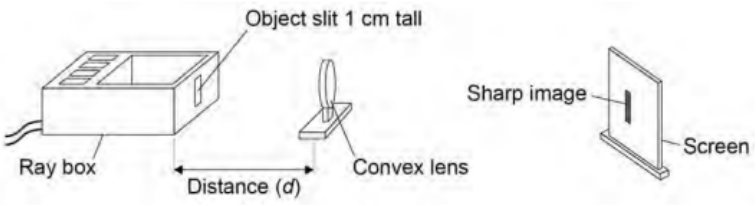
Waves GCSE AQA Higher Physics Past Papers Questions

01.

A student investigated how the magnification produced by a convex lens varies with the distance (*d*) between the object and the lens.

The student used the apparatus shown in **Figure 7**.

Figure 7



1 The student measured the magnification produced by the lens by measuring the image height in centimetres.

Explain why the image height in centimetres was the same as the magnification.

[2 marks]

The data recorded by the student is given in **Table 1**.

Table 1

Distance between the object and the lens in cm	Magnification
25	4.0
30	2.0
40	1.0
50	0.7
60	0.5

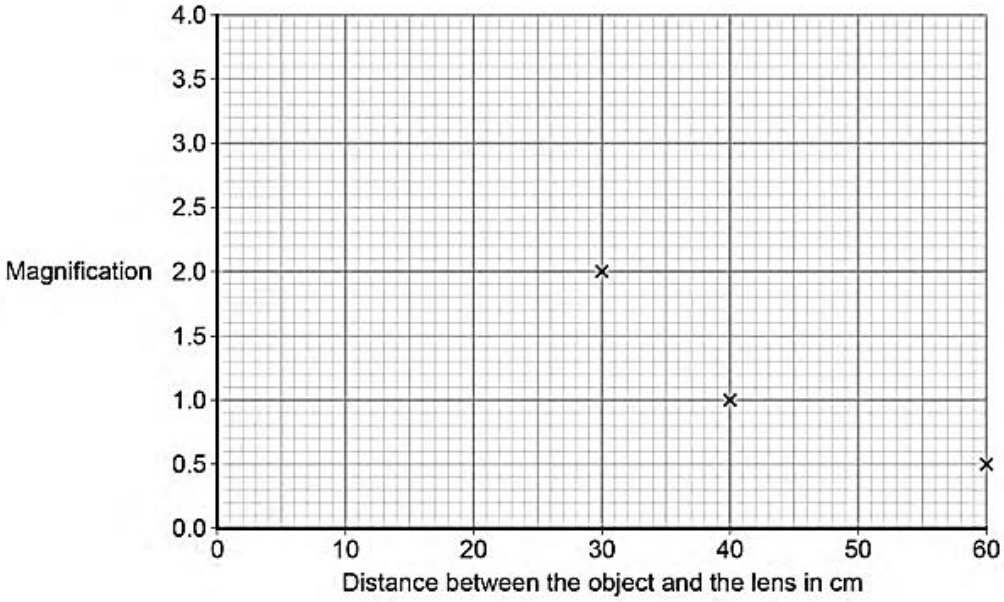
2 It would be difficult to obtain accurate magnification values for distances greater than 60 cm.

Suggest **one** change that could be made so that accurate magnification values could be obtained for distances greater than 60 cm.

[1 mark]

The graph in **Figure 8** is incomplete.

Figure 8



3 Complete the graph in **Figure 8** by plotting the missing data and then drawing a line of best fit.

[2 marks]

4 How many times bigger is the image when the object is 35cm from the lens compared to when the object is 55 cm from the lens?

[2 marks]

. 5 During the investigation the student also measured the distance between the lens and the image.

Table 2 gives both of the distances measured and the magnification.

Table 2

Distance between the lens and the image in cm	Distance between the lens and the object in cm	Magnification
100	25	4.0
60	30	2.0
40	40	1.0
33	50	0.7
30	60	0.5

Consider the data in **Table 2**.

Give a second way that the student could have determined the magnification of the object.

Justify your answer with a calculation.

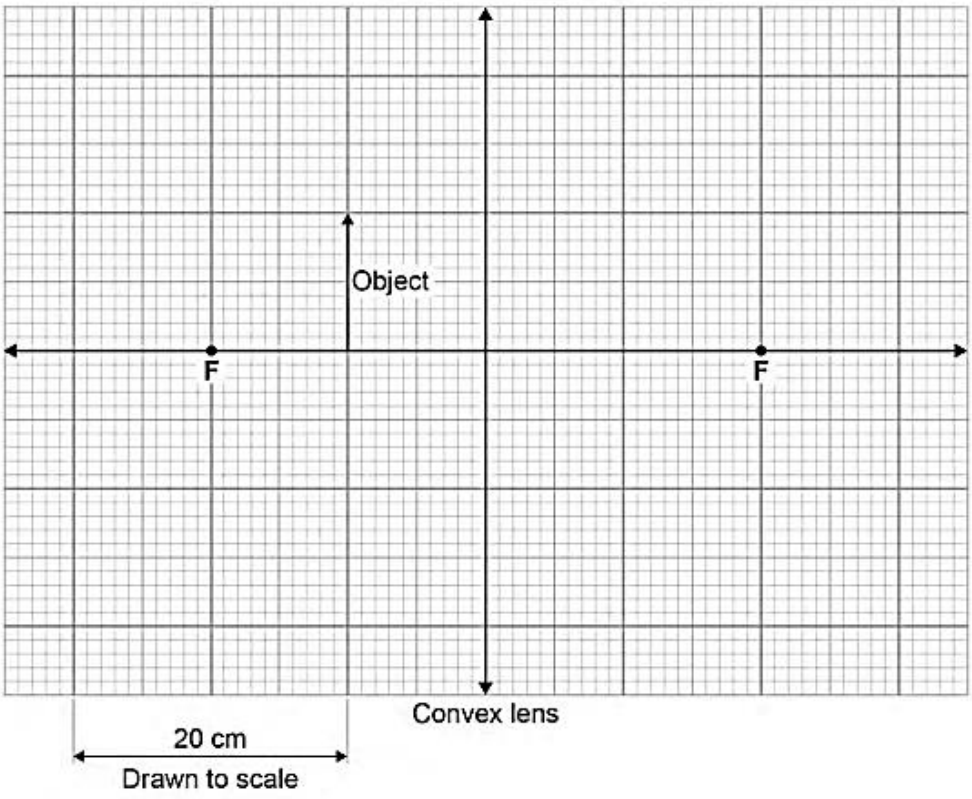
[2 marks]

6 Complete the ray diagram in **Figure 9** to show how the convex lens produces the image of a close object.

Use an arrow to represent the image.

[3 marks]

Figure 9



02.

The data given in **Table 3** was obtained from an investigation into the refraction of light at an air to glass boundary.

Table 3

Angle of incidence	Angle of refraction
20°	13°
30°	19°
40°	25°
50°	30°

1 Describe an investigation a student could complete in order to obtain similar data to that given in **Table 3**.

Your answer should consider any cause of inaccuracy in the data.

A labelled diagram may be drawn as part of your answer.

[6 marks]

2 State the reason why light is refracted as it crosses from air into glass.

[1 mark]

03.

P-waves and S-waves are two types of seismic wave caused by earthquakes.

. 1 Which **one** of the statements about P-waves and S-waves is correct?

