

Waves part 7 AQA Triple Physics

Name:

Class:

Date:

Time: **75 minutes**

Marks: **71 marks**

Comments:

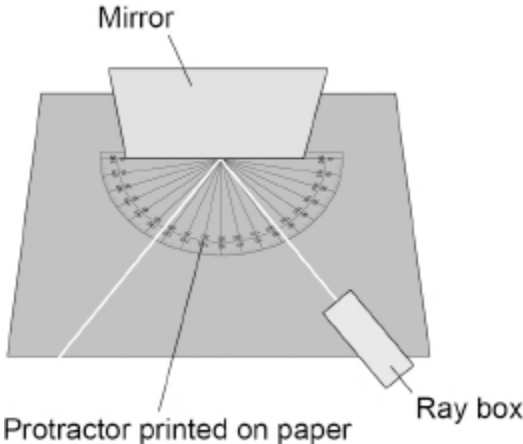
1.

A student investigated the behaviour of light.

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

Figure 1 shows the equipment used.

Figure 1



(a) What name is given to reflection from a smooth surface?

(1)

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

The table below shows the results.

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

(b) What conclusion can be made from the results in the table above?

(1)

(c) What type of error caused the variation in the results for the angle of reflection?

Suggest **one** cause of this error.

Type of error _____

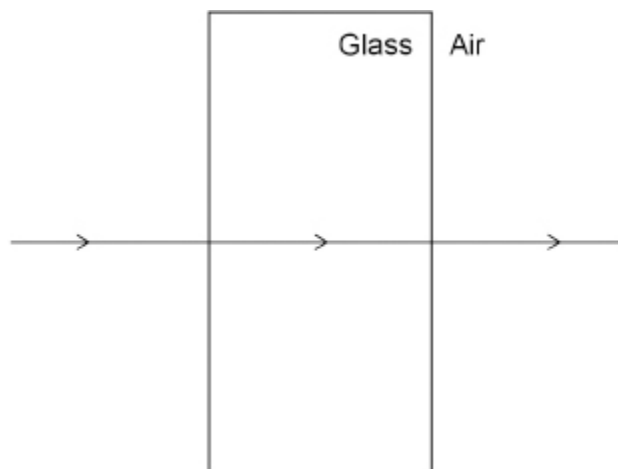
Cause of error _____

(2)

The student also investigated the refraction of light.

(d) **Figure 2** shows the path of a ray of light through a glass block.

Figure 2



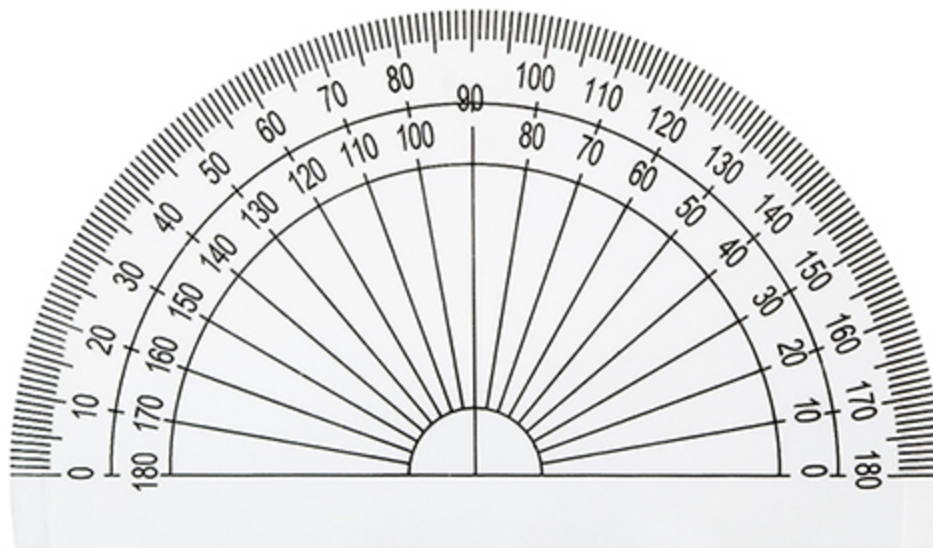
Why has refraction **not** occurred?

