Waves part 5 AQA Triple Physics

Name: _____

Class: _____

Date: _____

Time: **78 minutes**

Marks: **72 marks**

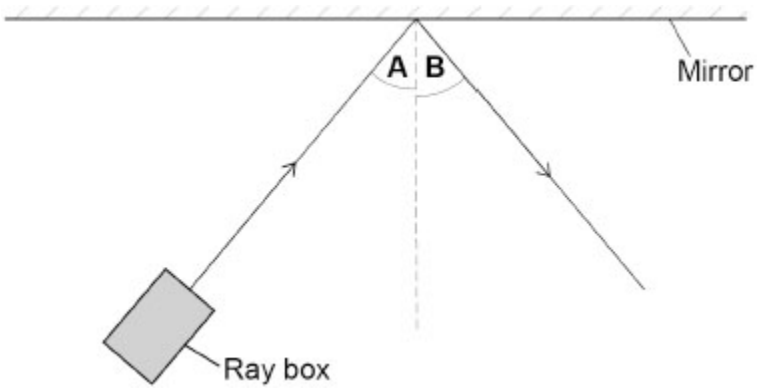
Comments:

1. Light waves and water waves can both be reflected.

A student used a ray box and a mirror to investigate the reflection of light.

Figure 1 shows some of the apparatus used.

Figure 1



(a) The student measured angle **A** and angle **B**.

What equipment should the student have used to measure each angle?

_____

_____

(1)

The student moved the ray box and changed the direction of the ray of light.

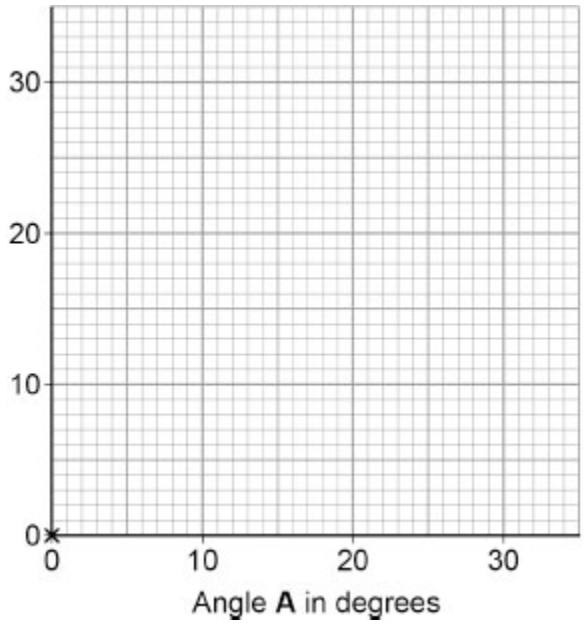
The student recorded different pairs of values of angle **A** and angle **B**.

The table below shows the results.

Angle A in degrees	Angle B in degrees
0	0
5	5
11	11
20	20
29	29

(b) **Figure 2** shows an incomplete graph of the results.

Figure 2



Complete **Figure 2**.

You should:

- label the *y*-axis
- plot the remaining data from the table above
- draw a line of best fit.

(4)

(c) What is the relationship between angle **A** and angle **B**?

Tick (✓) **one** box.

Angle **A** is directly proportional to angle **B**. ☐

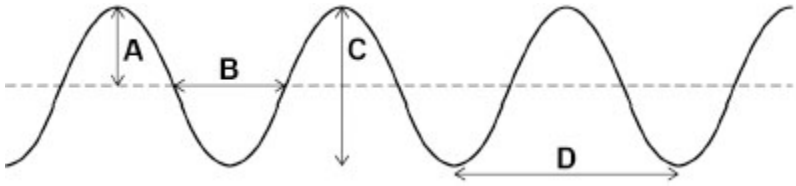
There is a negative correlation between angle **A** and angle **B**. ☐

The relationship between angle **A** and angle **B** is non-linear. ☐

(1)

Figure 3 represents a water wave.

Figure 3



(d) Which letter represents the amplitude of the water wave in **Figure 3**?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(e) Which letter represents the wavelength of the water wave in **Figure 3**?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(f) A water wave in a ripple tank has a wave speed of 0.125 m/s.

The wave has a frequency of 2.5 Hz.