Tick **one** box.

[1 mark]

P-waves and S-waves are transverse. ☐

P-waves and S-waves are longitudinal. ☐

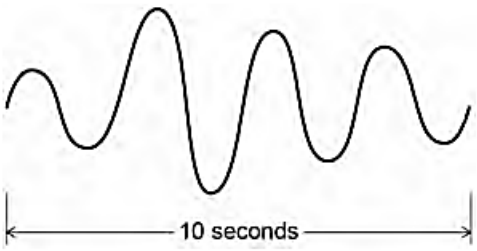
P-waves are transverse and S-waves are longitudinal. ☐

P-waves are longitudinal and S-waves are transverse. ☐

Seismometers on the Earth's surface record the vibrations caused by seismic waves.

Figure 3 shows the vibration recorded by a seismometer for one P-wave.

Figure 3



2 Calculate the frequency of the P-wave shown in **Figure 3**.

[1 mark]

_____

_____

Frequency = _____ Hz

3 Write down the equation which links frequency, wavelength and wave speed.

[1 mark]

_____

4 The P-wave shown in **Figure 3** is travelling at 7200 m/s.

Calculate the wavelength of the P-wave.

[3 marks]

_____

_____

_____

_____

Wavelength = _____ m

5 Explain why the study of seismic waves provides evidence for the structure of the Earth's core.

[2 marks]

_____

_____

_____

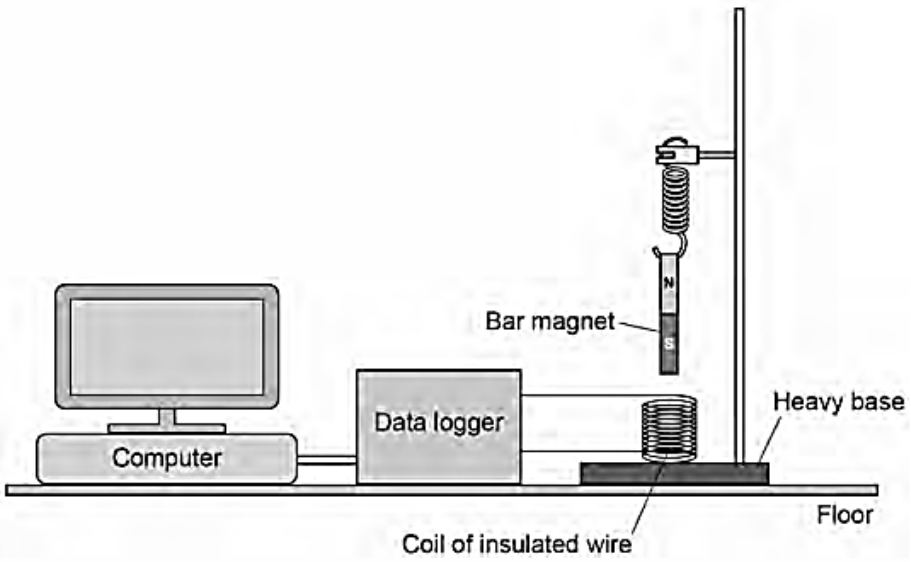
_____

_____

_____

Figure 4 shows a simple seismometer made by a student.

Figure 4



To test that the seismometer works, the student pushes the bar magnet into the coil and then releases the bar magnet.

6 Why does the movement of the bar magnet induce a potential difference across the coil?

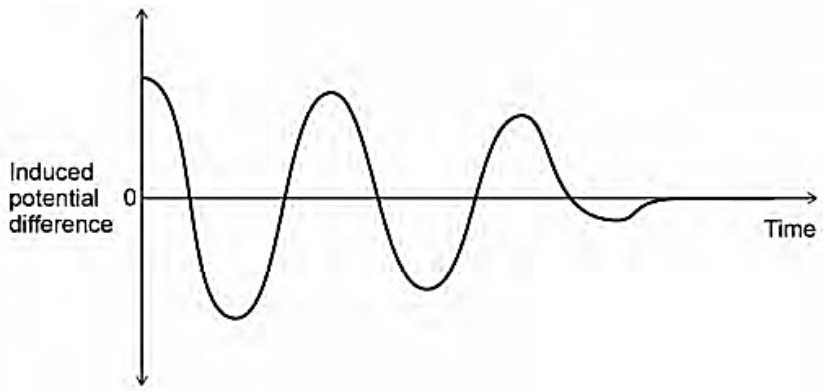
[1 mark]

7 Why is the induced potential difference across the coil alternating?

[1 mark]

. 8 **Figure 5** shows how the potential difference induced across the coil varies after the bar magnet has been released.

Figure 5



Which statement describes the movement of the magnet when the induced potential difference is zero?

Tick **one** box.

[1 mark]

Accelerating upwards. ☐

Constant speed upwards. ☐

Decelerating downwards. ☐

Stationary. ☐

. 9 The seismometer cannot detect small vibrations.

Suggest **two** changes to the design of the seismometer that would make it more sensitive to small vibrations.

[2 marks]

1 _____

_____

2 _____

_____

13

04.

Figure 7 shows the apparatus a student used to investigate the reflection of light by a plane mirror.

The student drew four ray diagrams for each angle of incidence.

The student measured the angle of reflection from each diagram.

Table 2 gives the student's results.

Figure 7

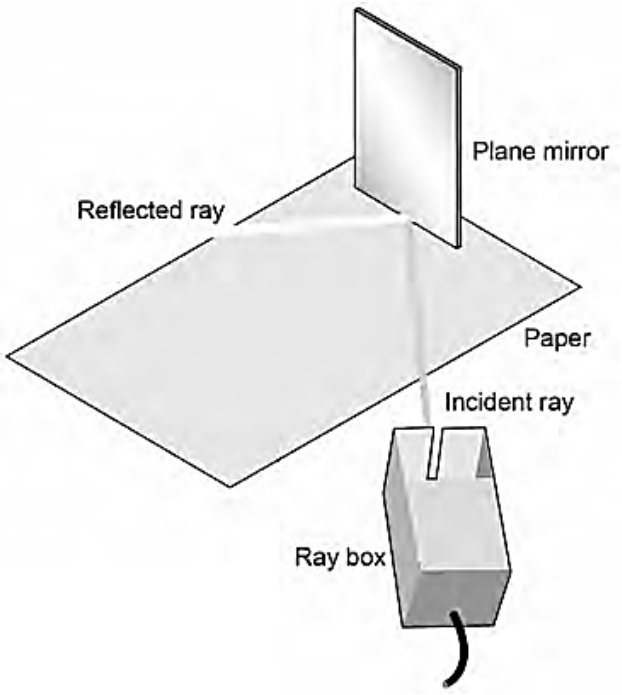


Table 2

	Angle of reflection			
Angle of incidence	**Test 1**	**Test 2**	**Test 3**	**Test 4**
20°	19°	22°	20°	19°
30°	31°	28°	32°	30°
40°	42°	40°	43°	41°
50°	56°	49°	53°	46°

1 For each angle of incidence, the angle of reflection has a range of values.

This is caused by an error.

What type of error will have caused each angle of reflection to have a range of values?

[1 mark]

2 Suggest what the student may have done during the investigation to cause each angle of reflection to have a range of values.

[1 mark]

3 Estimate the uncertainty in the angle of reflection when the angle of incidence is 50°.

Show how you determine your estimate.