(1)

(e) The student measured the angle of refraction for different angles of incidence.

Figure 3 shows the protractor used.

Figure 3



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

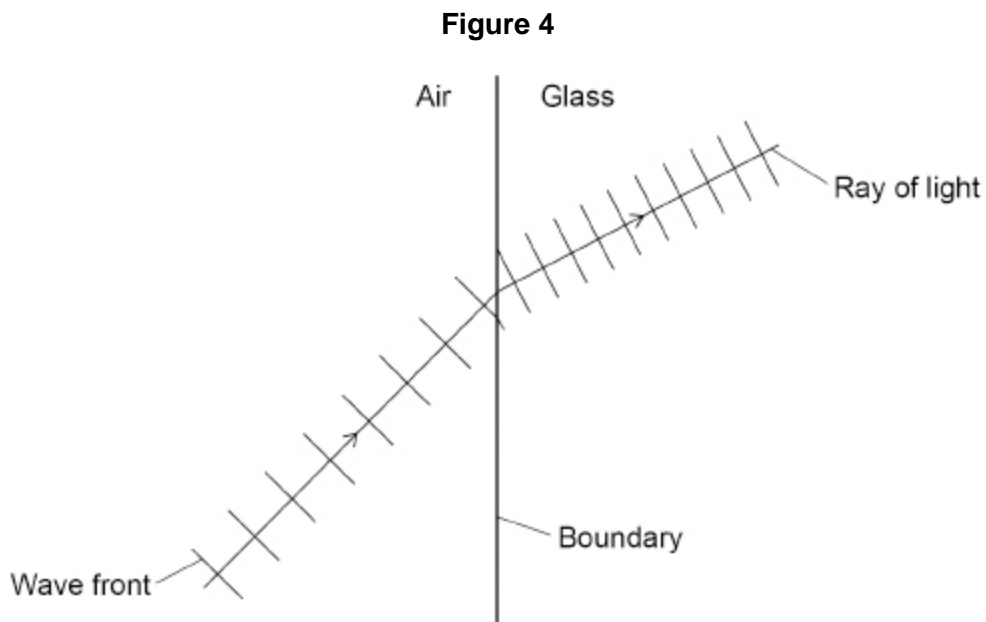
The student recorded the measurements as:

6.0° 6.3° 6.4° 5.8°

Explain why the student should **not** have recorded these results when using the protractor in **Figure 3** to make the measurements.

(2)

- (f) **Figure 4** shows what happens to wave fronts as they pass across the boundary between air and glass.



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

(3)
(Total 10 marks)

2.

Ultraviolet and visible light are both parts of the electromagnetic spectrum.

- (a) How does the speed of ultraviolet in a vacuum compare to the speed of visible light in a vacuum?

Tick (✓) **one** box.

Ultraviolet travels at a faster speed than visible light.

Ultraviolet travels at a slower speed than visible light.

Ultraviolet travels at the same speed as visible light.

(1)

- (b) **Figure 1** shows parts of the electromagnetic spectrum.

Figure 1

Radio waves	A	B	C	D	X-rays	Gamma rays
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Which letters represent the positions of ultraviolet and visible light in the electromagnetic spectrum?

Ultraviolet _____

Visible light _____

(2)

(c) **Table 1** shows the range of wavelengths for different types of ultraviolet.

Table 1

Type	Range of wavelength in nanometres
Ultraviolet A (UVA)	315–400
Ultraviolet B (UVB)	280–315
Ultraviolet C (UVC)	100–280

Determine which type of ultraviolet shown in **Table 1** has the largest range of wavelengths.

To gain full marks you must calculate the range of wavelengths for each type of ultraviolet.

Type of ultraviolet with the largest range of wavelengths _____

(3)

Figure 2 shows how different types of ultraviolet are absorbed by the ozone layer in the Earth's atmosphere.

