

Waves part 1 AQA Triple Physics

Name:

Class:

Date:

Time: **79 minutes**

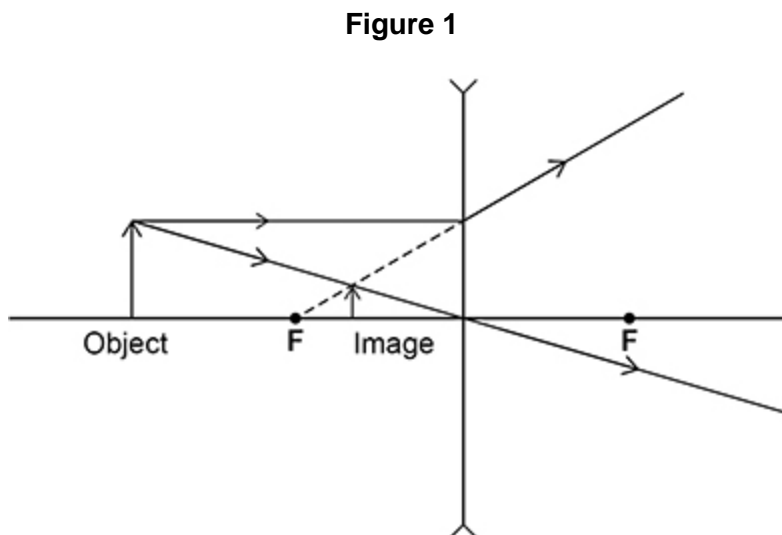
Marks: **76 marks**

Comments:

1.

Lenses are used to form images of objects.

(a) **Figure 1** shows how a concave lens forms an image of an object.



The image of the object in **Figure 1** is upright.

Give **two** other words that describe the image.

1 _____

2 _____

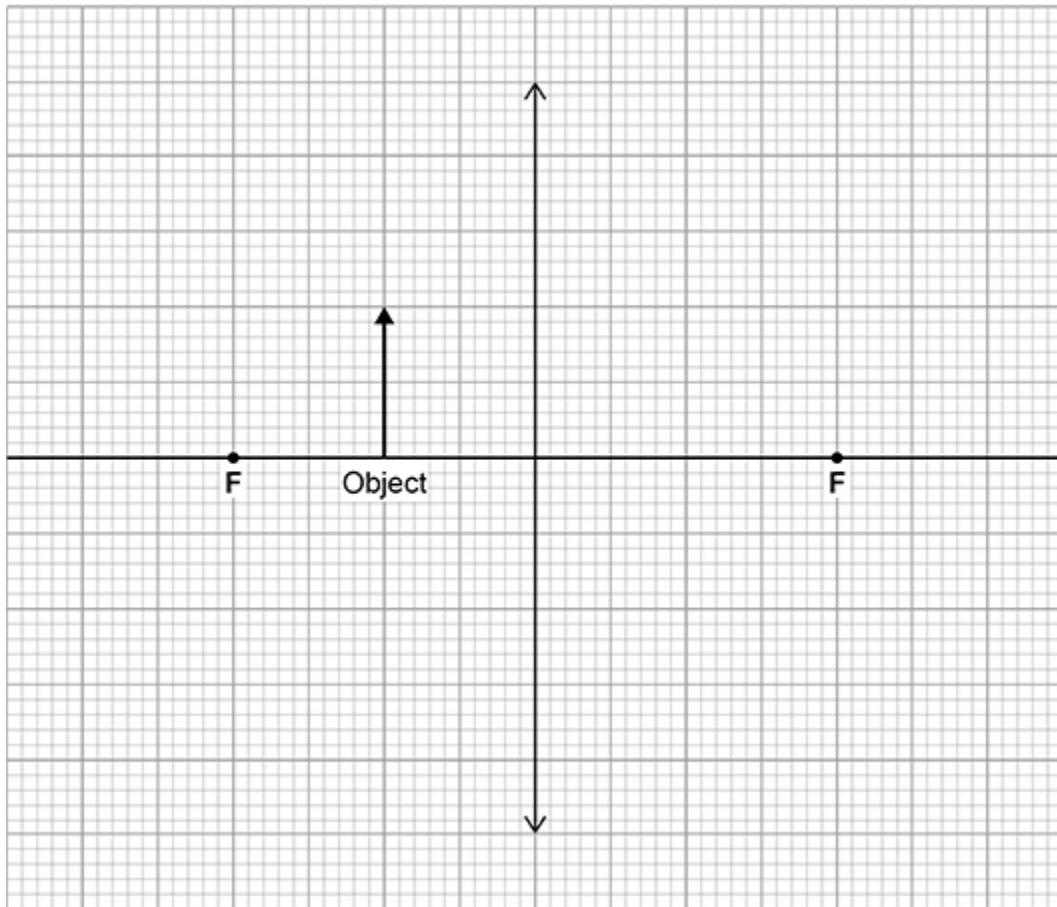
(1)

(b) **Figure 2** shows an object near to a **convex** lens.

