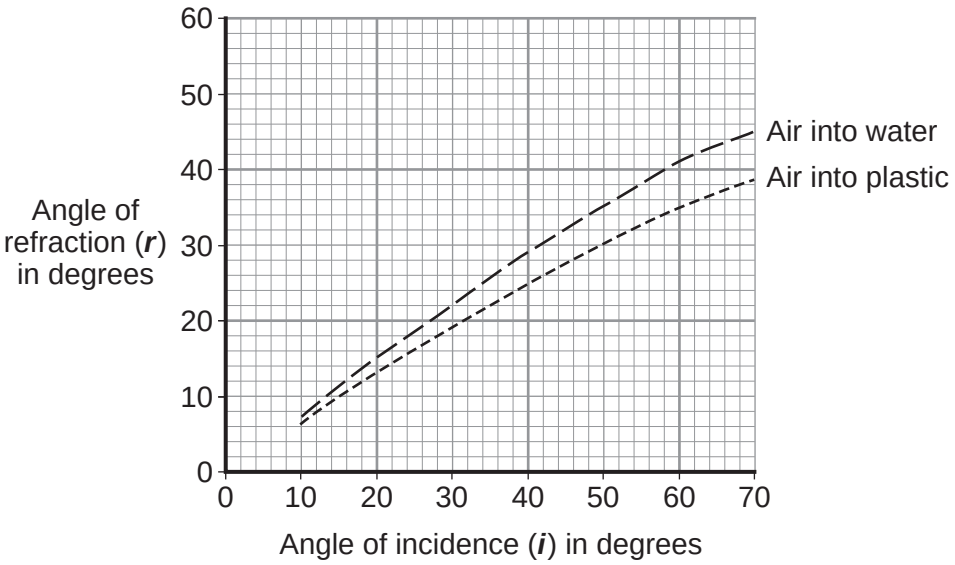
Question 4 continues on the next page

4.6.2.2 Properties of electromagnetic waves 1

Question 08 · continued

4 (b) (ii) **Graph 2** shows the student's results for light passing from air into plastic. The graph also shows the results for light passing from air into water.

Graph 2



How does the refraction of light passing from air into water compare to the refraction of light passing from air into plastic?

.....

.....

(1 mark)

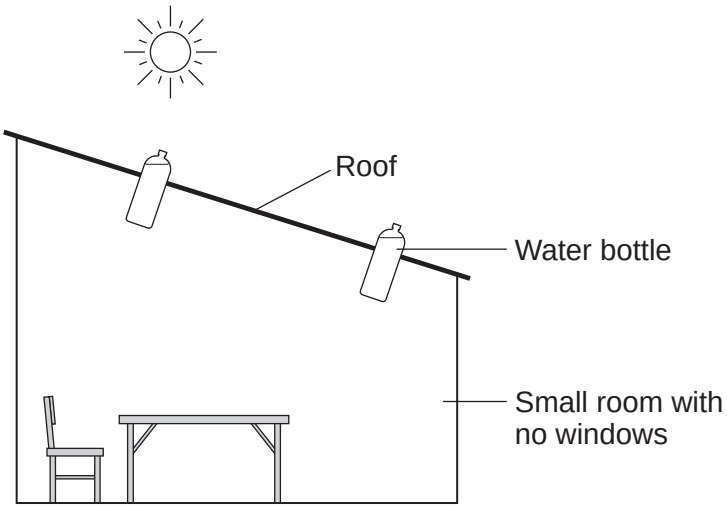
4.6.2.2 Properties of electromagnetic waves 1

Question 08 · continued

4 (c) In some countries people are too poor to pay for electricity. Some people living in small houses with no natural light are using bottles filled with water instead of light bulbs.

The bottles are fitted into small holes in the roof of the house. Sunlight refracts as it passes into and out of the bottle, causing light to spread into the room. This simple device gives about the same amount of light as a 50 W light bulb.

Diagram 3



4 (c) (i) Suggest **one** way this simple device can help improve the lives of the people using it.

.....

.....

(1 mark)

4 (c) (ii) The increasing use of energy resources to generate electricity within developed countries has ethical implications.

Suggest **one** ethical implication.

.....

.....

(1 mark)

7

4.6.2.2 Properties of electromagnetic waves 1

Question 09

June 2014 | PH3HP | Original Q5 | Legacy

5 (a) Human eyes and digital cameras both have parts with the same function.

Complete the missing parts in **Table 2**.

[2 marks]

Table 2

Details of part	Part of eye	Part of digital camera
Refracts light to produce an image	Cornea and lens	Lens
Images are focused here	Retina	.....
Variable opening where light enters	.....	Aperture

5 (b) Long sight is a defect of the human eye.

State **two** causes of long sight.

[2 marks]

1 .....

.....

2 .....

.....

4.6.2.2 Properties of electromagnetic waves 1

Question 09 · continued

5 (c) Long sight can be corrected by wearing spectacles with converging (convex) lenses.

A lens in these spectacles has a power of +3.2 dioptres.

Calculate the focal length of this lens.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

.....

.....

.....

Focal length = ... metres

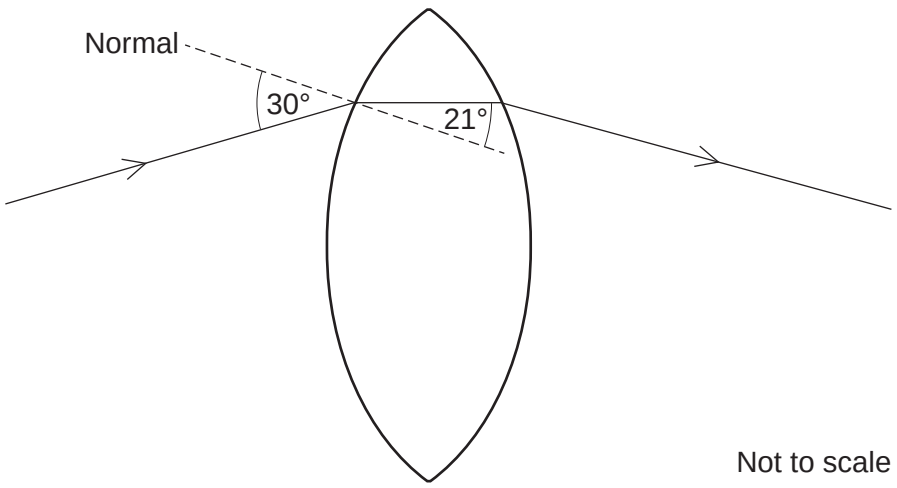
Question 5 continues on the next page

4.6.2.2 Properties of electromagnetic waves 1

Question 09 · continued

5 (d) **Figure 8** shows a ray of light passing through a converging (convex) lens.

Figure 8



Not to scale

5 (d) (i) Use the information in **Figure 8** to calculate the refractive index of the glass used to make the lens.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

.....

.....

.....

.....

Refractive index = ...

5 (d) (ii) Different lenses of the same power can be made using glass of a different refractive index.

State **one** advantage of making spectacles using lenses made from glass of a higher refractive index.

[1 mark]

.....

.....

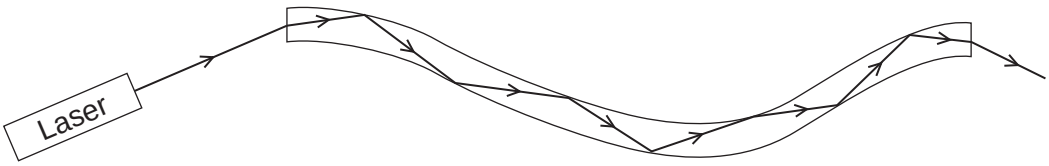
10

4.6.2.2 Properties of electromagnetic waves 1

Question 10

7 **Figure 11** shows how a ray of light from a laser travels along an optical fibre.