Table 2 shows the relative ionising power from each type of ultraviolet.

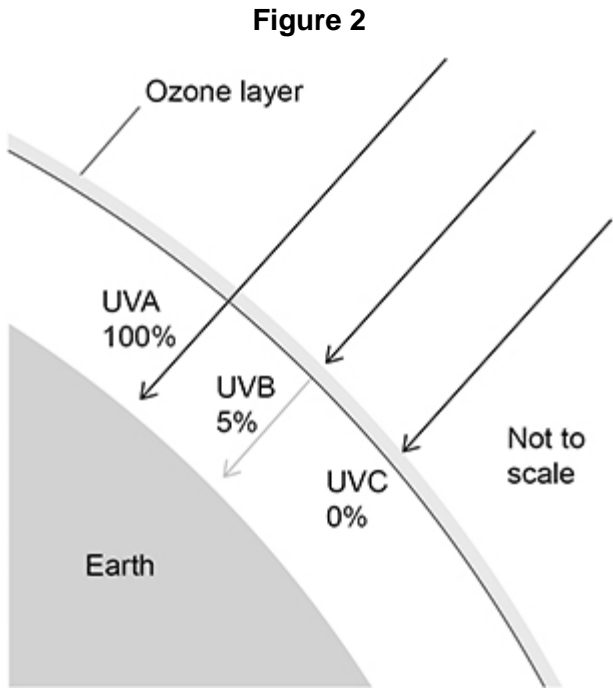


Table 2

Type	Relative ionising power
UVA	Low
UVB	Medium
UVC	High

(d) Explain the importance of the ozone layer in reducing the risk to people from all types of ultraviolet.

Use **Figure 2** and **Table 2**.

(4)

(e) The Sun emits visible light.

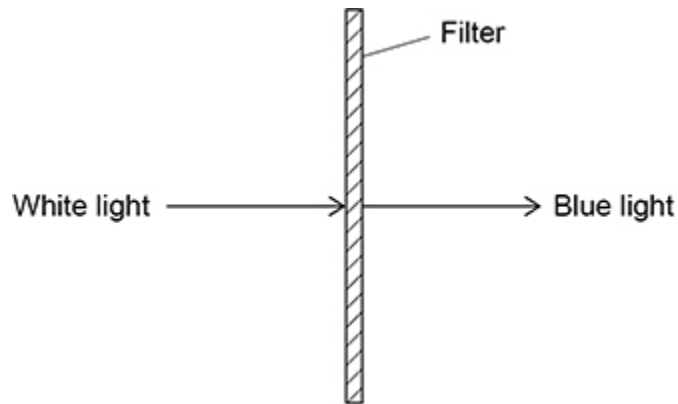
A student concludes that visible light is **not** absorbed by the ozone layer.

Give **one** piece of evidence that shows the student's conclusion is correct.

(1)

(f) **Figure 3** shows white light incident on a colour filter.

Figure 3



Complete the sentence.

Choose the answers from the box.

absorbed	radiated	reflected	refracted	transmitted
-----------------	-----------------	------------------	------------------	--------------------

When white light is incident on the filter, only blue light is _____

and all other colours of light are _____.

(2)

(Total 13 marks)

3.

Sound travels as longitudinal waves.

(a) Complete the sentences.

Choose the answers from the box.

amplitude	frequency	speed	wavelength
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The distance between the centre of one compression of a sound wave and the centre of the next compression is called the _____.

The number of waves passing a point each second is called the _____.

(2)

(b) Complete the sentence.

Choose the answer from the box.

opposite	perpendicular	parallel
-----------------	----------------------	-----------------

In a longitudinal wave, the oscillations are _____ to the direction of energy transfer.

(1)

(c) A sound wave has a frequency of 8.0 kHz.

Which of the following is the same as 8.0 kHz?

Tick (✓) **one** box.

0.0080 Hz

8.0 Hz

8000 Hz

800 000 Hz

(1)

(d) Calculate the period of a sound wave with a frequency of 8.0 kHz.