Complete the ray diagram to show how the image is formed.

Use an arrow to represent the image.

Figure 2

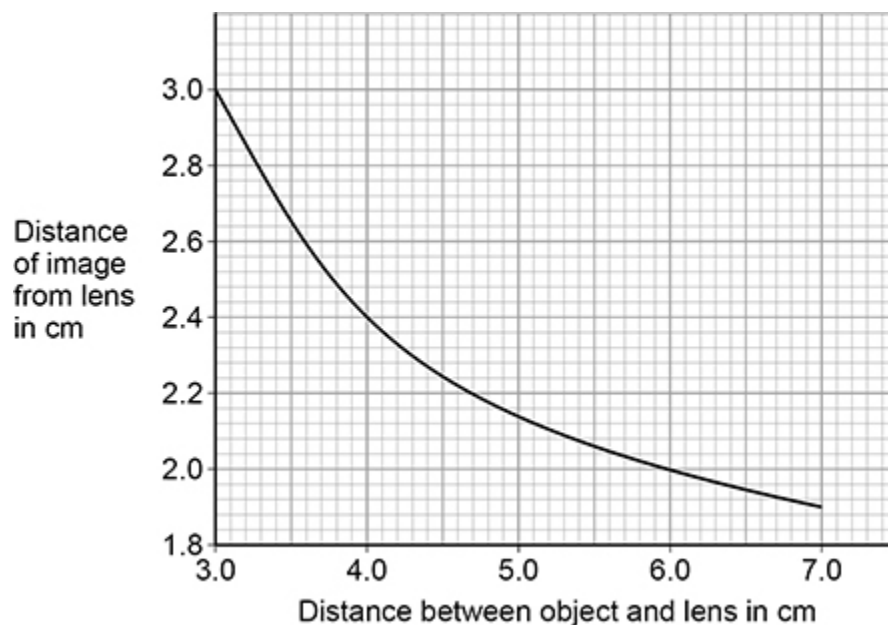


(3)

The position of an image formed by a convex lens varies with the distance between the object and the lens.

Figure 3 shows the results of a student's investigation using a convex lens.

Figure 3



- (c) Describe how the distance of the image from the lens decreases as the distance between the object and the lens increases.

(1)

- (d) The student measured the distance from the image to the lens four times.

The distance between the object and the lens did not change.

The 4 measurements from the image to the lens were:

1.9 cm 1.7 cm 2.2 cm 1.4 cm

Calculate the uncertainty in the measurements.

Uncertainty = \pm _____ cm

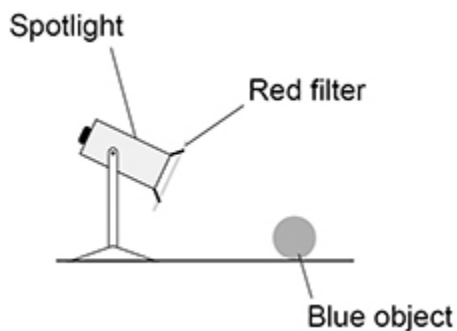
(2)

(e) **Figure 4** shows a spotlight containing a convex lens.

A red filter is placed in front of the spotlight.

The spotlight is directed at a blue object.

Figure 4



Explain why the blue object appears black.

(3)
(Total 10 marks)

2. Ultraviolet is a type of electromagnetic wave.

(a) Give **one** use of ultraviolet.

(1)

(b) An ultraviolet wave has a wavelength of 300 nanometres.

Which of the following is equal to 300 nanometres?

Tick (✓) **one** box.

3×10^7 m

3×10^{-7} m

3×10^9 m

3×10^{-9} m

(1)

(c) The speed of ultraviolet waves is 3×10^8 m/s.

Calculate the frequency of the ultraviolet wave.

Use your answer to part (b)

Frequency = _____ Hz

(3)

- (d) The table below gives the wavelength of an ultraviolet wave and three other electromagnetic waves.

	Ultraviolet	Wave E	Wave F	Wave G
Wavelength in nanometres	300	0.1	600	100 000

Draw **one** line from each wave to the name of the wave.

Wave

Name

Wave E

Infrared

Wave F

Visible light

Wave G

X-rays

(1)

- (e) Electromagnetic waves are transverse.

Some other types of wave are longitudinal.

Describe the difference between transverse and longitudinal waves.