Figure 11



7 (a) Why does the ray of light stay within the optical fibre?

[1 mark]

.....

.....

7 (b) The material used to make the optical fibre has a refractive index of 1.50.

Calculate the critical angle of this material.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

.....

.....

.....

.....

Critical angle = ... degrees

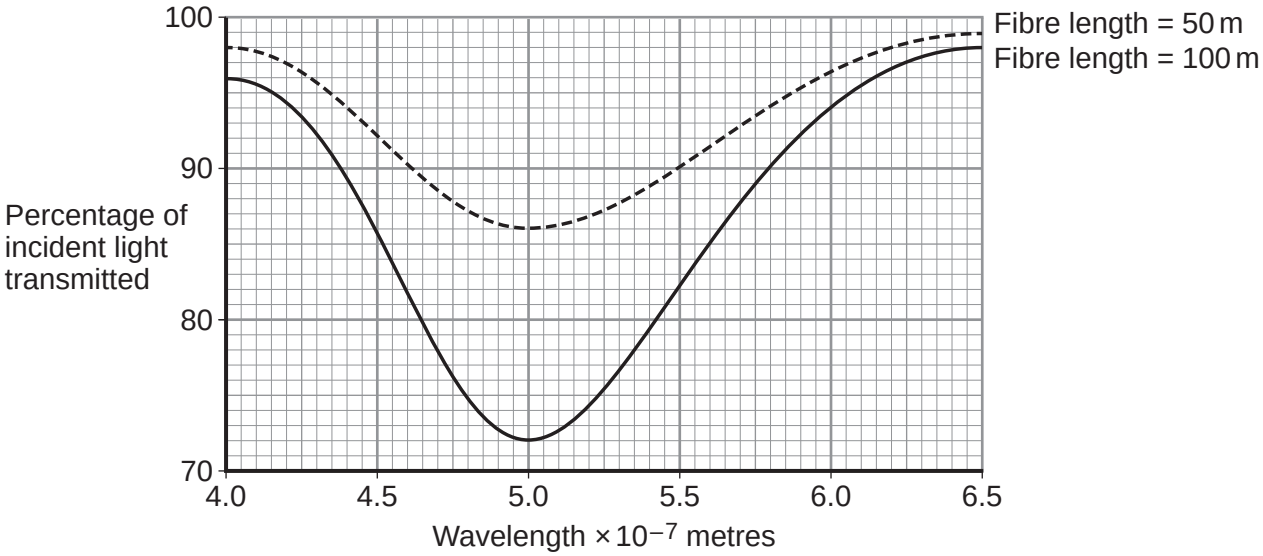
4.6.2.2 Properties of electromagnetic waves 1

Question 10 · continued

7 (c) Different wavelengths of light can be used to transmit information along optical fibres.

Figure 12 shows how the percentage of incident light transmitted through a fibre varies with the wavelength of light and the length of the fibre.

Figure 12



Compare the percentages of incident light transmitted through the two different fibres over the range of wavelengths shown.

[3 marks]

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6

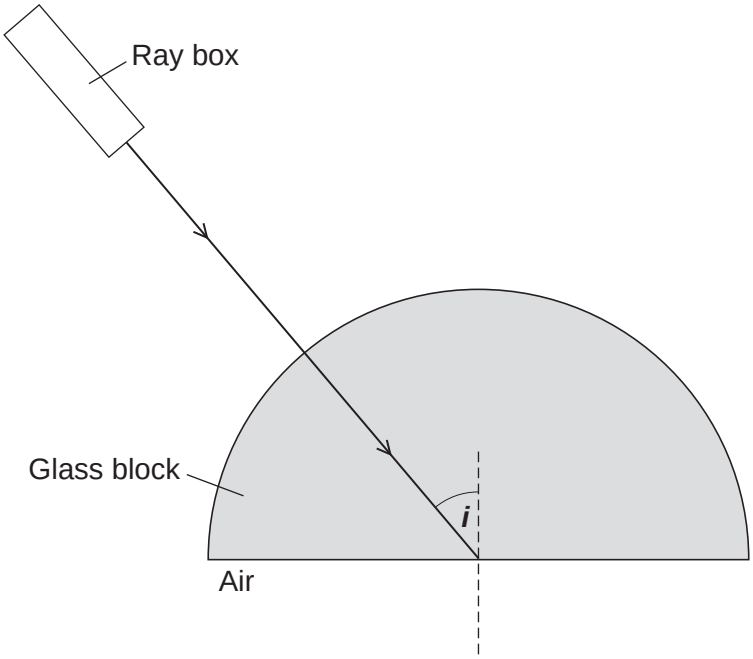
4.6.2.2 Properties of electromagnetic waves 1

Question 11

June 2015 | PH3HP | Original Q6 | Legacy

6 **Figure 11** shows a ray of light travelling through a semicircular glass block.
The angle of incidence is labelled ***i***.

Figure 11



6 (a) (i) The angle of incidence ***i*** equals the critical angle for the glass.

Complete **Figure 11** to show what happens to the ray of light at the glass-to-air boundary.

[1 mark]

6 (a) (ii) The critical angle for the glass is 41°.

Calculate the refractive index of the glass.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

.....

.....

.....

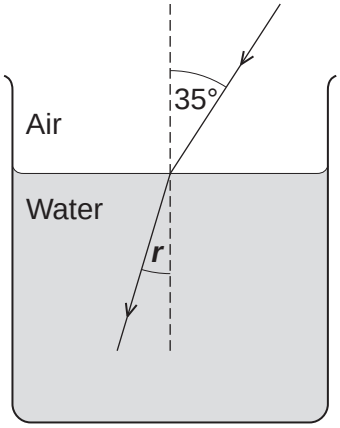
Refractive index = ...

4.6.2.2 Properties of electromagnetic waves 1

Question 11 · continued

6 (b) **Figure 12** shows what happens to a ray of light as it meets the boundary between air and water.

Figure 12



Not to scale

The refractive index of the water is 1.3

Calculate the angle of refraction ***r***.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

.....

.....

.....

.....

.....

Angle of refraction = ... degrees

6

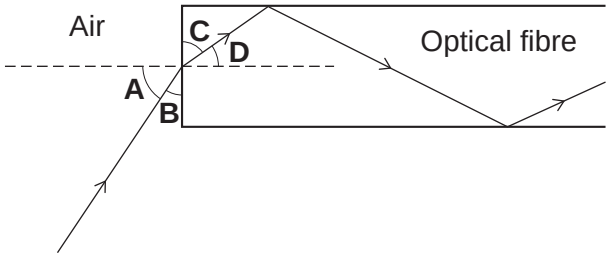
4.6.2.2 Properties of electromagnetic waves 1

Question 12

June 2016 | PH3HP | Original Q4 | Legacy

4 **Figure 6** shows a ray of light going from air into an optical fibre and then travelling through part of the optical fibre.

Figure 6



4 (a) Which **one** of the following pairs of angles correctly identifies the angle of incidence and the angle of refraction?

[1 mark]

Tick (✓) **one** box.

Angle of incidence	Angle of refraction	Tick (✓)
A	C	
A	D	
B	C	
B	D	

4 (b) The glass used to make this optical fibre has a refractive index of 1.5.