Calculate the wavelength of the wave.

Use the equation:

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

Choose the unit from the box.

m	Pa	kg / m

Wavelength = _____ Unit _____

(3)

(g) The wave has a frequency of 2.5 Hz.

Calculate the period of the wave.

Use the equation:

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

Period = _____ s

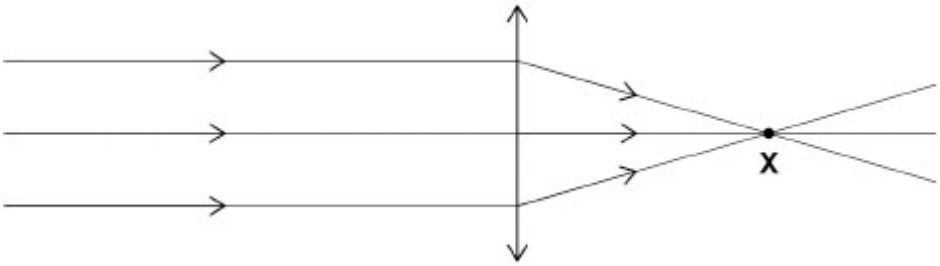
(2)

(Total 13 marks)

2. Some people wear glasses when they are reading.

Figure 1 shows parallel rays of light passing through a convex lens from a pair of reading glasses.

Figure 1



(a) What name is given to point **X** in **Figure 1**?

Tick (✓) **one** box.

Focal length ☐

Principal axis ☐

Principal focus ☐

(1)

(b) Light changes direction as it enters the lens.

What is the name of this process?

Tick (✓) **one** box.

Emission ☐

Reflection ☐

Refraction ☐

(1)

(c) Which of the following is the shape of a convex lens?

Tick (✓) **one** box.

 ☐

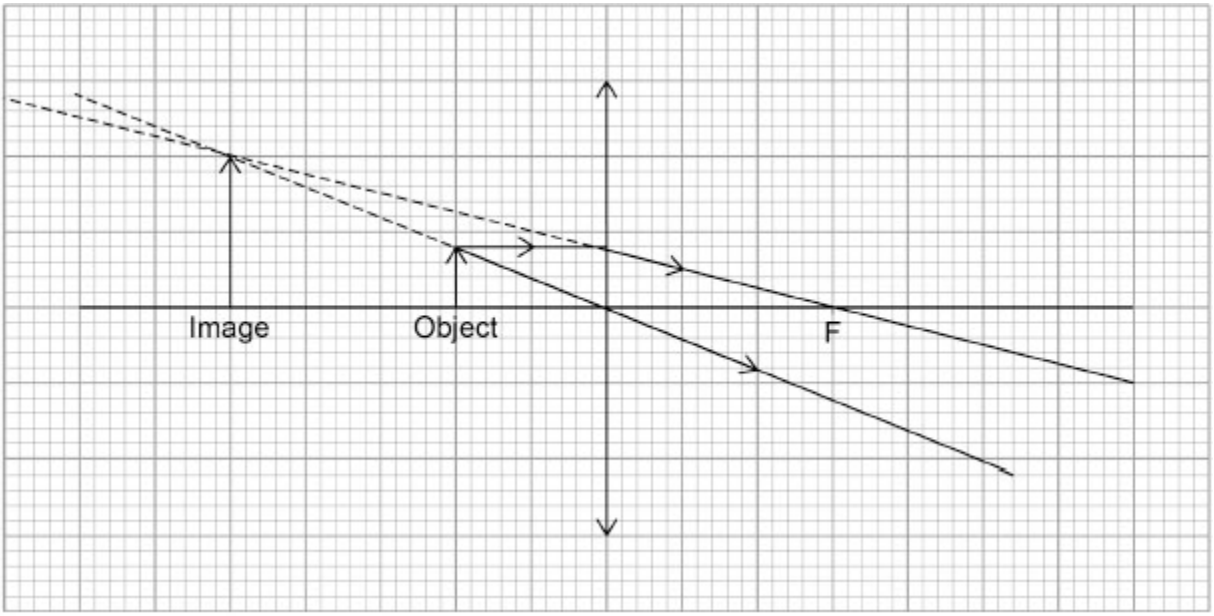
 ☐

 ☐

(1)

Figure 2 shows a lens forming a magnified image of an object.