[2 marks]

Uncertainty = $\pm$ _____ °

4 The student concluded that for a plane mirror, the angle of incidence is equal to the angle of reflection.

Explain whether you agree with this conclusion.

Use examples from the results in **Table 2** in your answer.

[2 marks]

. 5 What extra evidence could be collected to support the student's conclusion?

[1 mark]

. 6 State **one** change the student should make to the apparatus if he wants to use the same method to investigate diffuse reflection.

[1 mark]

8

05. 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.

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. ☐

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

[1 mark]

_____

_____

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]

_____

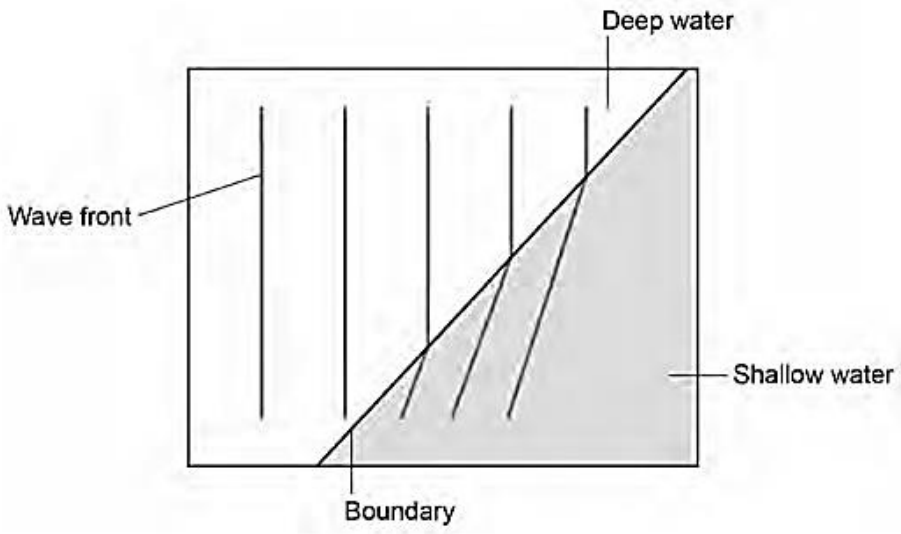
_____

_____

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

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

Figure 16

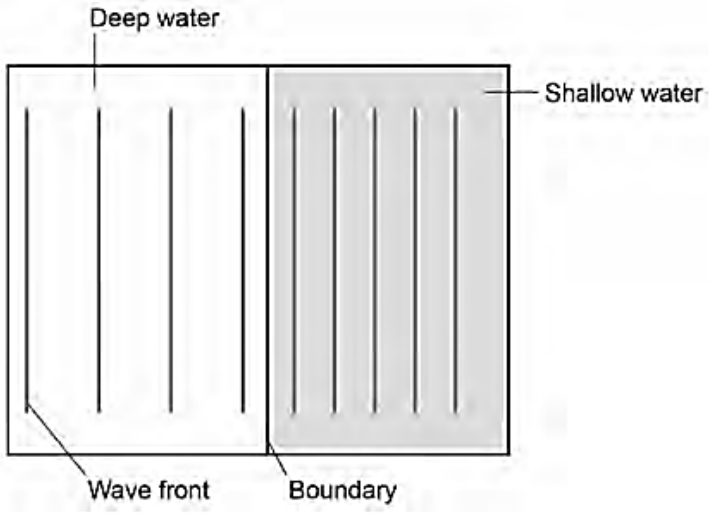


Explain why refraction happens at the boundary between the deep water and shallower water.

[3 marks]

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.

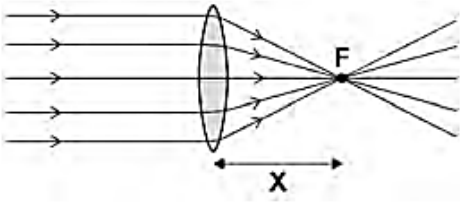
[2 marks]

11

06.

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

Figure 1



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

[1 mark]

_____

. 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

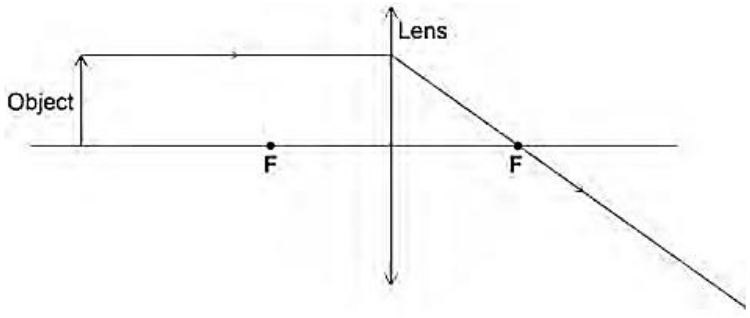
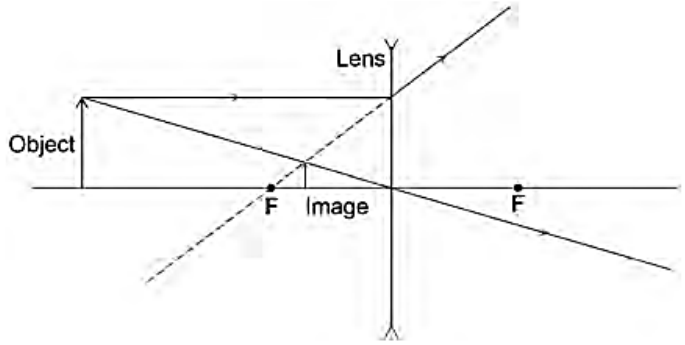


Figure 3 shows how a **concave** lens forms the image of an object.

Figure 3



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 _____

_____

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]

_____

_____

_____

_____

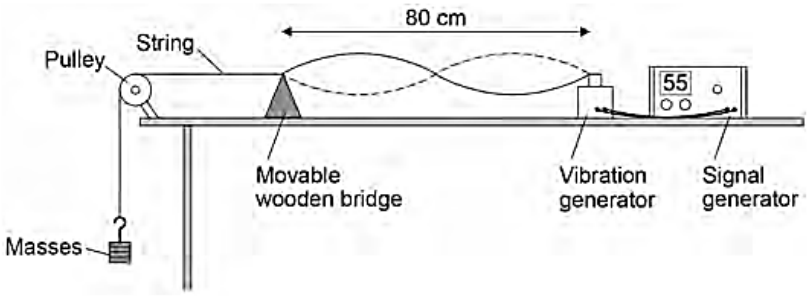
Height = _____ mm

—
8

07.

Figure 4 shows the apparatus used to investigate the waves in a stretched string.

Figure 4



The frequency of the signal generator is adjusted so that the wave shown in **Figure 4** is seen.

At this frequency the string vibrates between the two positions shown in **Figure 4**.

1 The wavelength of the wave shown in **Figure 4** was measured as 80 cm

What piece of apparatus would have been suitable for measuring this wavelength?

[1 mark]

_____

2 Write down the equation which links frequency, wavelength and wave speed.

[1 mark]

_____

3 The string **in Figure 4** vibrates at 55 Hz

Calculate the wave speed of the wave shown in **Figure 4**.

Use data given in **Figure 4**.