Calculate the critical angle of the glass.
Give your answer to 2 significant figures.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

Critical angle = _____ degrees

4.6.2.2 Properties of electromagnetic waves 1

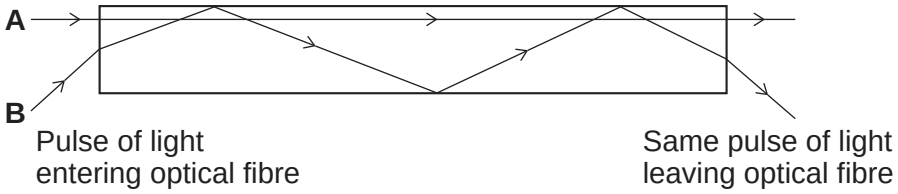
Question 12 · continued

4 (c) Short pulses of light can carry information through optical fibres.

Each pulse is made of lots of light rays. The light rays refract into the optical fibres at different angles when the pulse is sent.

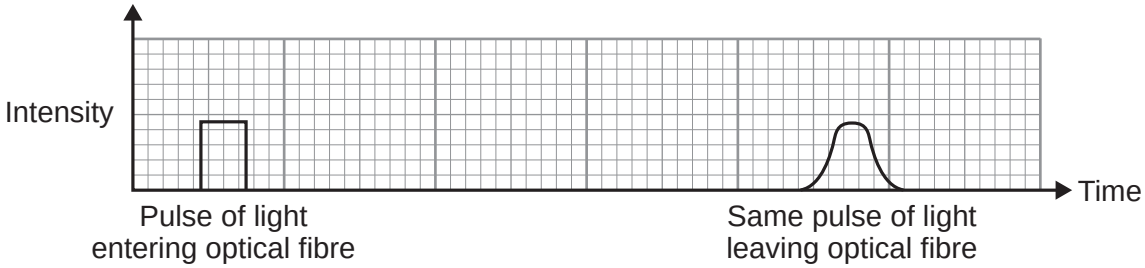
The paths of two possible rays, **A** and **B**, are shown in **Figure 7**. These rays make up part of the pulse shown in **Figure 8**.

Figure 7



A pulse of light entering the optical fibre has changed when it leaves the optical fibre, as shown in **Figure 8**.

Figure 8



By considering the paths of rays **A** and **B**, explain why the pulse of light shown in **Figure 8** changed as it passed through the optical fibre.

[2 marks]

6

4.6.2.2 Properties of electromagnetic waves 1

Question 13

June 2017 | PH3HP | Original Q4 | Legacy

4 One type of digital camera contains both a converging (convex) lens and a diverging (concave) lens.

4 (a) State the name of the light detector used in digital cameras.

[1 mark]

_____

4 (b) Converging and diverging lenses both produce images.

What type of images can be produced using converging and diverging lenses?

Tick (✓) **one** box for **each** type of lens.

[2 marks]

Converging lens

Real image only ☐

Virtual image only ☐

Both real and virtual images ☐

Diverging lens

Real image only ☐

Virtual image only ☐

Both real and virtual images ☐

Question 4 continues on the next page

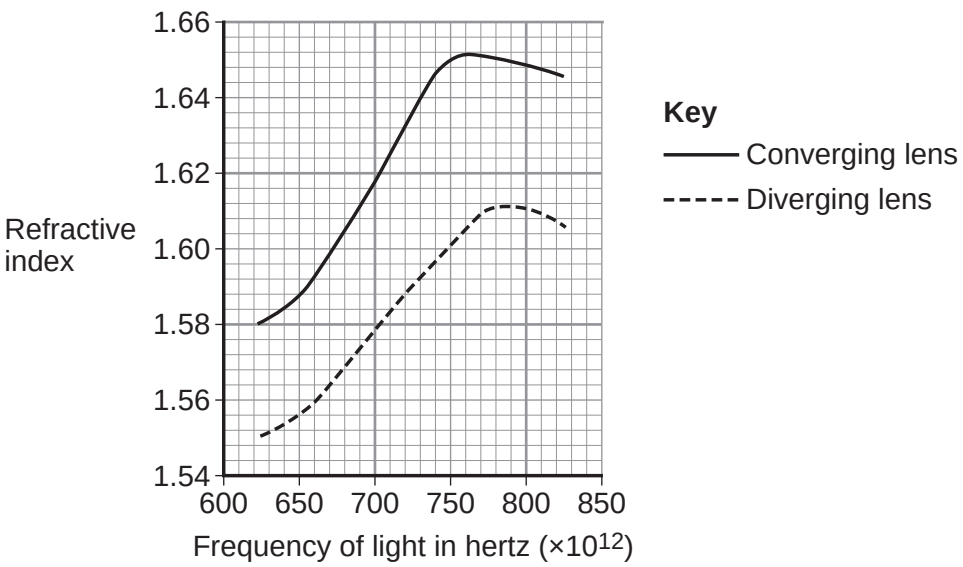
4.6.2.2 Properties of electromagnetic waves 1

Question 13 · continued

4 (c) Each lens in the digital camera is made from a different type of glass.

Figure 3 shows the relationship between the frequency of light and the refractive index of the glass used to make each lens.

Figure 3



Describe **three differences** between the refractive index of the glass used for the converging lens compared to the glass used for the diverging lens as the frequency of light increases.

[3 marks]

1 _____

_____

_____

2 _____

_____

_____

3 _____

_____

_____

4.6.2.2 Properties of electromagnetic waves 1

Question 13 · continued

4 (d) At one frequency, the glass of the diverging lens has a refractive index of 1.60
The angle of incidence of a ray of this light on the diverging lens is 20°

Calculate the angle of refraction for the ray of light.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

Angle of refraction = _____ degrees

4 (e) The focal length of the diverging lens is 40 cm.

Calculate the power of the diverging lens. Give the unit.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

Power = _____ unit _____

4 (f) Give **two** factors that affect the power of a lens.

[2 marks]

1 _____

2 _____

14

4.6.2.2 Properties of electromagnetic waves 1

Question 14

June 2018 | 8463/2H | Original Q9

0 9 Light is usually described as a wave. Light can also be described as a stream of particles.

These are two different scientific models of light.

0 9 . 1 Which statement describes a scientific model?

Tick **one** box.

[1 mark]

A small scale version of a real object. ☐

A way of guessing what will happen. ☐

An idea used to explain observations and data. ☐

0 9 . 2 Why do scientists sometimes have different models like the wave and particle models of light?

[1 mark]

0 9 . 3 Sometimes an old scientific model is replaced by a new model.

Explain why scientists replace an old scientific model with a new model.

Include an example from Physics in your answer.