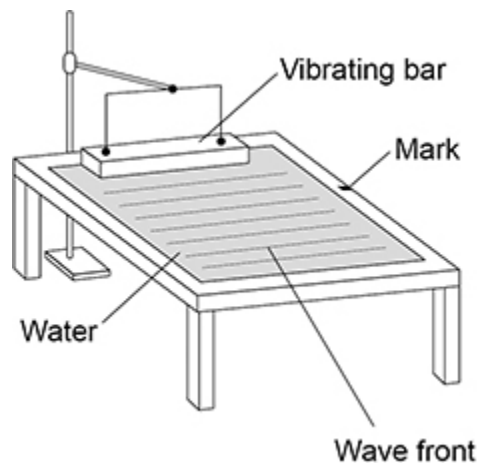
(2)

(Total 8 marks)

3.

A teacher demonstrated some features of waves using a ripple tank.

The figure below shows the ripple tank.



(a) The teacher measured the time taken for 10 wave fronts to pass the mark.

The teacher repeated this measurement three times and calculated the mean.

What is the advantage of repeating measurements and calculating a mean?

(1)

(b) The teacher's measurements for the time taken for 10 wave fronts to pass the mark were:

8.4 s 7.8 s 8.1 s

Calculate the mean frequency of the wave.

Give your answer to 2 significant figures.

Mean frequency (2 significant figures) = _____ Hz

(5)

(c) In a different investigation, the teacher wanted to determine the speed of water waves in the ripple tank.

The teacher did **not** measure the wavelength of the wave.

Explain how the teacher could determine the speed of the wave.

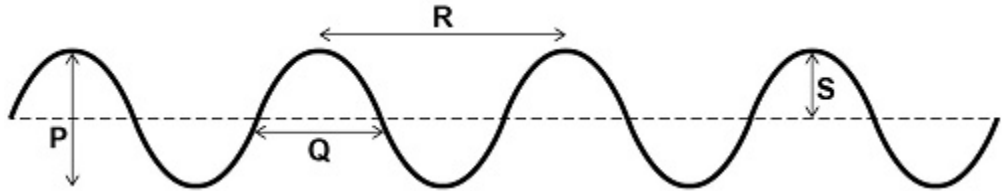
(3)

(Total 9 marks)

4.

Figure 1 shows some waves.

Figure 1



(a) Which arrow represents the wavelength of the waves?

Tick (✓) **one** box.

- P
- Q
- R
- S

(1)

(b) Which arrow represents the amplitude of the waves?

Tick (✓) **one** box.

- P
- Q
- R
- S

(1)

(c) The waves have a frequency of 0.20 hertz.

Calculate the period of the waves.

Use the equation:

$$\text{period} = \frac{1}{\text{frequency}}$$

Period = _____ s

(2)

(d) The frequency of the waves is increased. The speed of the waves stays the same.

What happens to the wavelength of the waves?

Tick (✓) **one** box.

The wavelength decreases.

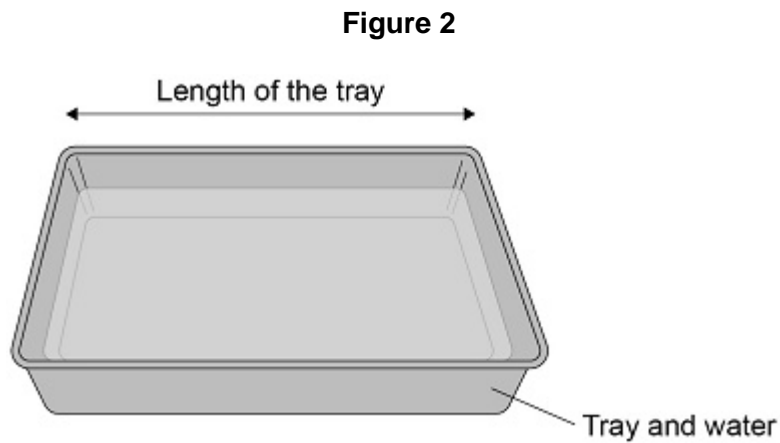
The wavelength increases.

The wavelength stays the same.

(1)

A student investigated how the speed of water waves is affected by the depth of water in a tray.

Figure 2 shows some water in a rectangular tray.



The student lifted one end of the tray and then dropped it.

This made a wave which travelled the length of the tray.

(e) The student measured the length of the tray.

What else should the student measure in order to calculate the speed of the wave?

Tick (✓) **one** box.

Area of the bottom of the tray

Depth of water in the tray

Temperature of the water in the tray

Time taken by the wave to travel the length of the tray

(1)

(f) What was the independent variable in this investigation?