[3 marks]

_____

_____

_____

Wave speed = _____ m/s

. 4 The frequency of the signal generator is increased.

This makes the wavelength of the wave change.

The wave speed stays the same.

Describe how the apparatus could be adjusted to show one complete wave without reducing the frequency.

[2 marks]

. 5 A student wants to investigate how the speed of a wave on a stretched string depends on the tension in the string.

The student uses the apparatus in **Figure 4**.

Describe a method the student could use for this investigation.

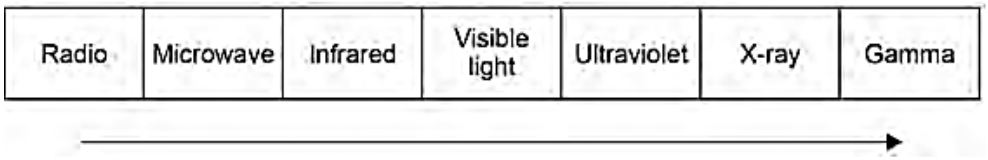
[4 marks]

11

08.

. 1 **Figure 12** shows the electromagnetic spectrum.

Figure 12



Which statement is correct for the direction of the arrow in **Figure 12**?

[1 mark]

Tick (✓) **one** box.

- The wavelength decreases and the wave speed in air increases. ☐
- The frequency increases and the wavelength increases. ☐
- The frequency increases and the wave speed in air stays the same. ☐
- The wavelength increases and the wave speed in air increases. ☐

. 2 Explain how the properties of X-rays make them suitable for the medical imaging of bones.

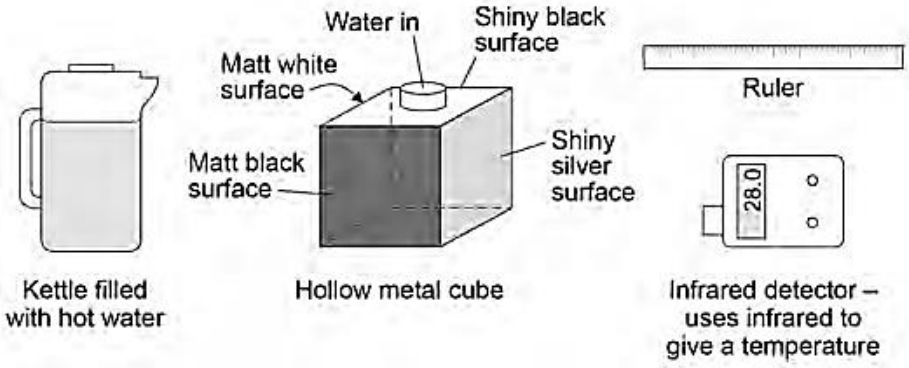
[2 marks]

A student investigated the infrared radiation emitted from the sides of a hollow metal cube.

The sides of the cube are different colours or textures.

Figure 13 shows the equipment used.

Figure 13



Boiling water was poured into the cube. The amount of infrared radiation emitted from each vertical surface was then measured.

3 Boiling water is a hazard in this investigation.

Suggest how the risk of harm could be reduced in this investigation.

[1 mark]

4 What is the control variable in this investigation?

[1 mark]

Table 2 shows the results.

Table 2

Type of surface	Temperature in °C
Matt black	68.0
Matt white	65.5
Shiny black	66.3
Shiny silver	28.0

. 5 The four temperature values in **Table 2** cannot be used to show that the infrared detector gives precise readings.

Give the reason why.

[1 mark]

. 6 The student looked at the data in **Table 2** and concluded:

'A black surface always emits more infrared radiation than a white surface.'

Explain how using an infrared detector with a resolution of 1 °C would have affected the student's conclusion.

[2 marks]

Albedo is a measure of the amount of solar radiation reflected by an object compared to the total solar radiation incident on the object.

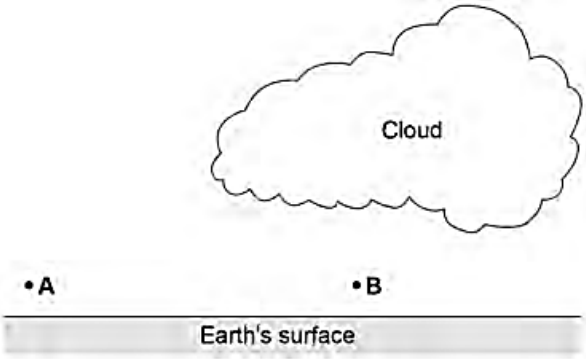
A perfect reflector has an Albedo value of 1.0
A perfect absorber has an Albedo value of 0.0

7 What is the Albedo value of a perfect black body?

[1 mark]

8 **Figure 14** shows two points, **A** and **B**, just above the Earth's surface.

Figure 14



The average Albedo value of the Earth's surface is 0.3
The Albedo value of thick cloud varies between 0.6 and 0.9

At night the air at point **A** cools faster than the air at point **B**.

Explain why.

[3 marks]

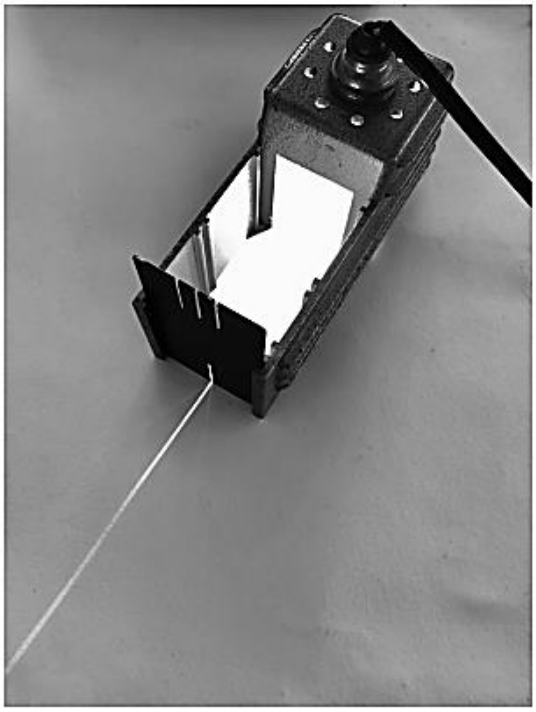
12

09.

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

Figure 3 shows the ray box used.