[4 marks]

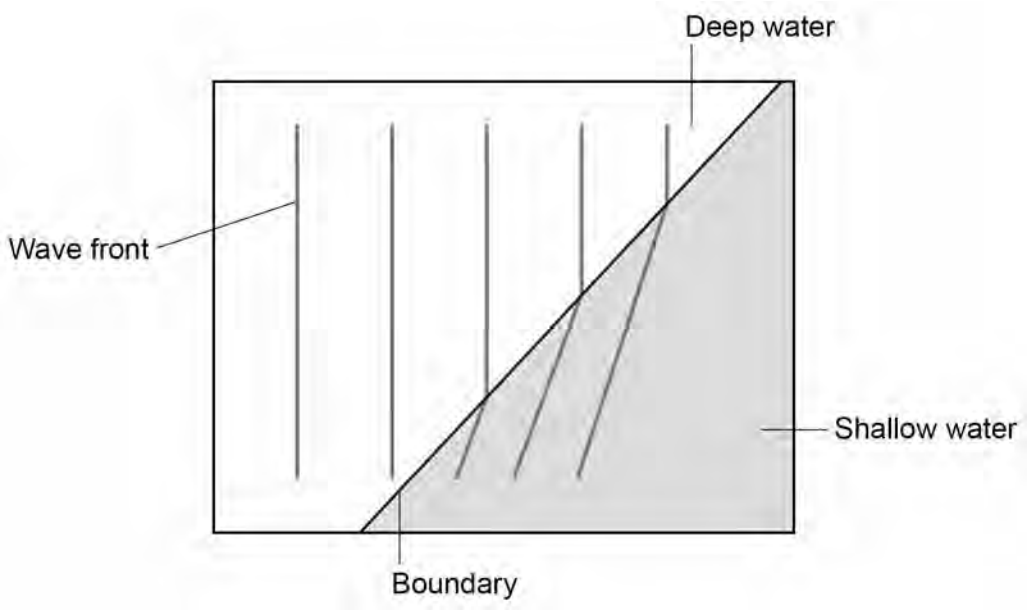
4.6.2.2 Properties of electromagnetic waves 1

Question 14 · continued

Some students used water waves in a ripple tank to model the behaviour of light waves.

0 9 . 4 **Figure 16** shows what happens to the wave fronts as they pass the boundary between deep water and shallower water.

Figure 16



Explain why refraction happens at the boundary between the deep water and shallower water.

[3 marks]

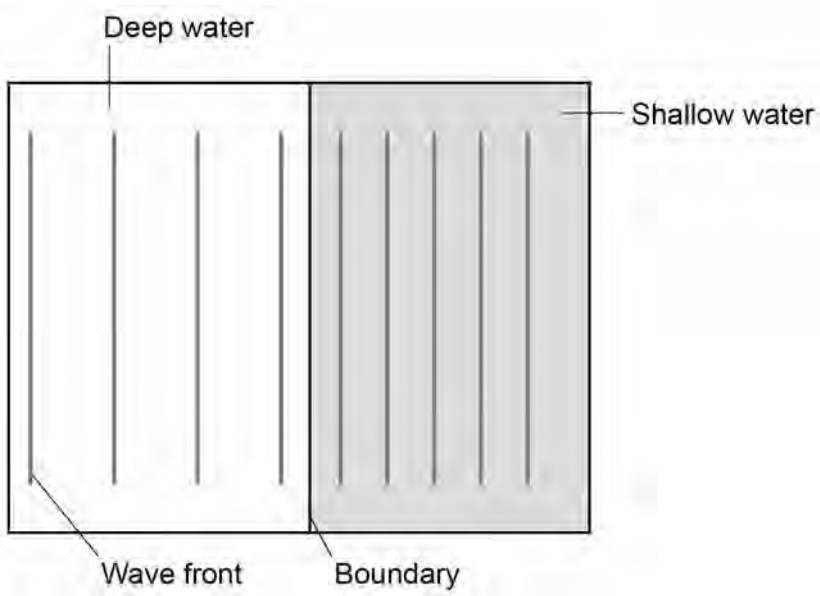
Question 9 continues on the next page

4.6.2.2 Properties of electromagnetic waves 1

Question 14 · continued

0 9 . 5 **Figure 17** shows the wave fronts travelling parallel to the boundary between deep water and shallower water.

Figure 17



Explain why the wave fronts in **Figure 17** do not refract at the boundary.

[2 marks]

1

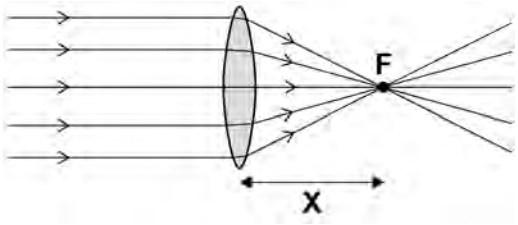
4.6.2.2 Properties of electromagnetic waves 1

Question 15

June 2019 | 8463/2H | Original Q1

0 1 . 1 **Figure 1** shows parallel rays of light being refracted by a convex lens.

Figure 1



What is distance '**X**' called?

[1 mark]

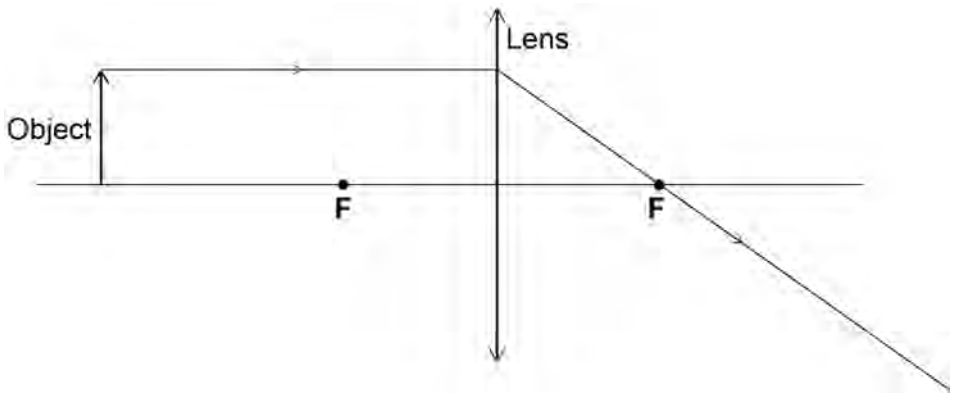
0 1 . 2 Lenses can be used to form the image of an object.

Complete the ray diagram in **Figure 2** to show how a **convex** lens forms the image of the object.

Use an arrow to represent the image.

[2 marks]

Figure 2

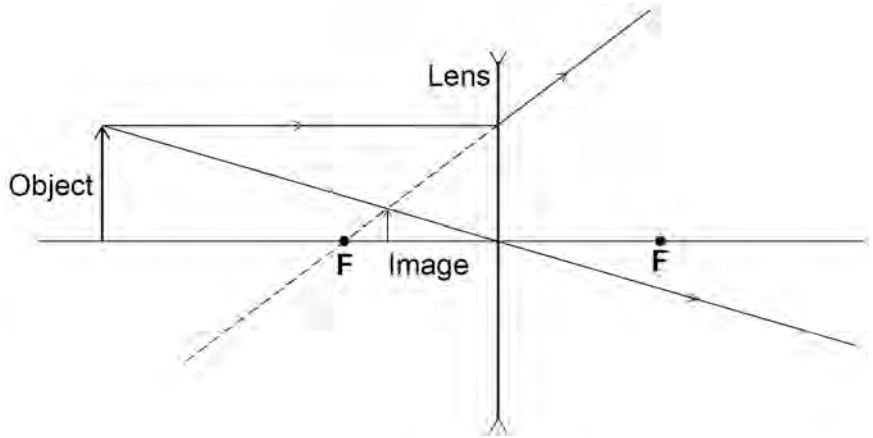


4.6.2.2 Properties of electromagnetic waves 1

Question 15 · continued

Figure 3 shows how a **concave** lens forms the image of an object.

Figure 3



0 1 . 3 Give **one** similarity and **one** difference between the image formed by the convex lens and the image formed by the concave lens.

[2 marks]

Similarity _____

_____

Difference _____

_____

0 1 . 4 A person uses a lens to read the letters on the back of a coin.

The image height of the letters on the coin is 9.0 mm

The magnification produced by the lens is 6.0

Calculate the height of the letters on the coin.

Use the Physics Equations sheet.