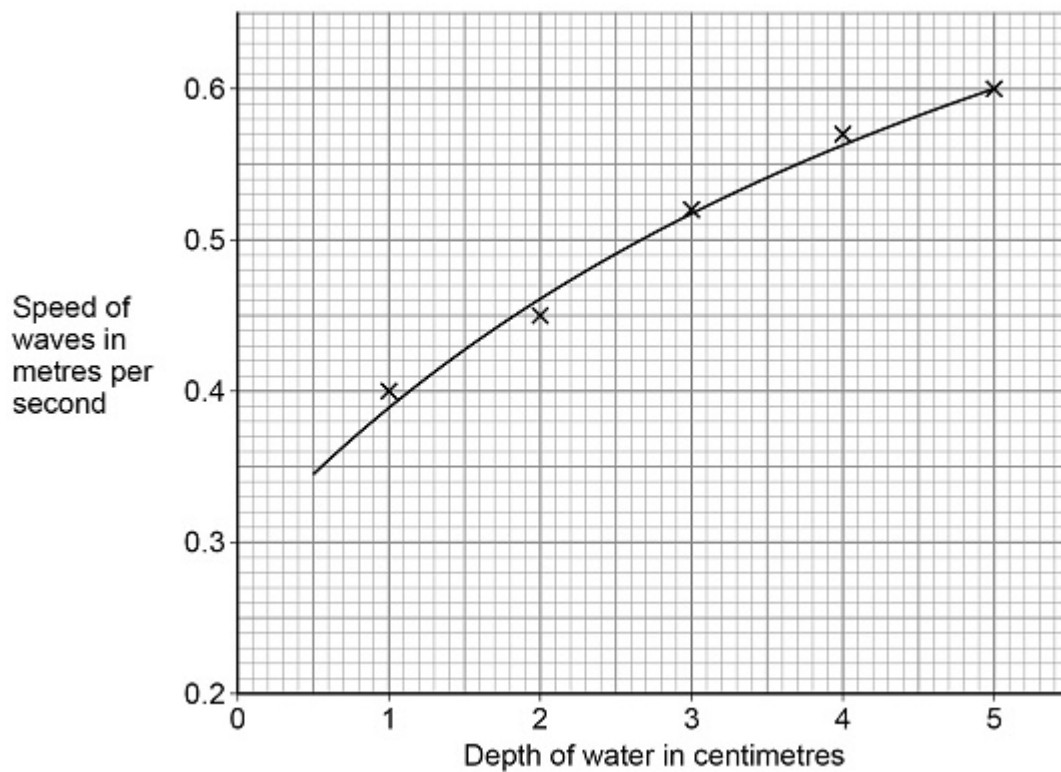
Depth of water

Length of tray

Speed of waves

(1)

The graph below shows the results.



(g) Give **one** conclusion that can be made from the graph.

(1)

(h) What was the speed of a wave when the depth of water was 2.5 cm?

Speed of wave = _____ m/s

(1)

(Total 9 marks)

5.

(a) Visible light is used for communications.

Which other parts of the electromagnetic spectrum are used for communications?

Tick (✓) **two** boxes.

Gamma rays

Microwaves

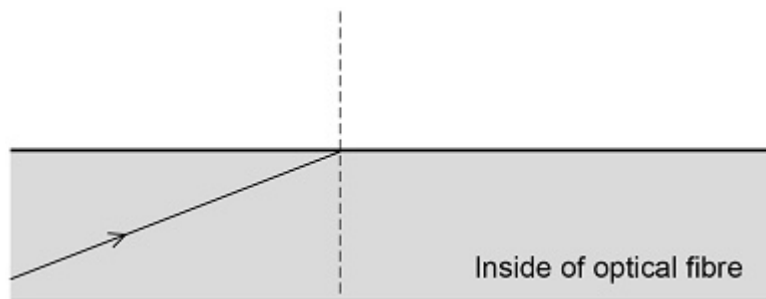
Radio waves

Ultraviolet

X-rays

(2)

The diagram below shows a ray of light in an optical fibre.



(b) What is the name given to the dotted line on the diagram?

(1)

(c) Where the ray of light touches the edge of the optical fibre it is reflected.

Draw the reflected ray on the diagram above.

(2)

(d) Optical fibres need to be able to bend around corners without breaking.

Suggest the property that optical fibres must have to allow them to bend around corners.

(1)

(e) The appearance of visible light can change when it interacts with different objects.

Complete the sentences.

Choose the answers from the box.

Each answer may be used once, more than once or not at all.

absorbed	reflected	refracted	transmitted
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When white light is incident on a green filter, only green light passes through the filter.

This is because green light is _____ by the filter.

All other colours of light are _____ by the filter.

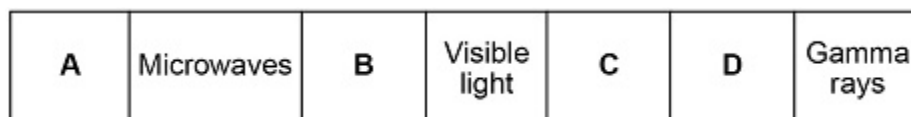
When red light shines on a blue object the red light is _____.

(3)

(Total 9 marks)

6.

(a) The diagram below shows the position of three types of wave in the electromagnetic spectrum.