Use the Physics Equations Sheet.

Period = _____ s

(2)

(e) Calculate the wavelength of a sound wave with a frequency of 6600 Hz.

speed of sound = 330 m/s

Use the equation:

$$\text{wavelength} = \frac{\text{speed}}{\text{frequency}}$$

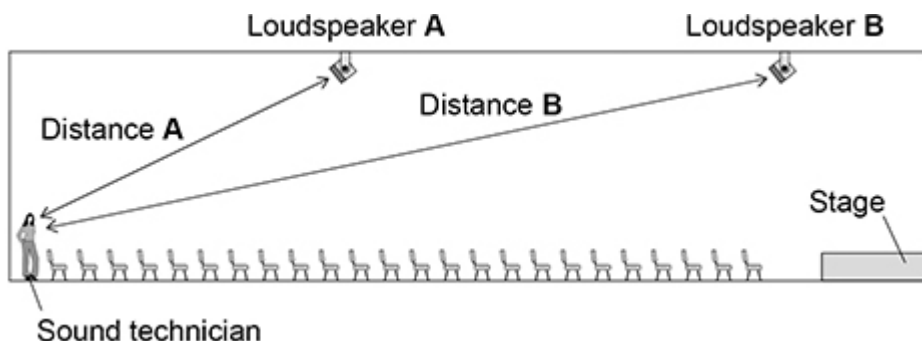
Choose the unit from the box.

kg	m	N
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Wavelength = _____ Unit _____

(3)

The figure below shows the arrangement of two loudspeakers at a concert venue.



The loudspeakers in above diagram are tested by playing the same song through both loudspeakers.

A sound technician listens to the song.

Use the Physics Equations Sheet to answer parts (f) and (g).

(f) Write down the equation which links distance (s), speed (v) and time (t).

(1)

(g) Distance **A** on above diagram is 13.2 m.

speed of sound = 330 m/s

Calculate the time taken for the sound to travel from loudspeaker **A** to the technician.

Time taken = _____ s

(3)

(h) The sound from each loudspeaker travels at the same speed.

For the sound technician to hear the song clearly, the sound from loudspeaker **B** should be emitted slightly before the sound from loudspeaker **A**.

Explain why.

(3)

(Total 16 marks)

4.

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

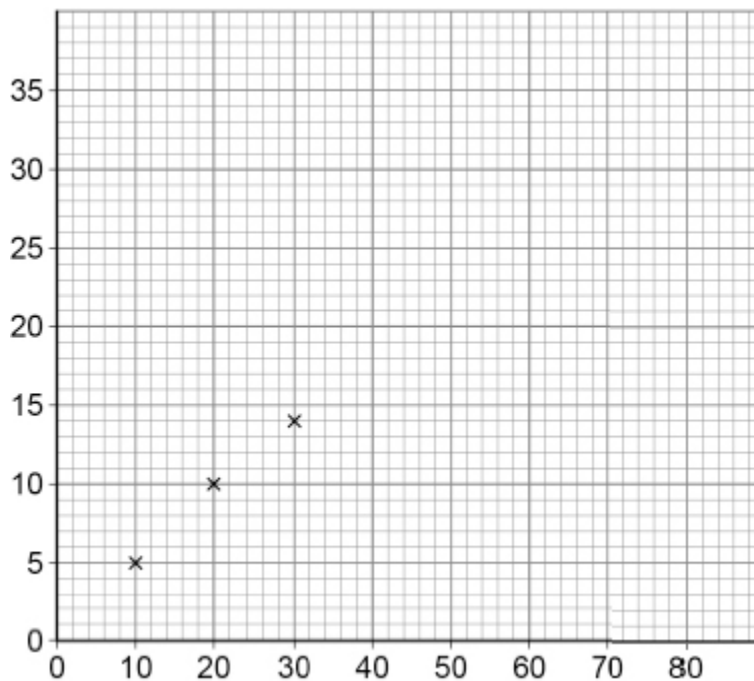
The student investigated how the angle of refraction varied with the angle of incidence.