[3 marks]

_____

_____

_____

_____

Height = _____ mm

8

4.6.2.2 Properties of electromagnetic waves 1

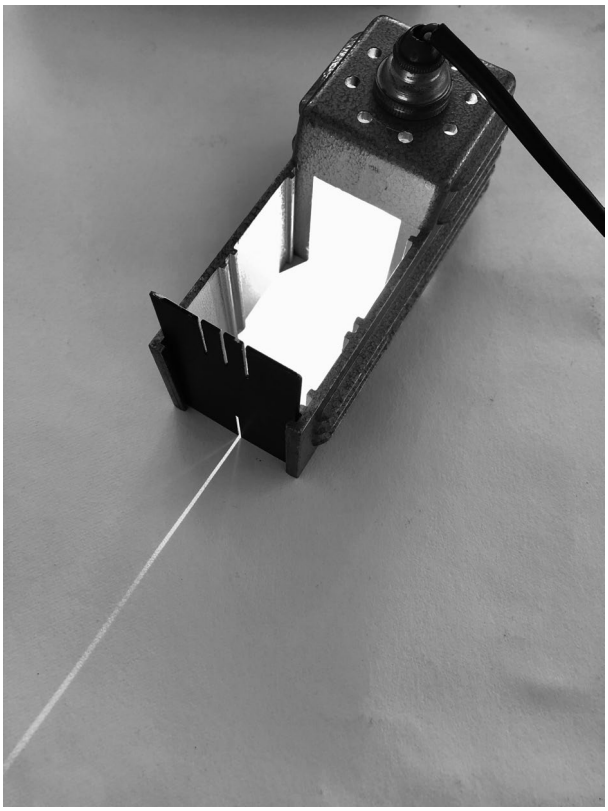
Question 16

November 2020 | 8463/2H | Original Q3

0 3 A student investigated the refraction of light at the boundary between air and glass.

Figure 3 shows the ray box used.

Figure 3



0 3 . 1 The ray of light from the ray box should be as narrow as possible.

Explain why using a wider ray would give less accurate results than using a narrower ray.

[2 marks]

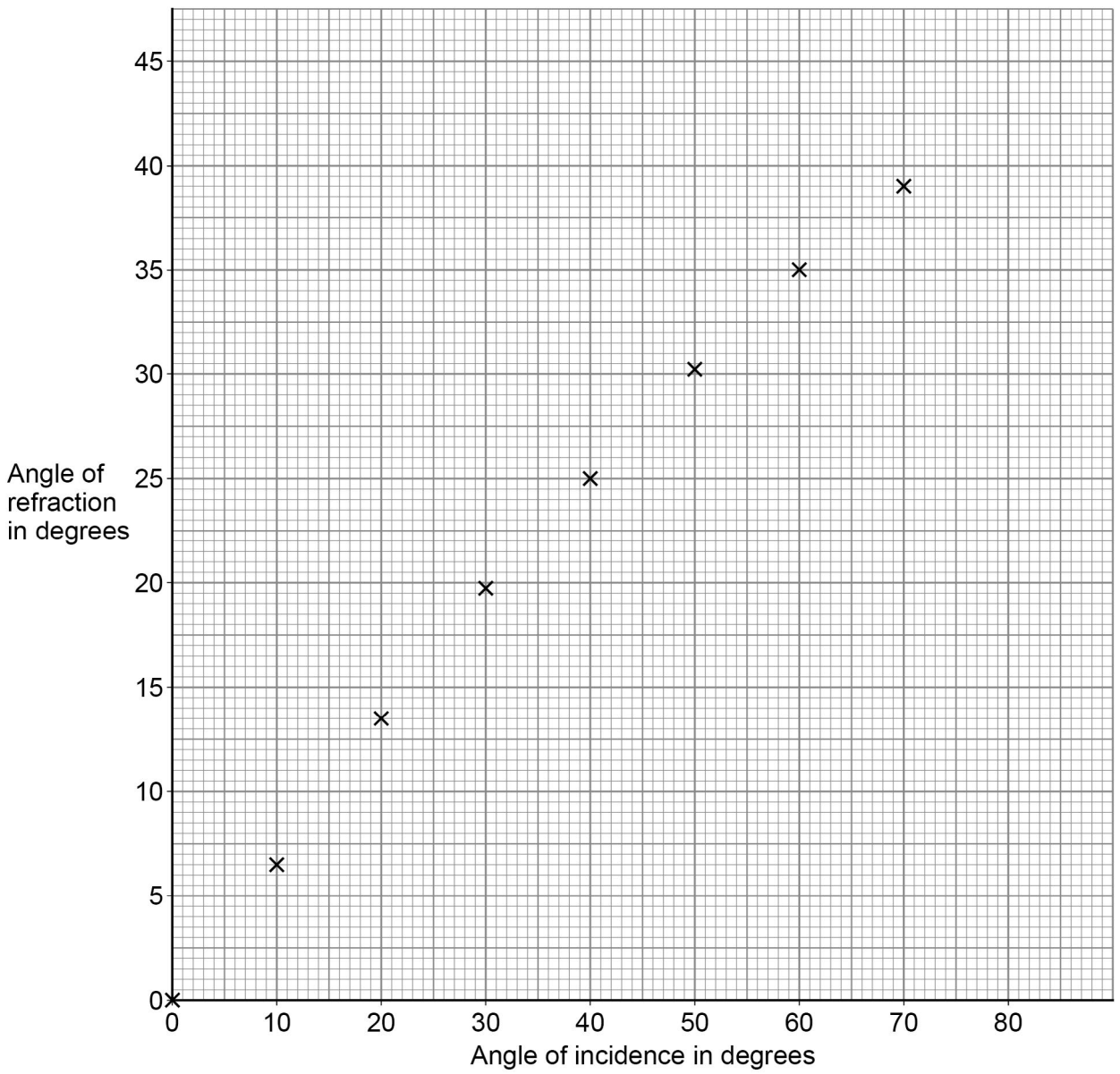
Question 3 continues on the next page

4.6.2.2 Properties of electromagnetic waves 1

Question 16 · continued

Figure 4 shows the results.

Figure 4



0 3 . 2 Estimate the angle of refraction when the angle of incidence is 80°.

Show on **Figure 4** how you obtained your answer.

[2 marks]

Angle of refraction = _____ °

4.6.2.2 Properties of electromagnetic waves 1

Question 16 · continued

0 3 . 3 Describe a method the student could have used to obtain the results shown in **Figure 4**.

[6 marks]

0 3 . 4 The student repeated each measurement three times.

When the angle of incidence was 40° the three measured values for the angle of refraction were

28° 25° 22°

Estimate the uncertainty in the angle of refraction when the angle of incidence was 40°.

Show how you determine your estimate.

[2 marks]

Uncertainty = ± _____ °

4.6.2.2 Properties of electromagnetic waves 1

Question 16 · continued

0 3 . 5 What property of the light wave changes when it is refracted?

[1 mark]

Tick (✓) **one** box.

Colour ☐

Frequency ☐

Velocity ☐

13

4.6.2.2 Properties of electromagnetic waves 1

Question 17

June 2022 | 8463/2HR | Original Q2

0 2 A student used a ray box to shine a ray of light through air into a glass block.

The student investigated how the angle of refraction varied with the angle of incidence.

Table 1 shows the results.

Table 1

Angle of incidence in degrees	Angle of refraction in degrees
10	5
20	10
30	14
40	19
50	23
60	26
70	28
80	29

0 2 . 1 Describe a method the student could have used to obtain the results in **Table 1**.

Your answer may include a labelled diagram.