Which letter represents the position of X-rays in the electromagnetic spectrum?

Tick (✓) **one** box.

A

B

C

D

(1)

A doctor needs to obtain an image of a bone in a patient's injured arm.

The doctor takes an X-ray of the arm.

(b) Give **one** possible harmful consequence of receiving a dose of X-ray radiation.

(1)

The table below gives information about two methods of bone imaging.

Method	Radiation dose in millisieverts
X-ray of arm	0.1
CT scan of arm	6.0

(c) Compare the risk of harm to the patient of having an X-ray rather than a CT scan.

(2)

(d) Which of the following is the same as 6.0 millisieverts?

Tick (✓) **one** box.

- 0.60 sieverts
- 0.060 sieverts
- 0.0060 sieverts
- 0.00060 sieverts

(1)

(e) The patient received a total radiation dose of 2.5 millisieverts during one year.

Calculate the percentage of this dose that came from one X-ray of the arm.

Use the data in the table above.

Percentage = _____ %

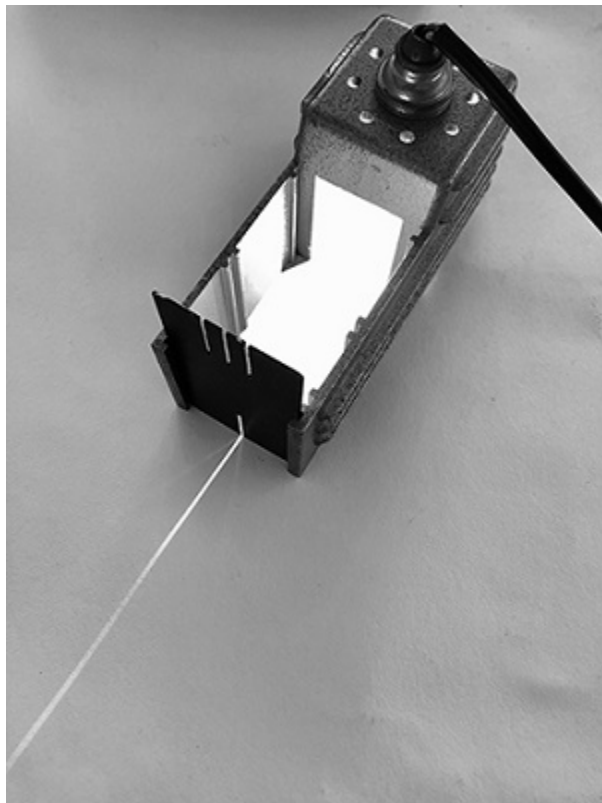
(2)

(Total 7 marks)

7.

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

The photograph below shows the ray box used.