Figure 2



(d) Measure the image height **and** the object height in **Figure 2**.

Image height = _____ cm

Object height = _____ cm

(1)

(e) Calculate the magnification produced by the lens.

Use your answers to part (d) and the equation:

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

_____

_____

_____

Magnification = _____

(2)

(f) Why does magnification have no unit?

Tick (✓) **one** box.

Magnification is a height. ☐

Magnification is a power. ☐

Magnification is a ratio. ☐

(1)

(g) Some reading glasses contain lenses made from blue glass.

The blue glass acts as a filter.

Describe what happens to white light incident on colourless glass **and** white light incident on blue glass.

Colourless glass _____

_____

_____

Blue glass _____

_____

_____

(3)

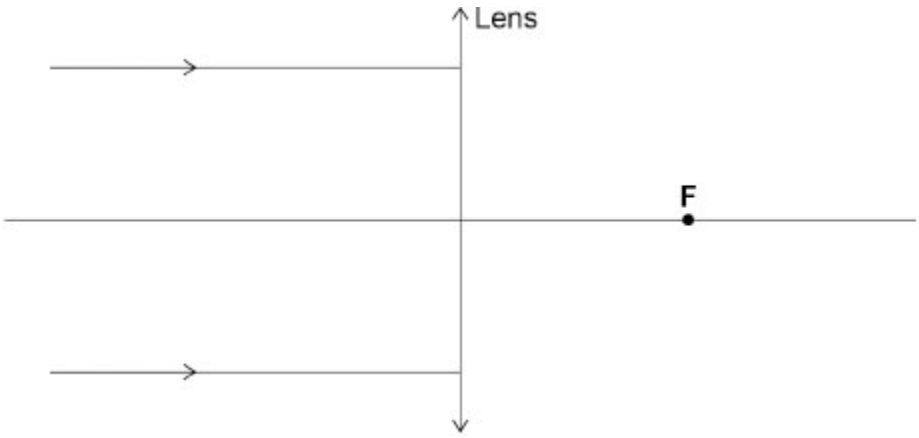
(Total 10 marks)

3. Telescopes are used to look at distant objects.

Some telescopes use lenses to form an image.

The figure below shows two parallel rays of light incident on a lens in a telescope.

The principal focus of the lens is labelled **F**.



(a) What type of lens is shown in the figure above?

_____

(1)

(b) Complete the ray diagram in the figure above.

(2)

The James Webb Space Telescope can detect electromagnetic radiation beyond the visible spectrum.

(c) The shortest wavelength of electromagnetic radiation that can be detected by the James Webb Space Telescope is 0.60 µm.

speed of electromagnetic radiation = 3.0×10^8 m/s

Calculate the frequency of electromagnetic radiation that has a wavelength of 0.60 µm.

Use the Physics Equations Sheet.

_____

_____

_____

_____

_____

_____

_____

Frequency = _____ Hz

(4)

(d) Complete the sentence.

Electromagnetic radiation detected from distant galaxies is red-shifted.

This means that the electromagnetic radiation shows an increase in

_____.

(1)

(e) Why is the electromagnetic radiation from distant galaxies red-shifted?

Tick (✓) **one** box.

All observed light from distant galaxies appears red. ☐

Distant galaxies are moving away from our galaxy. ☐

Distant galaxies are moving at the speed of light. ☐

(1)

(f) The James Webb Space Telescope has detected electromagnetic radiation from many different galaxies.

Electromagnetic radiation from one of the galaxies detected shows the greatest red-shift ever observed.

What conclusion can be made about the distance to this galaxy?

_____

_____

(1)

(g) The James Webb Space Telescope is an artificial satellite that orbits the Sun at a constant speed.

Explain why the velocity of the satellite changes as it orbits the Sun.

_____

_____

_____

_____

_____

_____

(3)

(Total 13 marks)

4. In a thunderstorm, lightning produces visible light waves and sound waves.

(a) Describe the similarities and differences between visible light waves and sound waves.

(6)

Use the Physics Equations Sheet to answer parts (b) and (c).

(b) Which equation links distance (*s*), speed (*v*) and time (*t*)?