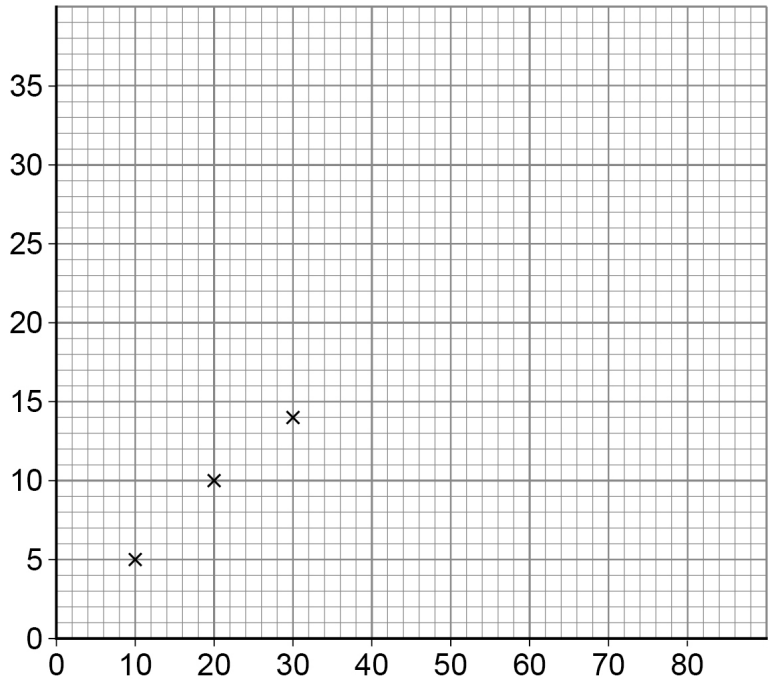
[6 marks]

4.6.2.2 Properties of electromagnetic waves 1

Question 17 · continued

0 2 . 2 **Figure 2** is an incomplete graph of the results.

Figure 2



Complete **Figure 2** using data from **Table 1**.

- Label the axes.
- Plot the remaining data.
- Draw a line of best fit.

[4 marks]

Question 2 continues on the next page

4.6.2.2 Properties of electromagnetic waves 1

Question 17 · continued

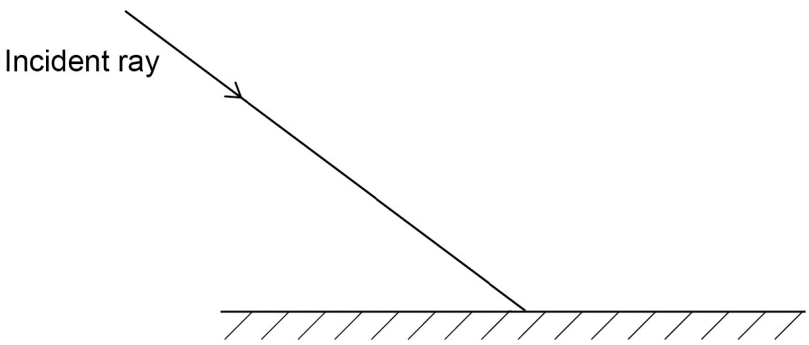
0 2 . 3 Complete the ray diagram in **Figure 3** to show the reflection of light from the surface of a plane mirror.

You should:

- draw the normal line
- draw the reflected ray.

[2 marks]

Figure 3



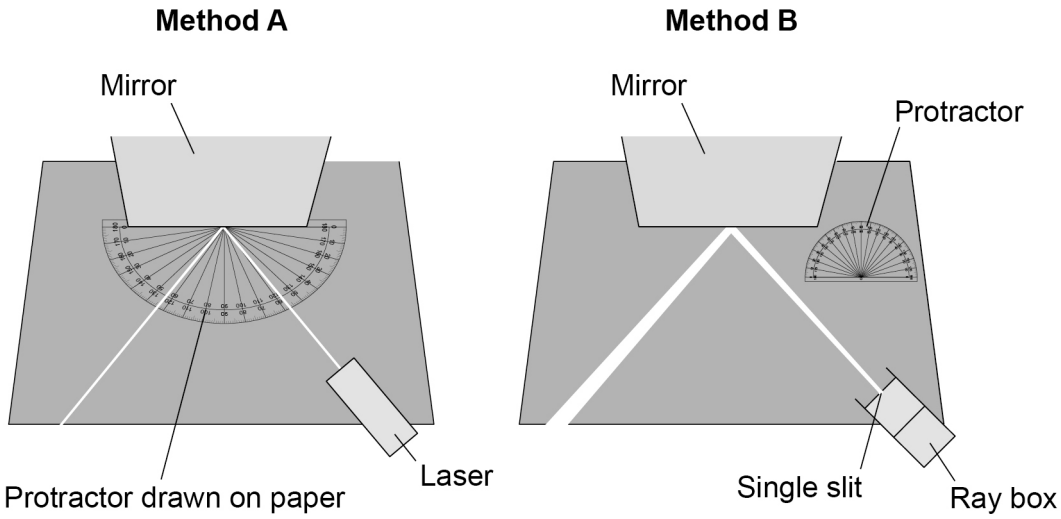
4.6.2.2 Properties of electromagnetic waves 1

Question 17 · continued

0 2 . 4 Two students investigated the reflection of light by a plane mirror.

Figure 4 shows the different equipment the students used.

Figure 4



Explain **two** ways that **Method A** is better than **Method B**.

[4 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

16

4.6.2.2 Properties of electromagnetic waves 1

Question 18

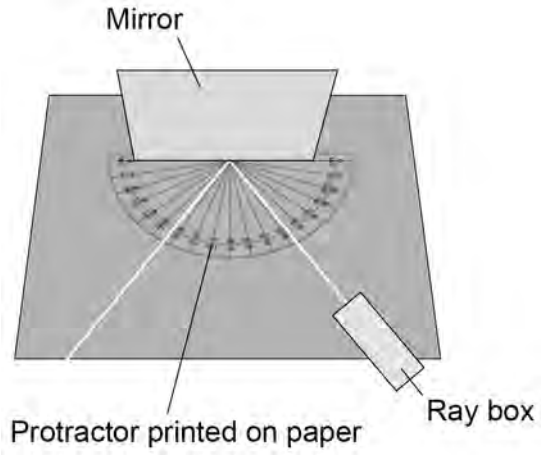
June 2023 | 8463/2H | Original Q7

0 7 A student investigated the behaviour of light.

The student used a mirror with a smooth surface to investigate reflection.

Figure 17 shows the equipment used.

Figure 17



0 7 . 1 What name is given to reflection from a smooth surface?

[1 mark]

4.6.2.2 Properties of electromagnetic waves 1

Question 18 · continued

The student measured the angle of reflection for different angles of incidence.

Table 2 shows the results.

Table 2

Angle of incidence in degrees	Angle of reflection in degrees			
	Test 1	Test 2	Test 3	Mean
10	8	10	11	10
20	20	21	20	20
30	28	29	32	30
40	39	41	41	40
50	49	50	52	50

0 7 . 2 What conclusion can be made from the results in **Table 2**?

[1 mark]

0 7 . 3 What type of error caused the variation in the results for the angle of reflection?

Suggest **one** cause of this error.