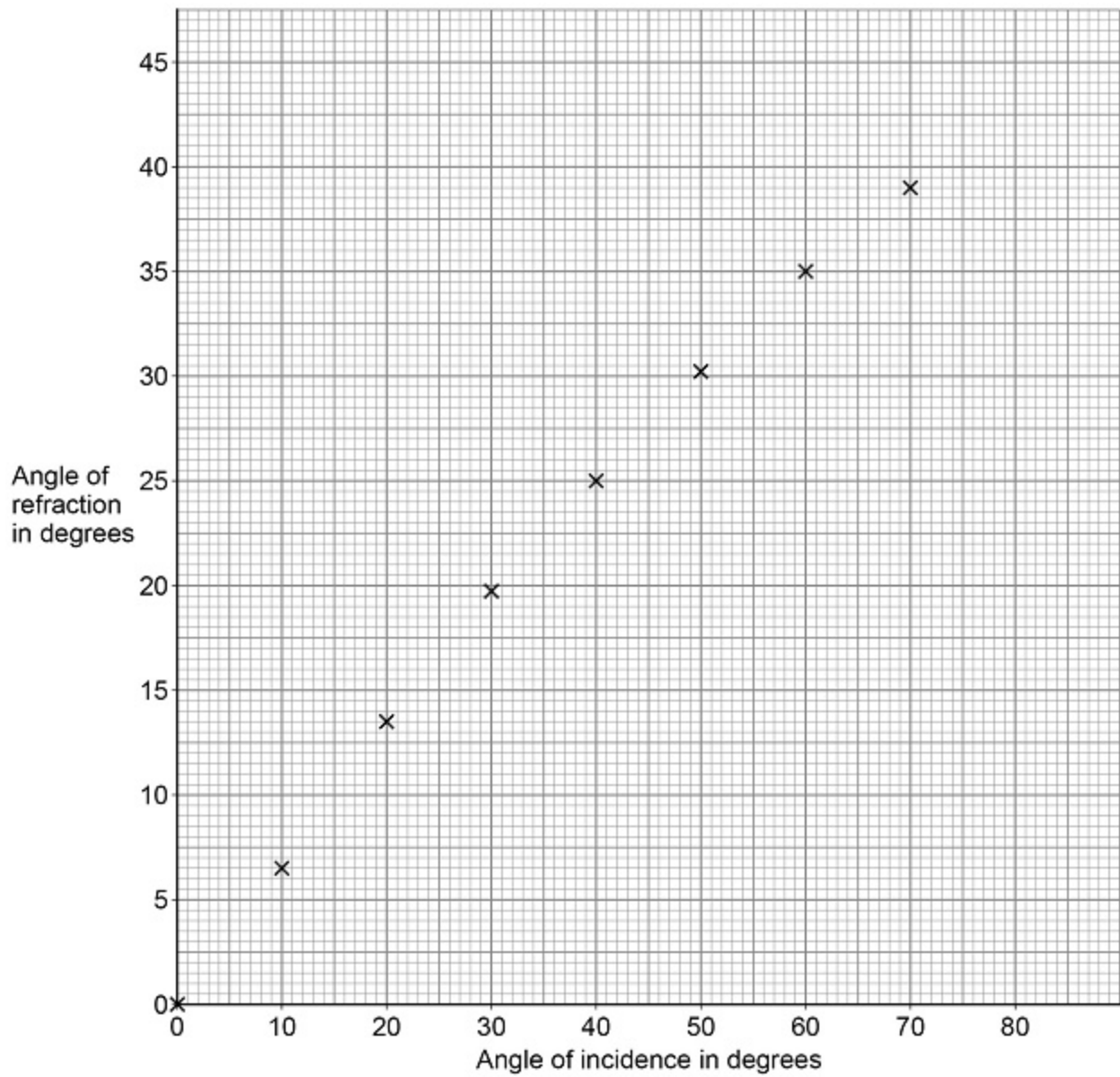


(a) The ray of light from the ray box should be as narrow as possible.

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

(2)

The graph below shows the results.



(b) Estimate the angle of refraction when the angle of incidence is 80° .

Show how you obtained your answer on the graph above.

Angle of refraction = _____ $^\circ$

(2)

(e) What property of the light wave changes when it is refracted?

Tick (✓) **one** box.

Colour

Frequency

Velocity

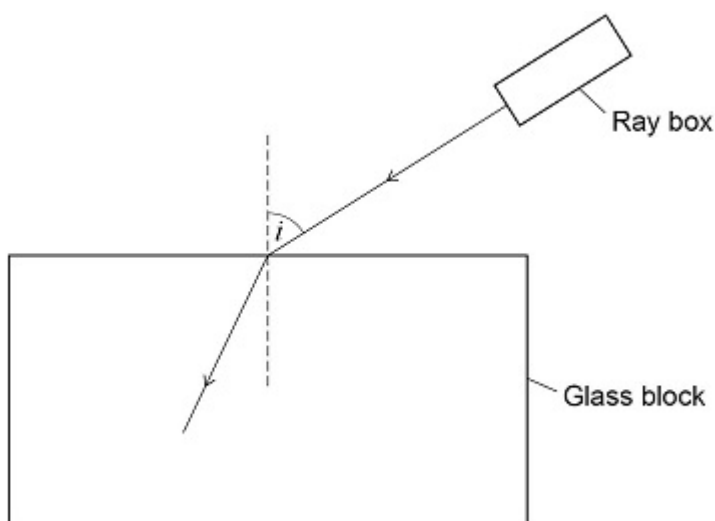
(1)

(Total 13 marks)

8.

A student used a ray box and glass block to investigate refraction of light.

The figure below shows a ray of light entering the glass block.



(a) In the figure, the angle of incidence is labelled with the letter *i*.

Label the angle of refraction in the figure with the letter *r*.

(1)

(b) Measure the angle of incidence in the figure above.

Angle of incidence = _____°

(1)

(c) Complete the figure above to show the path taken by the ray of light through the glass block and out into the air.

(3)

(d) Complete the sentence.

Choose an answer from the box.

random	systematic	zero
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The student repeated the measurement three times and calculated the mean to reduce the effect of _____ errors.

(1)

The following table shows the student's values for the angles of incidence and the mean angles of refraction.

Angle of incidence in degrees	Mean angle of refraction in degrees
20	13
30	19
40	X
50	31

(e) For an angle of incidence of 40° the three measurements for the angle of refraction were:

23° 27° 25°

Calculate the value of **X** in the table above.

X = _____ $^\circ$

(1)

(f) Complete the sentence.

Choose the answer from the box.

equal to	greater than	less than
-----------------	---------------------	------------------

The student used the data in the table above and correctly concluded that the angle of refraction is _____ the angle of incidence used.

(1)

(g) Why is the student's conclusion only valid for angles of incidence between 20° and 50°?