The table below shows the results.

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

(b) **Figure 1** is an incomplete graph of the results.

Figure 1



Complete **Figure 1** using data from above table.

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

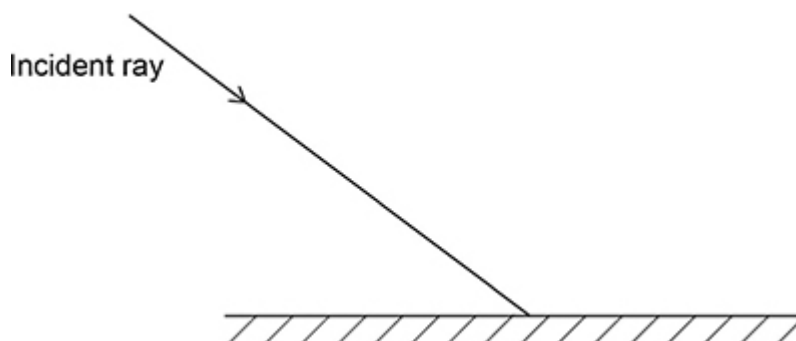
(4)

(c) Complete the ray diagram in **Figure 2** to show the reflection of light from the surface of a plane mirror.

You should:

- draw the normal line
- draw the reflected ray.

Figure 2

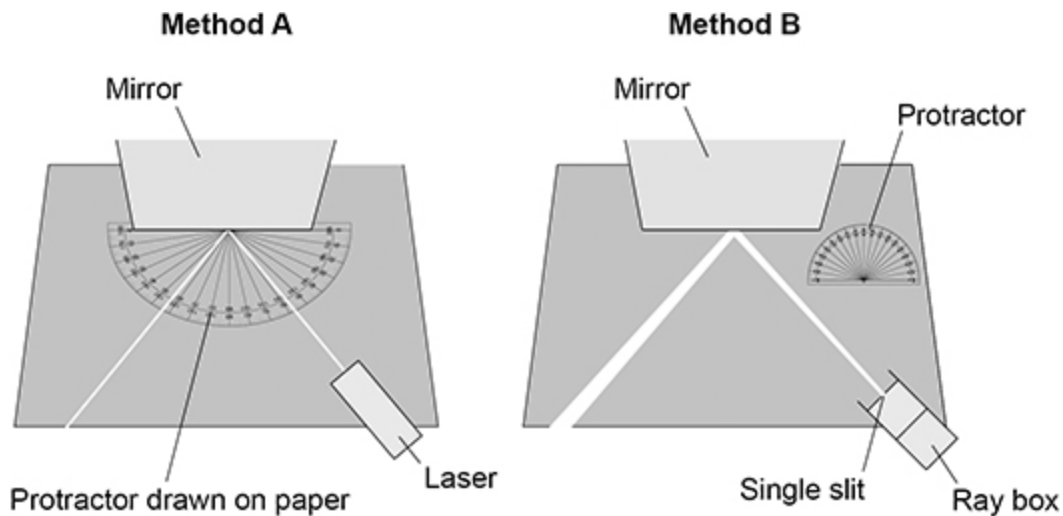


(2)

(d) Two students investigated the reflection of light by a plane mirror.

Figure 3 shows the different equipment the students used.

Figure 3



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

1. _____

2. _____

(4)
(Total 16 marks)

5. Figure 1 shows a water wave.

Figure 1



(a) What type of wave is a water wave?

Tick (✓) **one** box.

Electromagnetic

Longitudinal

Transverse

(1)

(b) Which statement describes the movement of the water at point **X**?

Tick (✓) **one** box.

The water at point **X** does **not** move.

The water at point **X** moves to the left and right.

The water at point **X** moves up and down.

(1)

(c) The wave has a frequency of 2.0 hertz.

The wavelength is 0.032 metres.

Calculate the wave speed.

Use the equation:

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$

Choose the unit from the box.

m^2/s	m/s	s^2
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Wave speed = _____ Unit _____

(3)

(d) What is transferred by all waves?