[2 marks]

Type of error _____

Cause of error _____

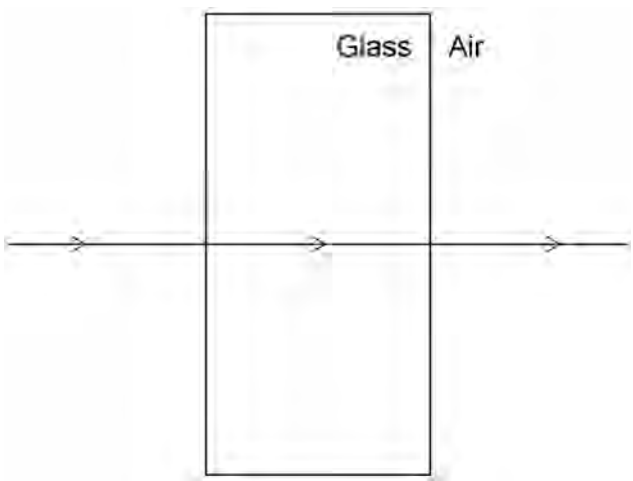
4.6.2.2 Properties of electromagnetic waves 1

Question 18 · continued

The student also investigated the refraction of light.

0 7 . 4 **Figure 18** shows the path of a ray of light through a glass block.

Figure 18



Why has refraction **not** occurred?

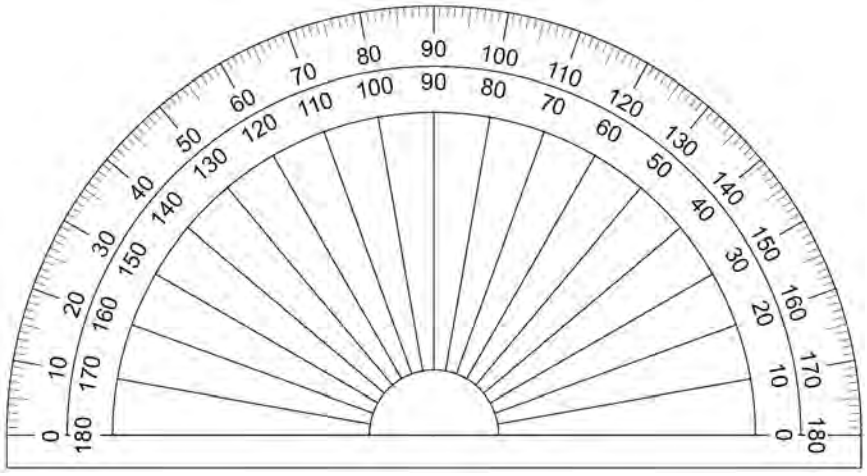
[1 mark]

Question 18 · continued

0 7 . 5 The student measured the angle of refraction for different angles of incidence.

Figure 19 shows the protractor used.

Figure 19



When the angle of incidence was 10° the student measured the angle of refraction four times.

The student recorded the measurements as:

6.0° 6.3° 6.4° 5.8°

Explain why the student should **not** have recorded these results when using the protractor in **Figure 19** to make the measurements.

[2 marks]

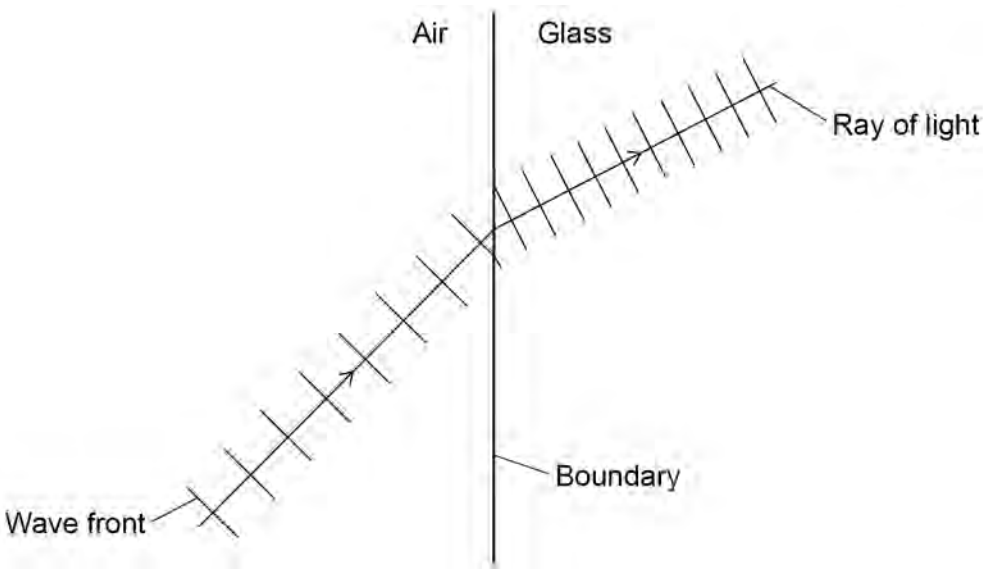
Question 7 continues on the next page

4.6.2.2 Properties of electromagnetic waves 1

Question 18 · continued

0 7 . 6 **Figure 20** shows what happens to wave fronts as they pass across the boundary between air and glass.

Figure 20



Explain in terms of the wave fronts, why refraction happens at the boundary between air and glass.

[3 marks]

10

4.6.2.2 Properties of electromagnetic waves 1

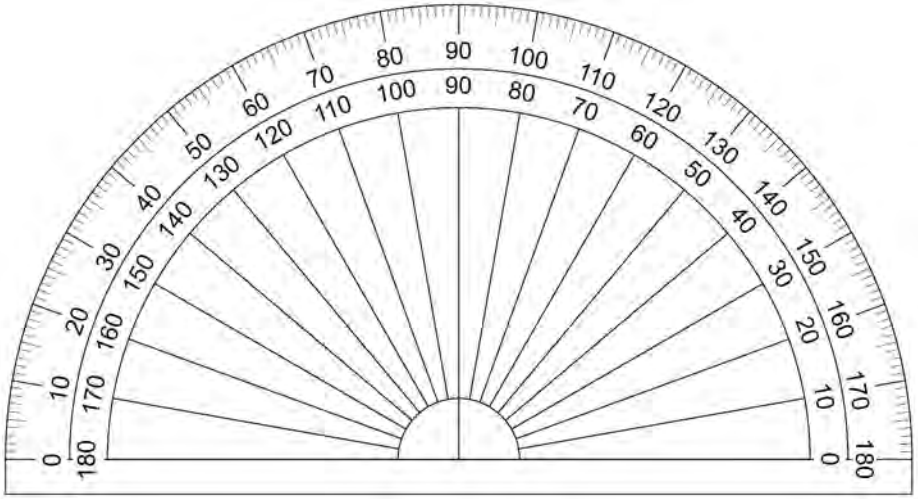
Question 19

June 2024 | 8463/2H | Original Q1

0 1 A student investigated the refraction of light by a glass block.

Figure 1 shows the protractor used to measure the angles of incidence and the angles of refraction.

Figure 1



0 1 . 1 What is the resolution of the protractor used to measure the angles?

[1 mark]

Resolution = _____ °

Table 1 shows the results.

Table 1

Angle of incidence in degrees	Angle of refraction in degrees
10	6
20	12
30	18
40	23
50	28
60	32

4.6.2.2 Properties of electromagnetic waves 1

Question 19 · continued

0 1 . 2 Describe a method the student could have used to obtain the data in **Table 1**.

You may include a labelled diagram.