(1)

(h) The student repeated the investigation using a transparent plastic block.

Why did the student use a transparent block and not an opaque block?

(1)

(i) The student wanted to compare the refraction caused by the plastic with the refraction caused by the glass.

What must the student keep the same for both the plastic block and the glass block?

Tick (✓) **one** box.

The angles of incidence tested

The angles of refraction tested

The number of results recorded

The size of the two blocks

(1)

(Total 11 marks)

Mark schemes

1.

- (a) **both** answers correct

answers may be in either order

virtual

diminished

allow a description of diminished (eg smaller / reduced)

1

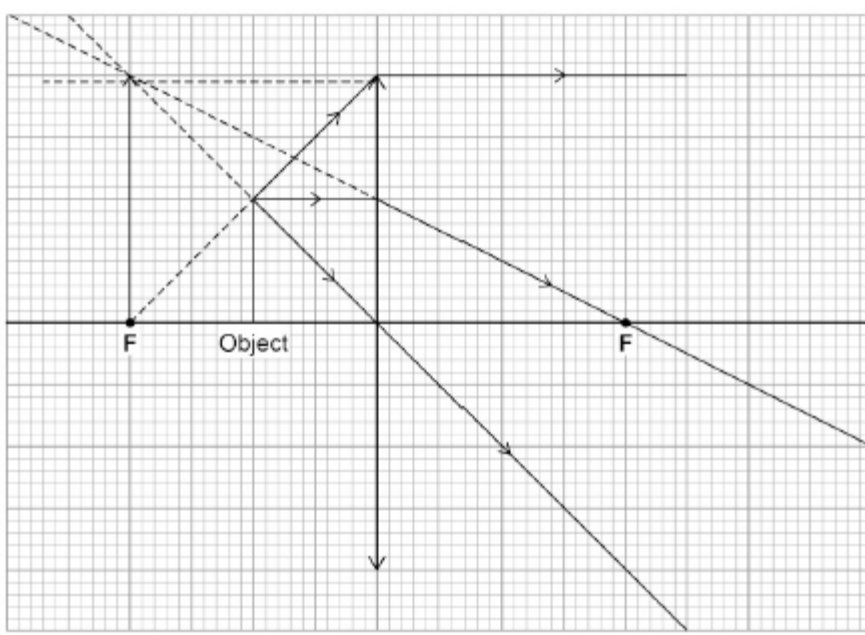
- (b) any **two** correct lines drawn from the top of the object, passing through the lens and traced backwards

allow construction lines that are not dashed

*allow 1 mark for **two** correct lines drawn from the top of the object, passing through the lens BUT not traced backwards*

2

image drawn in the correct position and with the correct orientation



mark only scores if first two marks score

1

- (c) (increasing the object distance) decreases the image distance more rapidly at small (object) distances / more gradually at larger (object) distances

*do **not** accept inversely proportional*

1

(d) $\frac{(2.2 - 1.4)}{2}$

1

uncertainty = (\pm) 0.4 (cm)

allow

$$\frac{1.9 + 1.7 + 2.2 + 1.4}{4} = 1.8 \quad (1)$$

$$(2.2 - 1.8 =) (\pm) 0.4 \text{ (cm)} \quad (1)$$

1

(e) only red is transmitted by the filter

1

red is absorbed by the (blue) object

1

(so) no light is reflected by the (blue) object

1

[10]

2.

(a) any **one** from:

- (sun) tan
- energy efficient lamps

allow

- *(invisible) security coding*
- *detecting forged bank notes*
- *kill microbes*
- *attract insects*
- *sterilise (surgical) equipment*
- *cause the body to produce vitamin D*
- *increasing the growth rate of plants*
- *water purification*

1

(b) 3×10^{-7} m

1

(c) $3.0 \times 10^8 = \text{frequency} \times 3 \times 10^{-7}$

allow ecf from part (b)

1

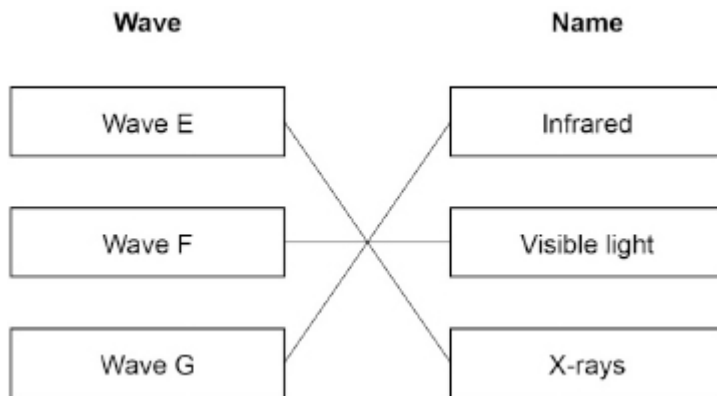
$$\text{frequency} = \frac{3.0 \times 10^8}{3 \times 10^{-7}}$$

1

frequency = 1×10^{15} (Hz)

1

(d)



all three lines correct for 1 mark

1

(e) in a transverse wave, the oscillations / vibrations are perpendicular to the direction of energy transfer

allow direction of wave travel for direction of energy transfer

1

in a longitudinal wave, the oscillations / vibrations are parallel to the direction of energy transfer

1

[8]

3.