Tick (✓) **one** box.

Energy

Information

Water

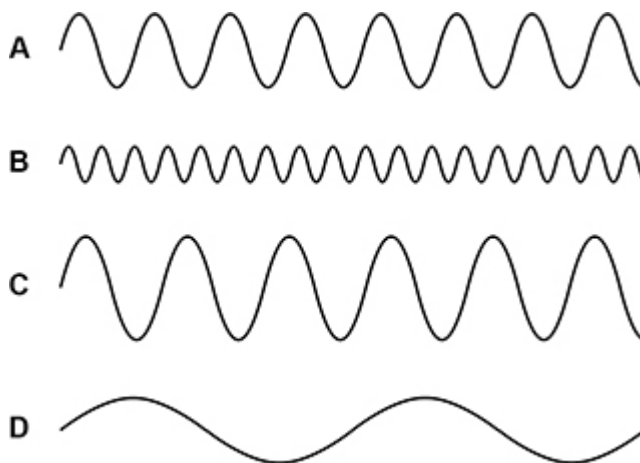
(1)

Figure 2 shows four water waves.

The waves are all drawn to the same scale.

The waves all travel at the same speed.

Figure 2



(e) Which wave has the longest wavelength?

Tick (✓) **one** box.

A

B

C

D

(1)

(f) Which wave has the highest frequency?

Tick (✓) **one** box.

A

B

C

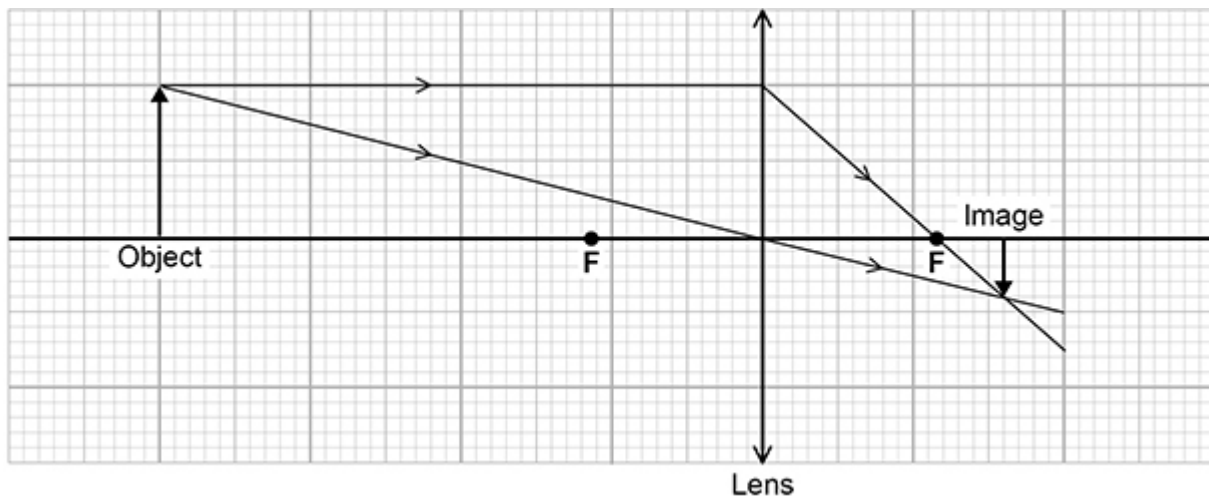
D

(1)

(Total 8 marks)

6.

The graph below shows how a lens forms an image of an object.



(a) What type of lens is represented in the graph above?

Tick (✓) **one** box.

Concave

Convex

Diverging

(1)

(b) Measure the image height and the object height in the graph above.

Image height = _____ cm

Object height = _____ cm

(1)

(c) Calculate the magnification produced by the lens.

Use the equation:

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

Magnification = _____

(2)

(d) Which **two** words describe the image in the graph above?

Tick (✓) **two** boxes.