Figure 3



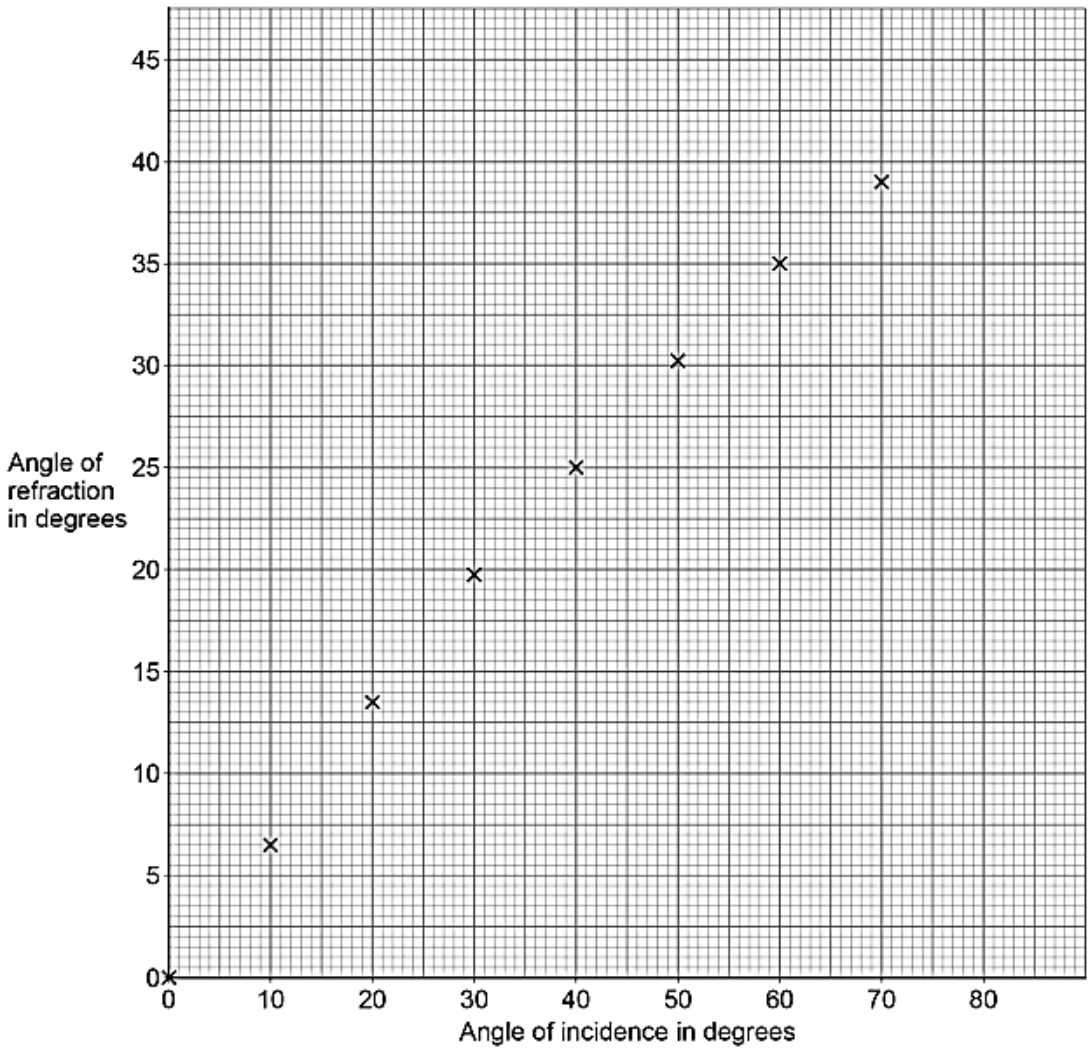
1 The ray of light from the ray box should be as narrow as possible.

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

[2 marks]

Figure 4 shows the results.

Figure 4



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 = _____ °

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

[6 marks]

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 = ± _____ °

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

[1 mark]

Tick (✓) **one** box.

Colour ☐

Frequency ☐

Velocity ☐

13

10.

A door is fitted with a security lens and a lock.

The security lens allows a person to see a visitor before opening the door.

The security lens is concave.

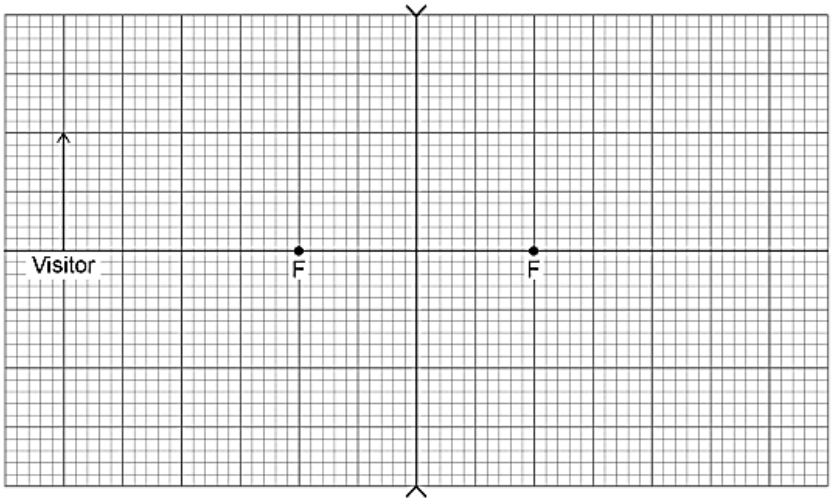
1 **Figure 5** is an incomplete ray diagram representing a visitor standing near the security lens.

Complete **Figure 5** to show how an image of the visitor is formed by the concave lens.

Draw an arrow to represent the image.

[3 marks]

Figure 5



11.

2 The visitor moves further away from the security lens in the door.

How does the size of the image change?

[1 mark]

Tick (✓) **one** box.

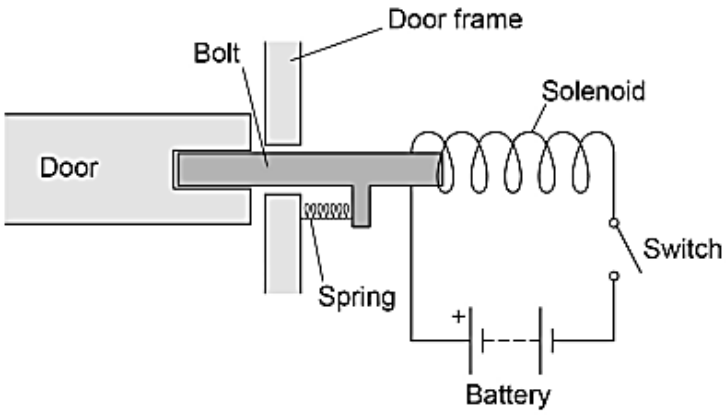
Decreases ☐

Increases ☐

Stays the same ☐

Figure 6 shows a diagram of the lock. The door unlocks when the switch is closed.

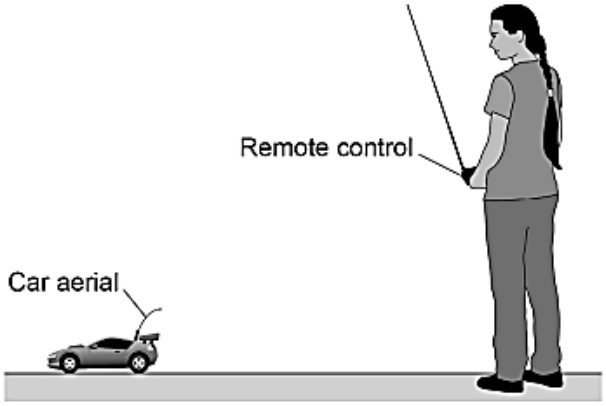
Figure 6



12.

Figure 8 shows a student playing with a remote-controlled car.

Figure 8



1 The remote control transmits radio waves to the car aerial.

The transmitted radio waves have a frequency of 320 MHz.

speed of radio waves = 3.0×10^8 m/s

Calculate the wavelength of the radio waves.

Give the unit.

[5 marks]

Wavelength = _____ Unit _____

2 The car aerial is connected to an electrical circuit in the car.

Describe what happens in the electrical circuit when the car aerial absorbs radio waves.

[2 marks]

3 The car produces sound waves.

Give **two** ways in which radio waves are different to sound waves.