Tick (✓) **one** box.

speed = distance × time ☐

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$ ☐

$$\text{speed} = \frac{\text{time}}{\text{distance}}$$ ☐

(1)

(c) Lightning strikes the ground 13 200 m from a student.

The speed of sound in air is 330 m/s.

Calculate the time taken for the sound created by the lightning strike to reach the student.

_____

_____

_____

_____

_____

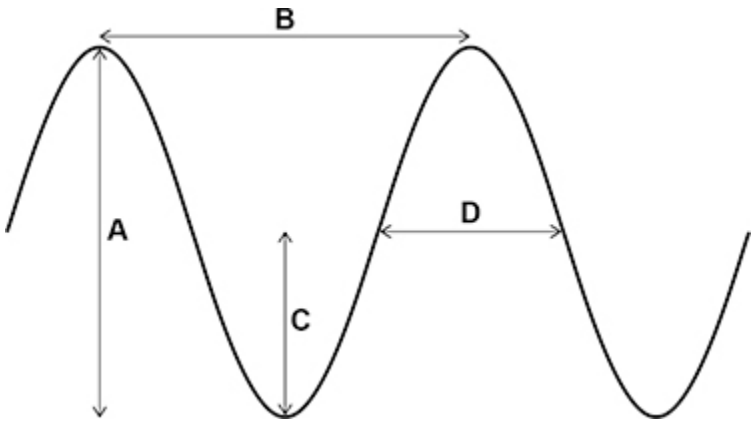
Time = _____ s

(3)

(Total 10 marks)

5. **Figure 1** represents a transverse wave.

Figure 1



(a) Which arrow represents the amplitude of the wave?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(b) Which arrow represents the wavelength of the wave?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(c) A wave has a frequency of 5000 Hz.

Calculate the period of the wave.

Use the equation:

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

Period = _____ s

(2)

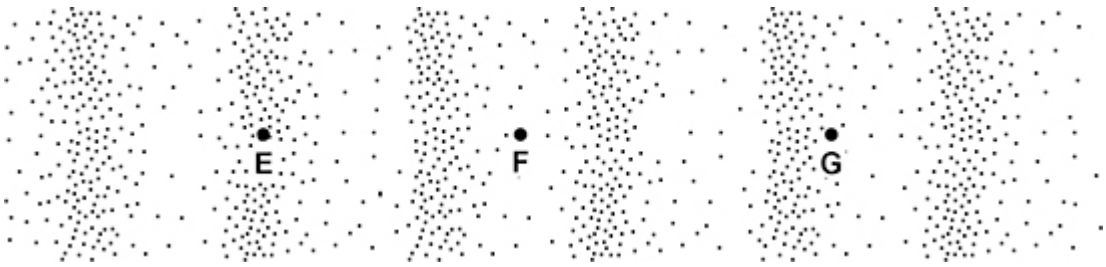
(d) Give **one** example of a transverse wave that can travel through a vacuum.

_____

(1)

(e) **Figure 2** represents a longitudinal wave.

Figure 2



Which point is at the centre of a rarefaction?

Tick (✓) **one** box.

E ☐ **F** ☐ **G** ☐

(1)

(f) A sound wave has a frequency of 750 Hz.

speed of sound in air = 330 m/s

Calculate the wavelength of the sound wave.

Use the equation:

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

Wavelength = _____ m

(2)

(g) Describe a method that could be used to determine the speed of sound in air.

(4)

(h) When a sound wave moves from air into water, the speed of the wave increases.

The frequency of the sound wave does **not** change.

Complete the sentence.

Choose the answer from the box.