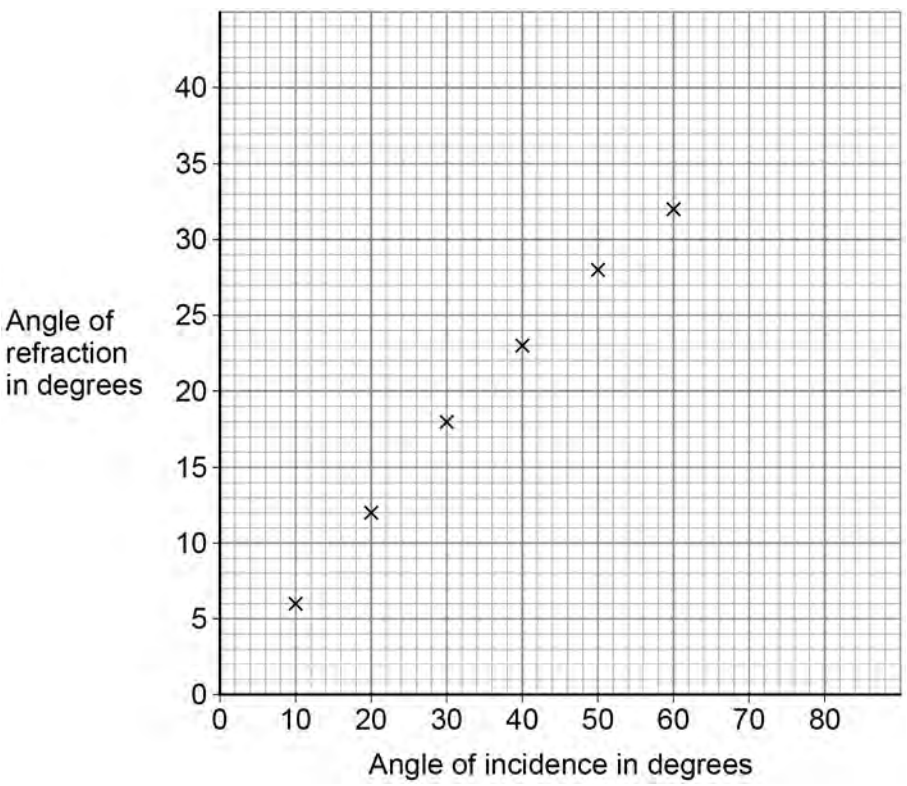
[6 marks]

4.6.2.2 Properties of electromagnetic waves 1

Question 19 · continued

Figure 2 shows some of the results.

Figure 2



The student measured the angles of refraction for two additional angles of incidence.

Table 2 shows the additional results.

Table 2

Angle of incidence in degrees	Angle of refraction in degrees
70	35
80	37

4.6.2.2 Properties of electromagnetic waves 1

Question 19 · continued

0 1 . 3 Complete **Figure 2**.

You should:

- plot the results from **Table 2**
- draw the line of best fit.

[2 marks]

0 1 . 4 How does **Figure 2** show that the angle of refraction is **not** directly proportional to the angle of incidence?

[1 mark]

Question 1 continues on the next page

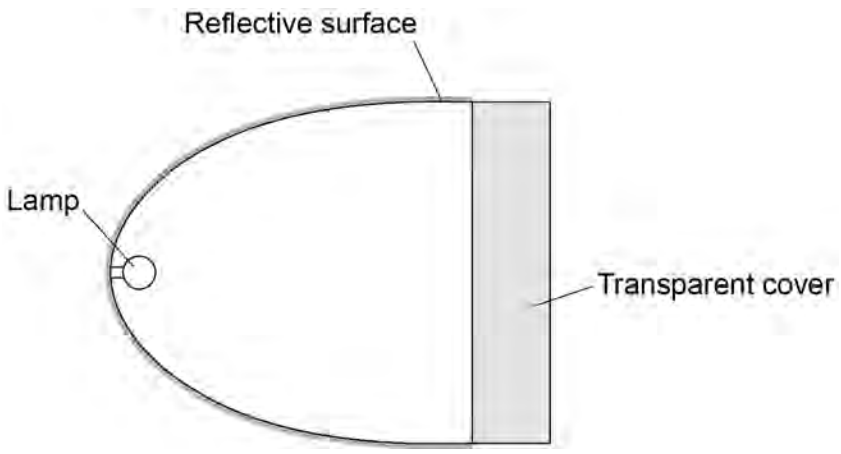
4.6.2.2 Properties of electromagnetic waves 1

Question 19 · continued

Figure 3 shows a diagram of a car headlight.

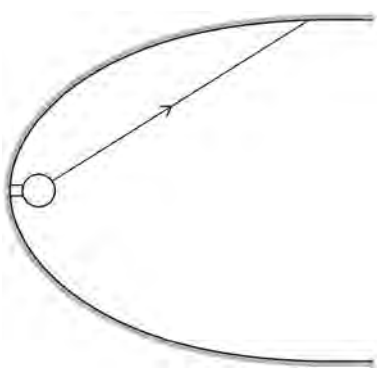
The headlight has a lamp, a reflective surface and a transparent cover.

Figure 3



0 1 . 5 **Figure 4** shows a ray of light incident on the reflective surface.

Figure 4



Complete **Figure 4** to show the reflected ray of light.

You should include the normal line at the point where the incident ray meets the reflecting surface.

[2 marks]

4.6.2.2 Properties of electromagnetic waves 1

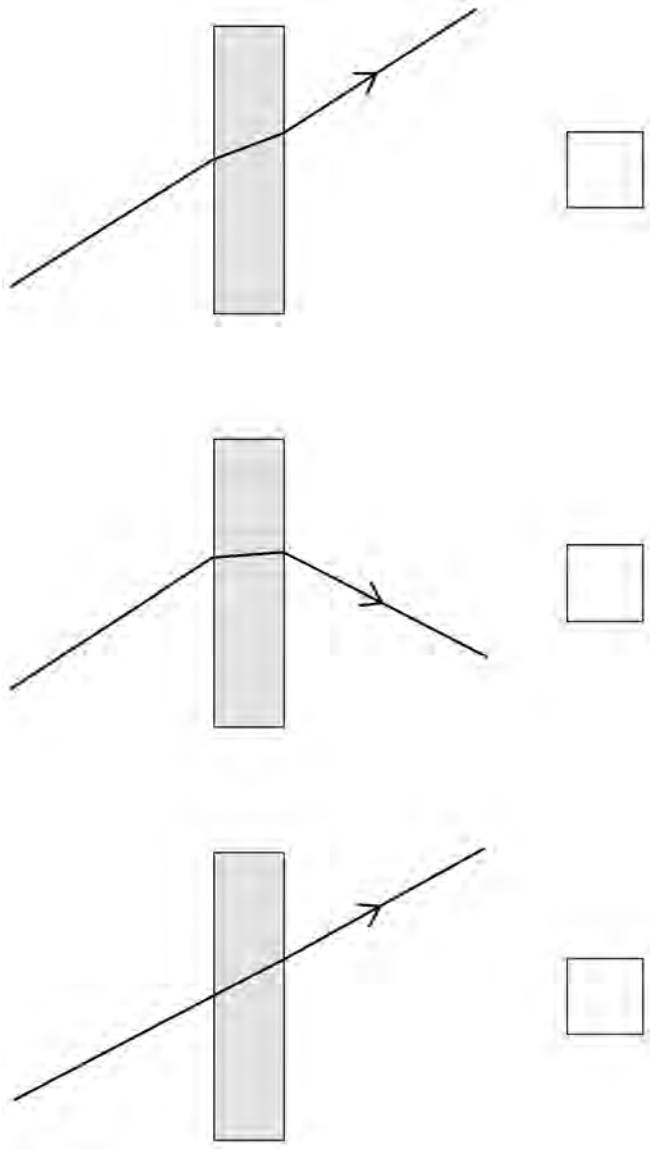
Question 19 · continued

0 1 . 6 Rays of light pass through the transparent cover of the headlight.

Which diagram shows how a ray of light passes through the transparent cover?

[1 mark]

Tick (✓) **one** box.



13