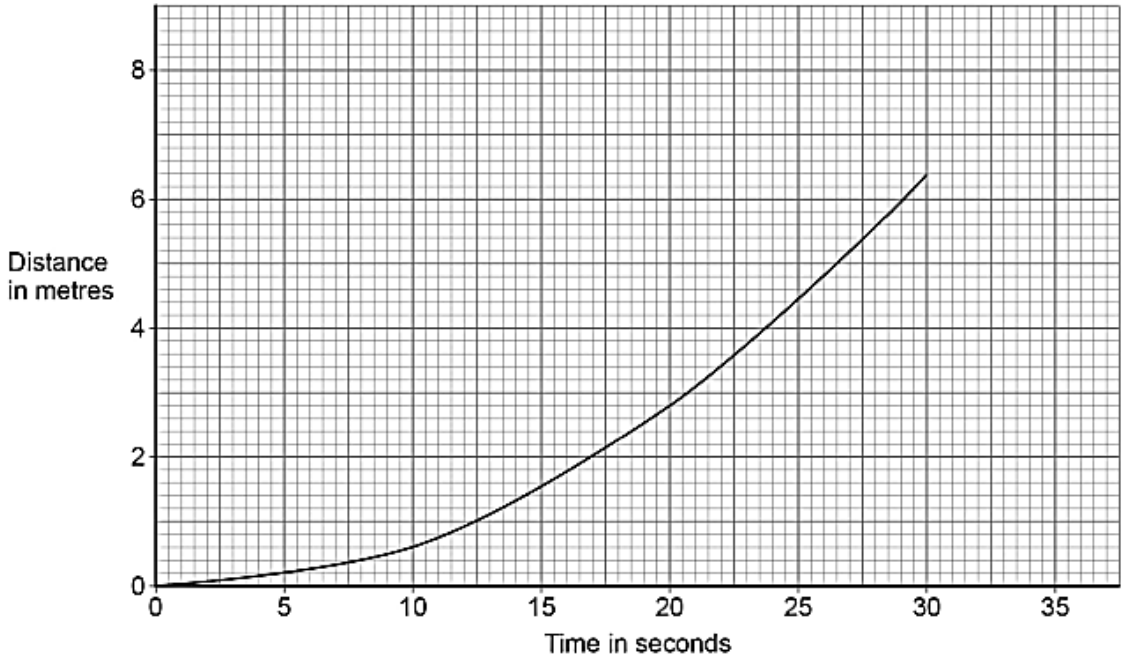
[2 marks]

1 _____

2 _____

Figure 9 shows the distance-time graph for the first 30 seconds of the car's motion.

Figure 9



4 Describe the motion of the car during the first 30 seconds.

[1 mark]

_____

5 Determine the speed of the car 20 seconds after it started to move.

[4 marks]

_____

_____

_____

_____

_____

Speed = _____ m/s

6 A different car accelerated from 0.12 m/s to 0.52 m/s.

The acceleration of the car was 0.040 m/s^2.

The work done to accelerate the car was 0.48 J.

Calculate the resultant force needed to accelerate the car.

[6 marks]

Resultant force = _____ N

7 Explain why the car has a maximum speed.

[4 marks]

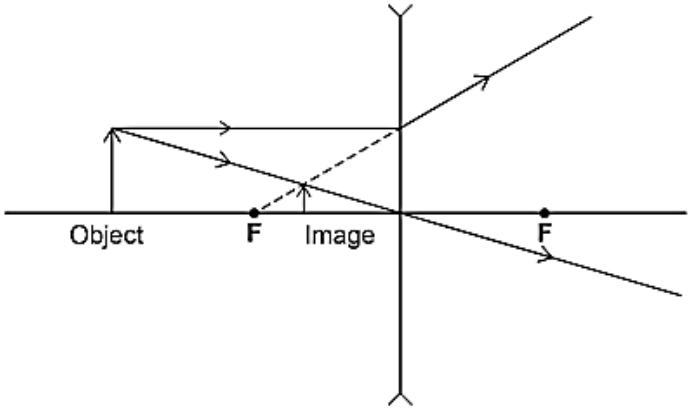
24

13.

Lenses are used to form images of objects.

1 **Figure 6** shows how a concave lens forms an image of an object.

Figure 6



The image of the object in **Figure 6** is upright.

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

[1 mark]

1 _____

2 _____

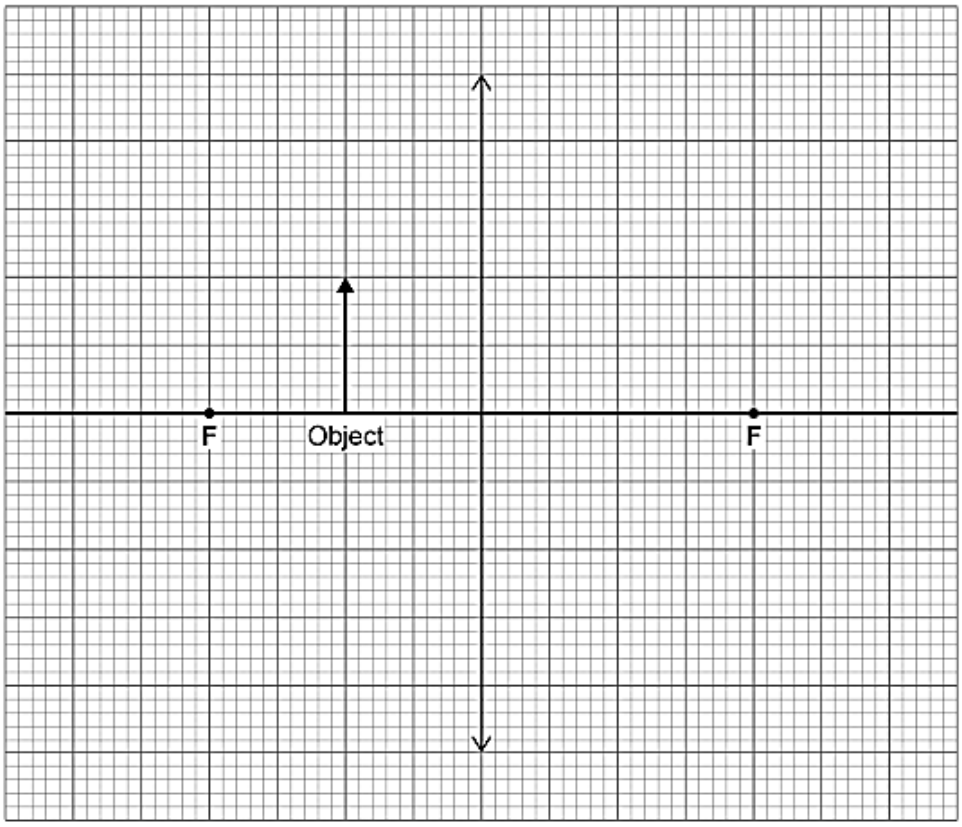
2 **Figure 7** shows an object near to a **convex** lens.

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

Use an arrow to represent the image.

