Questions are for both separate science and combined science students unless indicated in the question

1. There are different groups of waves in the electromagnetic spectrum.

(a) **Figure 1** shows the position of three groups of the waves.

Figure 1

A	**Microwaves**	**B**	**Visible light**	**C**	**D**	**Gamma rays**

Which letter shows the position of infrared?

Tick (✓) **one** box.

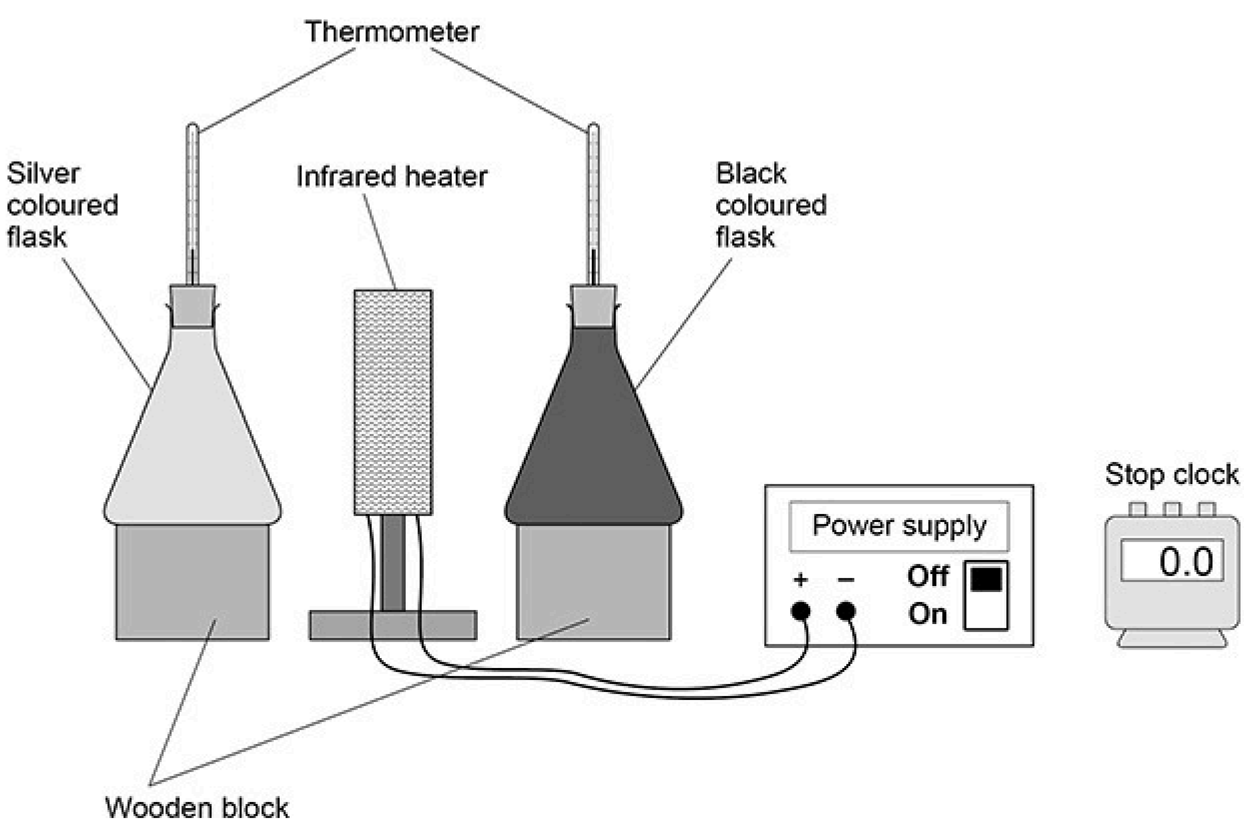
A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

A student investigated how the colour of a surface affects the amount of infrared the surface absorbs.

Figure 2 shows the equipment used.

Figure 2



(b) Complete the sentence.
Choose the answer from the box.

a control	the dependent	the independent

In this investigation the distance between each flask and the infrared heater

is ____________________ variable.

(1)

(c) The student wrote the hypothesis:

‘Surface colour of the flask affects the amount of infrared absorbed when the heater is switched on for five minutes.’

Describe how the equipment in **Figure 2** could be used to test this hypothesis.

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(4)

The table below shows the results.

Colour of flask	**Temperature increase in °C**		
	Test 1	**Test 2**	**Test 3**
Black	19	17	27
Silver	10	12	11

(d) Which **one** of the results for the black flask is anomalous?

____

(1)

(e) The anomalous result was caused by reading the thermometer incorrectly.

What should the student do with the anomalous result?

____

____

(1)

(f) Calculate the mean temperature increase for the silver flask.

____

____

Mean temperature increase = ____________________ °C

(1)

(g) What conclusion can be made from the table above?

Tick (✓) **one** box.