(a) to reduce the effect of random errors

allow gives a more accurate mean

ignore reference to anomalous results

ignore measurements are more accurate

1

(b) $\frac{(8.4+7.8+8.1)}{3} = 8.1 \text{ (s)}$

1

$\frac{8.1}{10} = 0.81 \text{ (s)} = 0.81 \text{ (s)}$

1

frequency = $\frac{1}{0.81}$

allow a correct substitution of an incorrectly calculated value for time

1

frequency = 1.2345...

this mark may be awarded if the time is incorrectly calculated

1

frequency = 1.2 (Hz)

allow a calculated value correctly rounded to 2 sig figs

1

(c) measure the distance travelled by a wave using a metre rule

allow measure the length of the (ripple) tank using a metre rule

1

measure the time taken (for the wave to travel the measured distance) with a timer / stopwatch

1

divide the distance by the time

dependant on scoring the first two mark points

1

[9]

4.

(a) R

1

(b) S

1

(c) $T = \frac{1}{0.20}$

1

$T = 5(.0 \text{ s})$

1

(d) The wavelength decreases

1

(e) Time taken by the wave to travel the length of the tray

1

(f) Depth of water

1

(g) as the depth increases, the speed increases

allow positive correlation (between speed and depth)

1

(h) 0.49 (m/s)

1

[9]

5.

(a) Microwaves

1

Radio waves

1

(b) normal

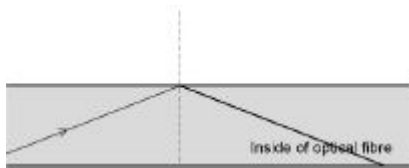
1

(c) reflected ray drawn to the right of the normal

ignore arrows

1

correct ray of light drawn using a ruler with $i = r$



1

(d) they need to be flexible

ignore bendy / ductile / malleable / elastic

1

(e) transmitted

1

absorbed

1

absorbed

1

[9]

6.

(a) D

1

- (b) Any **one** from:
- mutation (of genes/DNA/chromosomes)
allow can damage OR destroy genes/DNA/chromosomes
ignore damage/destroy cells/tissues/organs
ignore mutates cells
 - cancer/tumour
 - cell death
allow kills cells

1

- (c) the risk of harm is lower from the X-ray

1

by a factor of 60

1

- (d) 0.0060 sieverts

1

- (e) $\frac{0.1}{2.5} \times 100$

1

4 (%)

allow 0.04 for 1 mark

1

[7]

7.

- (a) it is harder to judge where the centre of a wider ray is

1

causing a larger uncertainty (in the measurements)

allow increasing random errors (in the measurements)

1

- (b) line of best fit drawn and extrapolated to 80 degrees

1

41 (degrees)

allow 40 to 43 (degrees)

1

(c) **Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced. 5-6

Level 2: The design/plan 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 design/plan 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:

- 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 70 degrees.

allow use of optical pins instead of a ray box

(d) $\frac{(28 + 25 + 22)}{3} = 25$ 1

3 (degrees)

allow alternative method

$$28 - 22 = 6 (1)$$

$$= 3 (degrees) (1)$$

1

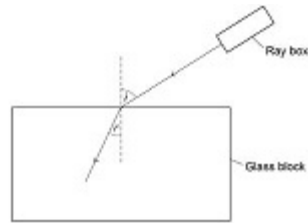
(e) Velocity 1

[13]

8.

(a) correct angle labelled

answer must indicate the angle, the letter r on it's own is insufficient



1

(b) 58 (degrees)

allow 57 to 59 inclusive

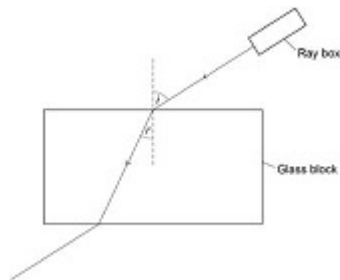
1

(c) ray continues in a straight line to the edge of the block

1

ray refracts away from the normal

1



both rays in the air should be parallel

judge by eye

1

(d) random

allow a correct answer indicated in the box provided the answer space is blank

1

(e) 25

1

(f) less than

allow a correct answer indicated in the box provided the answer space is blank

1

(g) there is no data/results outside of that range

allow that is all the student measured

1

(h) 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

(i) The angles of incidence tested

1

[11]