[3 marks]

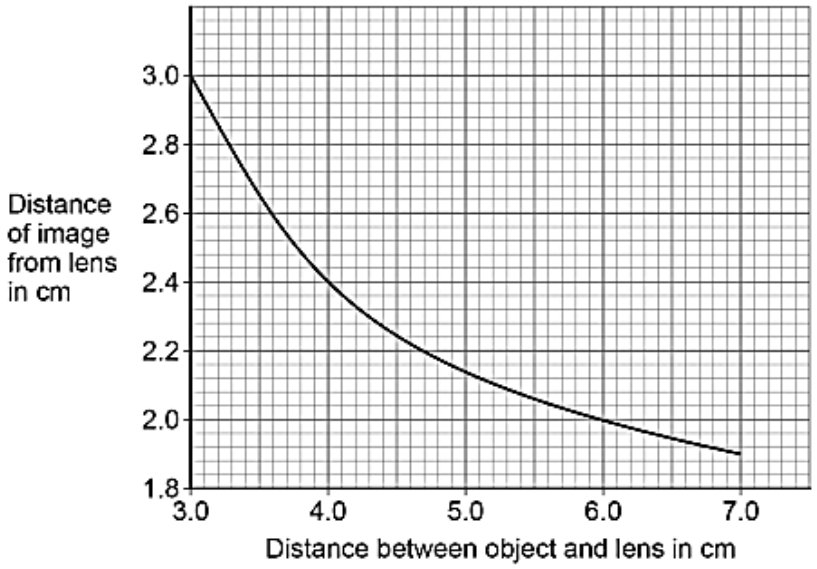
Figure 7



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

Figure 8 shows the results of a student's investigation using a convex lens.

Figure 8



. 3 Describe how the distance of the image from the lens decreases as the distance between the object and the lens increases.

[1 mark]

4 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.

[2 marks]

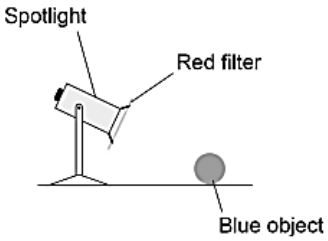
Uncertainty = ± _____ cm

5 **Figure 9** 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 9



Explain why the blue object appears black.

[3 marks]

10

14. Ultraviolet is a type of electromagnetic wave.

. 1 Give **one** use of ultraviolet.

[1 mark]

. 2 An ultraviolet wave has a wavelength of 300 nanometres.

Which of the following is equal to 300 nanometres?

[1 mark]

Tick (✓) **one** box.

3×10^{7} m ☐

3×10^{-7} m ☐

3×10^{9} m ☐

3×10^{-9} m ☐

3 The speed of ultraviolet waves is 3×10^{8} m/s.

Calculate the frequency of the ultraviolet wave.

Use your answer to Question **05.2**

[3 marks]

Frequency = _____ Hz

. 4 **Table 1** gives the wavelength of an ultraviolet wave and three other electromagnetic waves.

Table 1

	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.

[1 mark]

Wave	Name
Wave E	Infrared
Wave F	Visible light
Wave G	X-rays

5 Electromagnetic waves are transverse.

Some other types of wave are longitudinal.

Describe the difference between transverse and longitudinal waves.

[2 marks]

_____

_____

_____

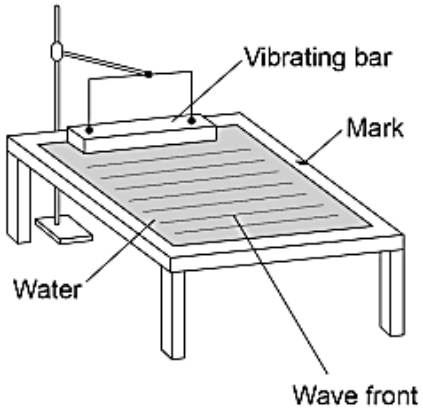
_____

8

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

Figure 10 shows the ripple tank.

Figure 10



. 1 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 mark]

. 2 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.

[5 marks]

Mean frequency (2 significant figures) = _____ Hz

. 3 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 marks]

16. 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

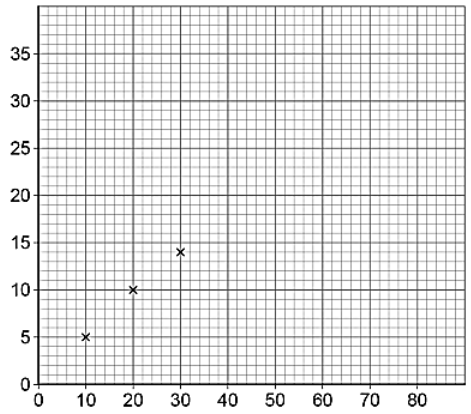
. 1 Describe a method the student could have used to obtain the results in **Table 1**.

Your answer may include a labelled diagram.

[6 marks]

. 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]

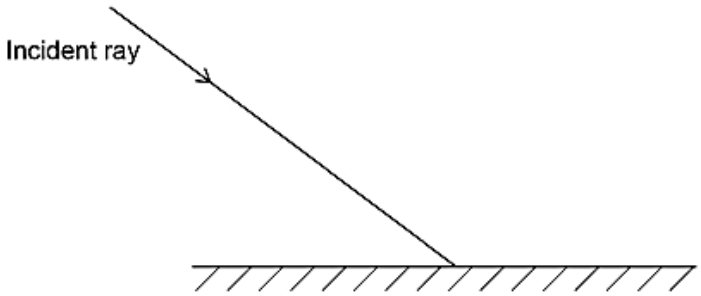
3 Complete the ray diagram in **Figure 3** to show the reflection of light from the surface of a plane mirror.

You should:

- draw the normal line
- draw the reflected ray.

[2 marks]

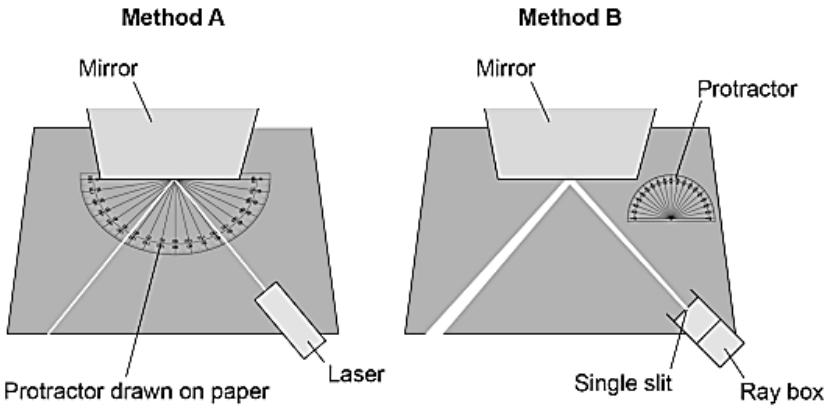
Figure 3



4 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

17.

Infrared waves are transverse waves.

1 Complete the sentence.

[1 mark]

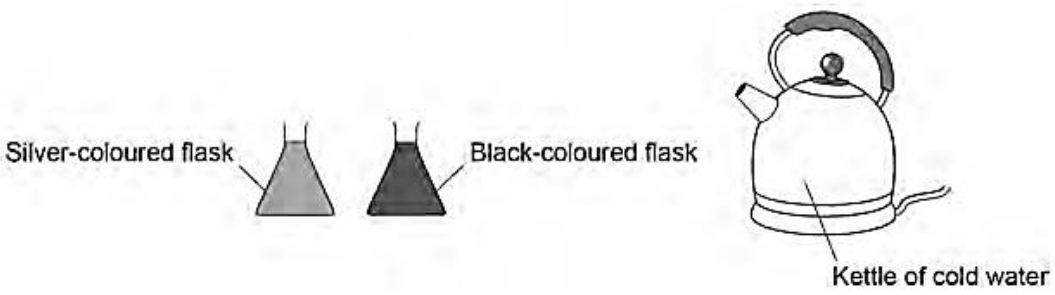
In a transverse wave, the direction of oscillation is _____

to the direction of energy transfer by the wave.