decreases	**stays the same**	**increases**

When a sound wave moves from air into water its wavelength

_____ .

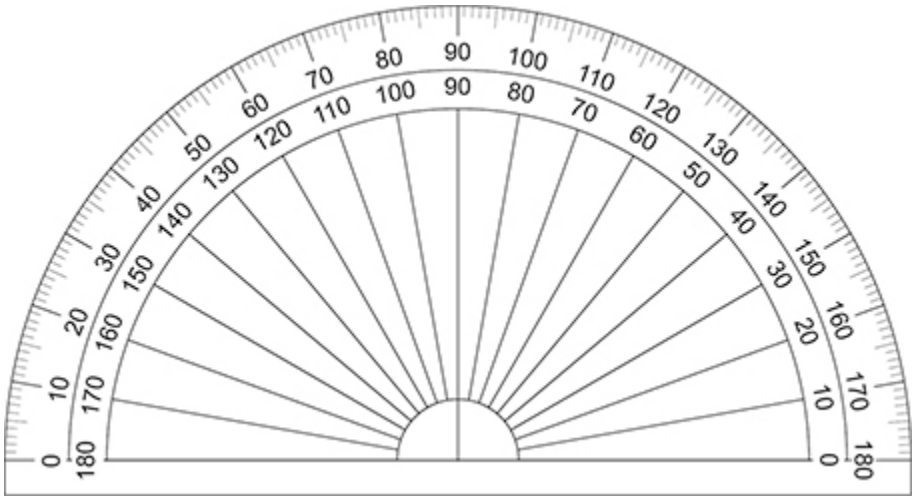
(1)

(Total 13 marks)

6. 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



(a) What is the resolution of the protractor used to measure the angles?

Resolution = _____ °

(1)

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

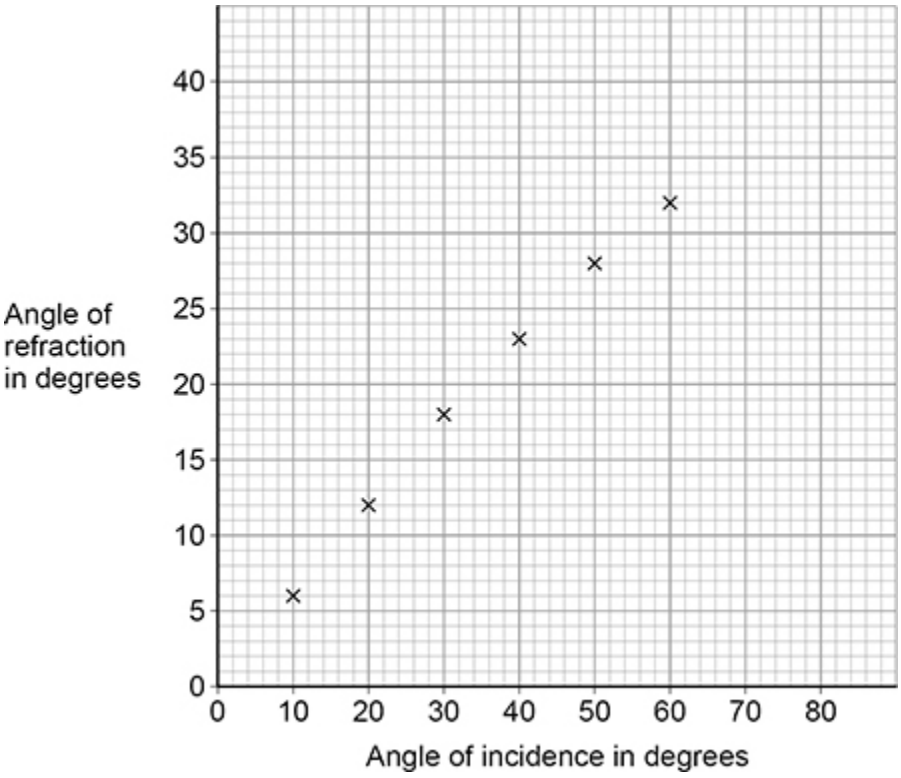
(b) Describe a method the student could have used to obtain the data in **Table 1**.

You may include a labelled diagram.

(6)

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

(c) Complete **Figure 2**.

You should:

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

(2)

(d) How does **Figure 2** show that the angle of refraction is **not** directly proportional to the angle of incidence?

_____

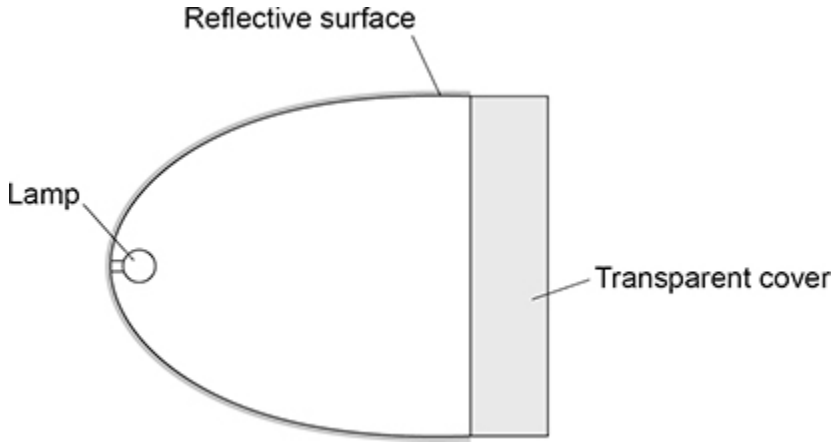
_____

(1)