Enlarged

Inverted

Real

Upright

Virtual

(2)

(e) The object was blue.

A student looked at the blue object through a green filter.

Complete the sentences.

Choose answers from the box.

black	blue	green	red	white
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Looking at the blue object through a green filter makes the object

appear _____.

This is because the green filter only transmits the light that is _____.

(2)

(Total 8 marks)

Mark schemes

- 1.** (a) specular (reflection) 1
- (b) the angle of incidence = the (mean) angle of reflection 1
- (c) random 1
- any **one** from:
- the student's eye / head might not be in the same position each time
allow parallax
 - the centre of the ray may not have been marked correctly
 - the mirror / ray box may not have been (re)placed correctly
allow protractor not in the correct position
incorrect measurement of the angle(s) is insufficient 1
- (d) all points on a wavefront enter the glass at the same time
allow incident ray (of light) is along the normal 1
- (e) the resolution (of the protractor) is 1(°) 1
- (so) could not be used to measure the difference between the results
allow (so) could not be used to measure to 1 decimal place 1
- (f) different parts of the wavefront enter the glass at different times 1
- the velocity / speed (of light) is less in glass 1
- (so) one part of the wave front changes speed before other parts 1
- [10]**
- 2.** (a) ultraviolet travels at the same speed as visible light 1
- (b) D 1
- C 1
- this order only*

- (c) A $400 - 315 = 85$ (nm)
 B $315 - 280 = 35$ (nm)
 C $280 - 100 = 180$ (nm)
- three calculations correct 2 marks*
one or two calculations correct 1 mark

2

ultraviolet C (UVC)

mark dependent on all three calculations being made

1

- (d) **Level 2:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.

3-4

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 doesn't 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

- (e) our eyes detect visible light
- allow it would be dark all the time*
allow specific effect ie plants couldn't grow

1

- (f) transmitted

1

absorbed

1

this order only

[13]

3. (a) wavelength 1
- frequency 1
- this order only*
- (b) parallel 1
- (c) 8000 Hz 1
- (d) period = $\frac{1}{8000}$ 1
- allow ecf from part (c)*
- 0.000125 (s) 1
- (e) $\lambda = \frac{330}{6600}$ 1
- $\lambda = 0.050$ 1
- allow 0.05*
- m 1
- (e) distance travelled = speed \times time
- or**
- $s = vt$
- allow any correct rearrangement* 1
- (f) $13.2 = 330 \times t$ 1
- $t = \frac{3600}{120}$ 1
- $t = 0.040$ (s) 1
- allow 0.040 (s)*

(g) loudspeaker **B** is closer to the technician (than speaker **A**)

'it' means speaker B

1

so the sound would take more time to travel (to the technician)

1

so the sound from each speaker arrives at the technician at the same time

1

[16]

4.

(a) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

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

- (b) angle of incidence in degrees / ° on x-axis **and** angle of refraction in degrees / ° on y-axis 1
- 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
- (c) normal drawn at 90° at the point where the incident ray strikes the mirror 1
- straight line drawn with a ruler **and** angle of incidence = angle of reflection
ignore any arrows 1
- (d) (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
- (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
- [16]**
- 5.** (a) transverse 1
- (b) the water at point **X** moves up and down 1

(c) $v = 2.0 \times 0.032$

1

$v = 0.064 \text{ (m/s)}$

1

m/s

1

(d) energy

1

(e) **D**

1

(f) **B**

1

[8]

6.

(a) convex

1

(b) In Exampro, the measurement of 0.8 cm or 2.0 cm will depend on the printing of the exported diagram and should therefore be checked by the teacher/student using this mark scheme.

image height = 0.8 (cm)

and

object height = 2 (.0 cm)

both correct for 1 mark

1

(c) magnification = $\frac{\text{magnification} = 0.8 \text{ (cm)}}{2 \text{ (.0 cm)}}$

allow their measured object and image heights from question (b)

1

magnification = 0.4(0)

1

(d) inverted

1

real

1

(e) black

this order only

1

green

1

[8]