A student investigated how the colour of a surface affects the rate at which the surface emits infrared radiation.

Figure 1 shows some of the equipment used.

Figure 1



2 The student wrote the following hypothesis:

'The black-coloured flask will emit more infrared radiation than the silver-coloured flask during 10 minutes of cooling.'

Describe a method to test this hypothesis.

[6 marks]

3 When will the flasks emit infrared radiation at the greatest rate?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

During the 1st minute ☐

During the 5th minute ☐

During the 9th minute ☐

Reason _____

Another student investigated the absorption of infrared radiation by different surface colours.

The student filled four hollow metal cubes with cold water.

Each cube was the same size but had a different surface colour.

The cubes were then placed the same distance from an infrared heater.

After 10 minutes, the student measured the temperature increase of the water inside each cube.

4 What was the dependent variable in this investigation?

[1 mark]

_____

_____

5 **Table 1** shows the results.

Table 1

Surface colour of the cube	Temperature increase after 10 minutes in °C
Matt white	3.0
Shiny white	2.0
Matt black	6.5
Shiny black	4.0

Give **two** conclusions that can be made from the results in **Table 1**.

[2 marks]

1 _____

_____

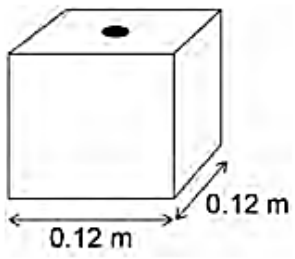
2 _____

_____

Figure 2 shows one of the cubes. The cube is filled with water.

The weight of the water exerts a pressure on the bottom of the cube.

Figure 2



Use the Physics Equations Sheet to answer questions **01.6** and **01.7**.

6 Which equation correctly links area, force and pressure?

[1 mark]

Tick (✓) **one** box.

pressure = force × area^2 ☐

pressure = force × area ☐

$\text{pressure} = \frac{\text{force}}{\text{area}}$ ☐

$\text{pressure} = \frac{\text{area}}{\text{force}}$ ☐

7 The water pressure at the bottom of the cube is 1500 Pa.

Calculate the force of the water on the bottom of the cube.

[4 marks]

Force = _____ N

17

18.

2 A space telescope uses microwaves to communicate with the Earth.

A microwave has a wavelength of 12.5 cm.

The speed of microwaves through space is 3.0×10^8 m/s.

Calculate the frequency of the microwave.

Use the Physics Equations Sheet.

Give your answer in standard form.

[5 marks]

Frequency (in standard form) = _____ Hz

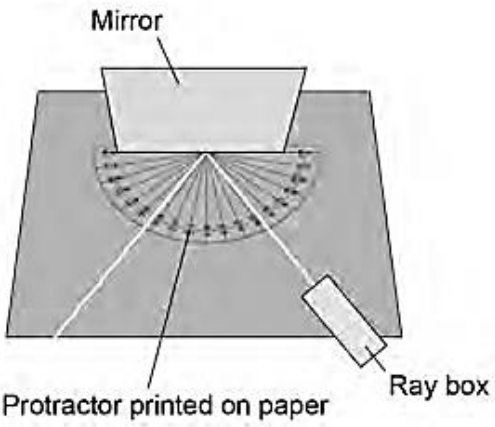
19.

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



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

[1 mark]

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

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

[1 mark]

_____

_____

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 _____

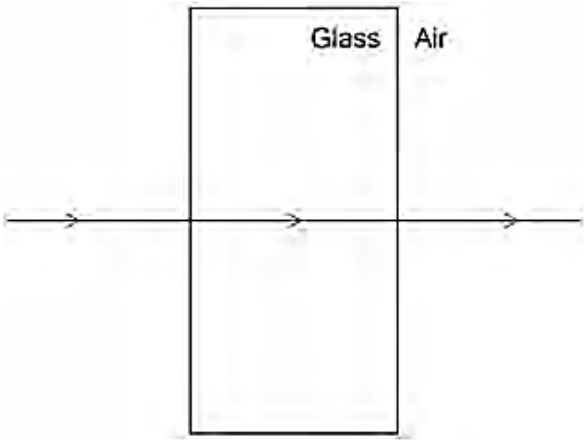
_____

_____

The student also investigated the refraction of light.

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

Figure 18



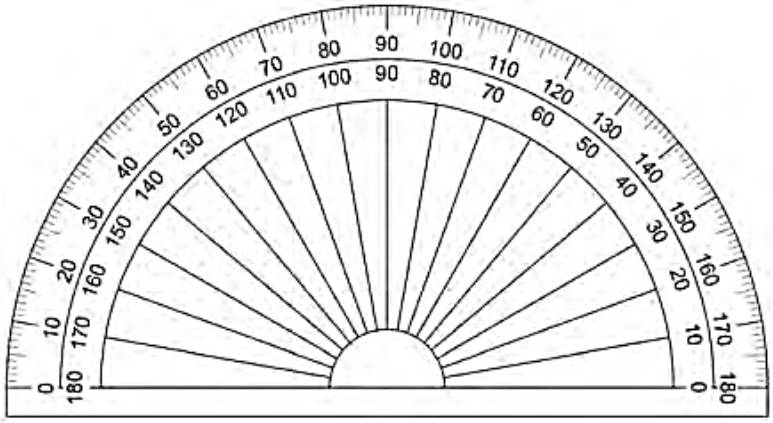
Why has refraction **not** occurred?

[1 mark]

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:

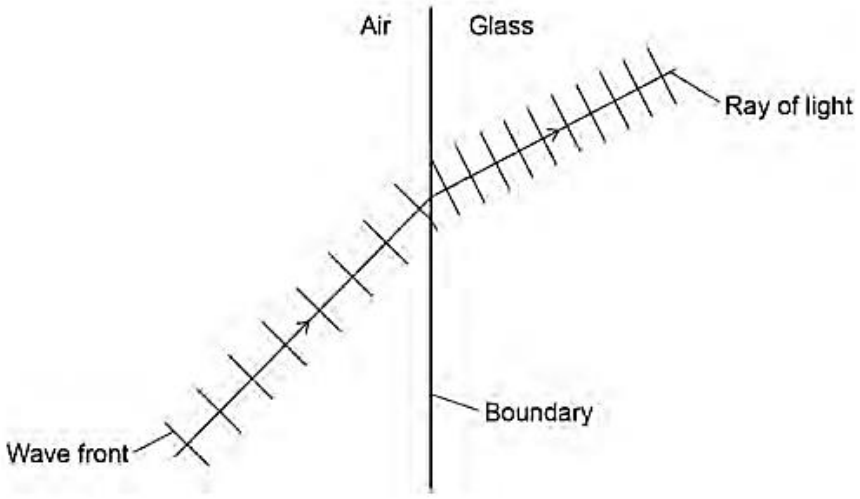
6.0° 6.3° 6.4° 5.8°

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

[2 marks]

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