Figure 3 shows a diagram of a car headlight.

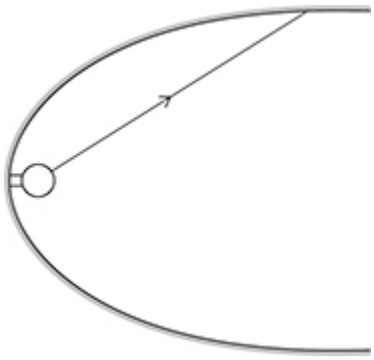
The headlight has a lamp, a reflective surface and a transparent cover.

Figure 3



(e) **Figure 4** shows a ray of light incident on the reflective surface.

Figure 4



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

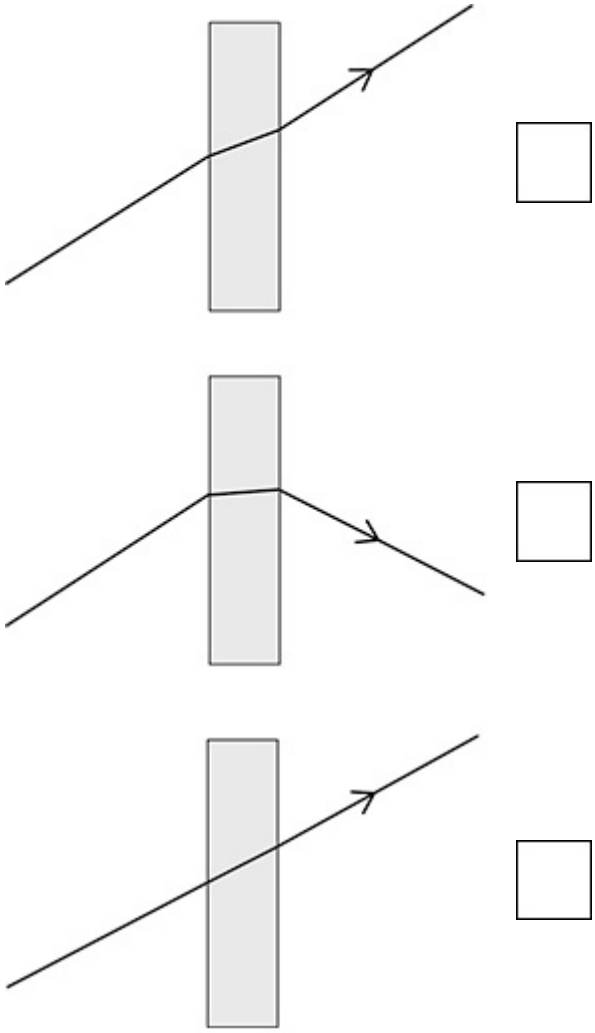
You should include the normal line at the point where the incident ray meets the reflecting surface.

(2)

(f) Rays of light pass through the transparent cover of the headlight.

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

Tick (✓) **one** box.



(1)

(Total 13 marks)

1.

(a) protractor

1

(b) angle **B** in degrees / ° on y-axis

1

all points correctly plotted

allow a tolerance of $\pm \frac{1}{2}$ *small square*

*allow **1** mark for 3 plotted correctly*

2

straight line of best fit drawn

allow a line of best fit from their plotted points

1

(c) angle **A** is directly proportional to angle **B**

1

(d) A

1

(e) D

1

(f)

$$\lambda = \frac{0.125}{2.5}$$

1

0.050

1

m

allow 5.0 cm

1

(g)

$$T = \frac{1}{2.5}$$

1

0.40 (s)

allow 0.4 (s)

1

[13]

2.

(a) principal focus

1

(b) refraction

1

(c)

1

(d) image height = 2.0 (cm)

and

object height = 0.8 (cm)

1

(e)

$$\text{magnification} = \frac{2.0}{0.8}$$

allow ecf from (d)

1

2.5

1

(f) magnification is a ratio

1

(g) colourless glass:
(white) light is transmitted

allow all colours / wavelengths / frequencies (of white light) are transmitted

1

blue glass:
(only) blue light is transmitted

1

all other colours / wavelengths / frequencies of light are absorbed

allow blue glass will absorb green and red light

1

[10]

3. (a) convex

allow converging

1

(b) (the parallel) rays converging

1

rays meeting/crossing at the principal focus

1

(c) $0.60\ \mu m = 0.6 \times 10^{-6}\ m$

allow 0.60 μm = 0.000 000 6 m

all subsequent marks may be awarded if wavelength is incorrectly / not converted

1

$3.0 \times 10^{8} = f \times 0.6 \times 10^{-6}$

1

$$f = \frac{3.0 \times 10^{8}}{0.6 \times 10^{-6}}$$

1

$f = 5.0 \times 10^{14}$ (Hz)

1

(d) wavelength

1

(e) distant galaxies are moving away from our galaxy

1

(f) the distance to this galaxy is greater than any previously observed galaxies

1

(g) a gravitational / centripetal / resultant force acts on the satellite

1

(so) the satellite accelerates (towards the centre of the orbit)

*do **not** accept acceleration causes a change in speed*

1

(so) the direction changes (which changes the velocity)

1

[13]

4. (a) **Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account

4-6

Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear

1-3

No relevant content

0

Indicative content

Differences

- sound waves are mechanical whereas visible light waves are electromagnetic waves
- sound waves require a medium to travel through whereas visible light waves can travel through a vacuum
- sound waves are longitudinal whereas visible light waves are transverse
- sound waves travel slower (in air) than visible light waves
- sound waves travel faster in solids than in air whereas visible light waves travel slower in solids than in air
- sound waves have longer wavelengths than visible light
- sound waves have a lower frequency than visible light waves

Similarities

- both types of waves can be reflected
- both types of waves can be refracted
- both types of waves can be diffracted
- both types of wave transfer energy

(b)

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

1

(c)

$$330 = \frac{13\,200}{t}$$

or

$13\,200 = 330 \times t$

1

$$t = \frac{13\,200}{330}$$

1

40 (s)

1

[10]

5. (a) C

1

(b) B

1

(c)

$$\text{period} = \frac{1}{5000}$$

1

period = 0.0002 (s)

1

(d) any named electromagnetic wave

allow electromagnetic (wave)

1

(e) F

1

(f)

$$\text{wavelength} = \frac{330}{750}$$

1

= 0.44 (m)

1

(g) **Level 2:** The method would lead to the production of a valid outcome. The key steps are identified and 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

method of making sound

eg cymbals, wooden blocks, starting pistol

measuring distance

- measuring distance between sound source and detector eg distance to wall, distance along track, distance between microphones
- use of measuring instrument eg tape measure, trundle wheel, metre rule

measuring time

- timing started when sound made and timing stopped when sound heard
- use of measuring instrument eg stopwatch, oscilloscope, data logger

extra detail

- dividing time by 2 or multiply distance by 2 for echo method
- use of equation speed = $\frac{\text{distance}}{\text{time}}$

(h) increases

1

[13]

6. (a) 1 (°)

1

(b) **Level 3:** The method would lead to the production of a valid outcome. The 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 60 degrees

Methods involving mirrors and reflection score zero

(c) points plotted correctly

allow tolerance of ± half a small square

1

curve drawn passing through points

allow a line starting at the origin

1

(d) the line curves

allow the line is not straight

allow line does not pass through the origin if consistent with their answer to question (c

1

(e) normal drawn

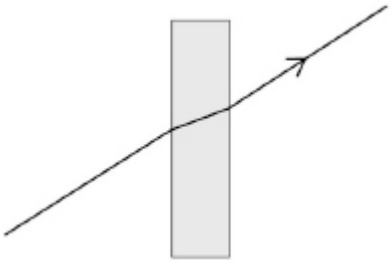
1

ray reflected so i = r

judge by eye

1

(f)



1

[13]