Both flasks absorbed the same amount of infrared during the five minutes.	☐
The black flask absorbed the most infrared during the five minutes.	☐
The silver flask absorbed the most infrared during the five minutes.	☐

(1)

(Total 10 marks)

2. The data given in the table below was obtained from an investigation into the refraction of light at an air to glass boundary.

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

Describe an investigation a student could complete in order to obtain similar data to that given in the table above.
Your answer should consider any cause of inaccuracy in the data.

A labelled diagram may be drawn as part of your answer.(separate only)

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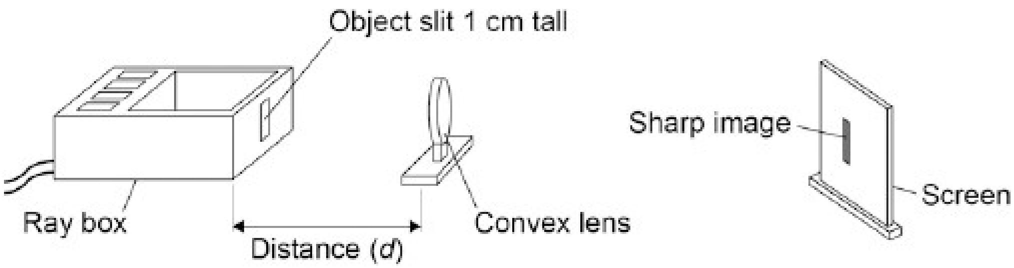
(Total 6 marks)

3. 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 1**.

Figure 1



(a) 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.
(separate only)

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(2)

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

Table 1

Distance between the object and the lens in cm 25 30 40 50 60	**Magnification**
	4.
	0
	2.
	0
	1.
	0
	0.
	7
	0.
	5

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.(separate only)

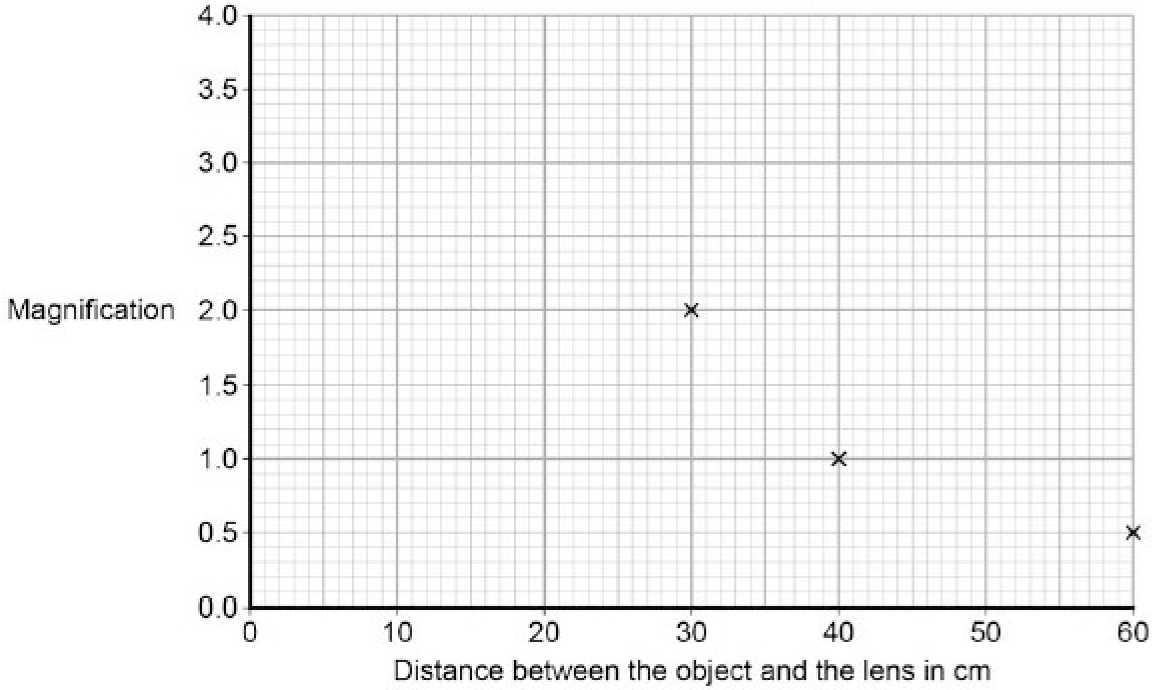
____

____

(1)

(c) The graph in **Figure 2** is incomplete.

Figure 2



Complete the graph in **Figure 2** by plotting the missing data and then drawing a line of best fit. (separate only)

(2)

(d) How many times bigger is the image when the object is 35 cm from the lens compared to when the object is 55 cm from the lens? (separate only)

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(2)

(e) 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.
60	30	0
40	40	2.
33	50	0
30	60	1.

0

Consider the data in **Table 2**.

0.

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

7

Justify your answer with a calculation. (separate only)

0.

5

____

____

____

____

____

(2)

(Total 9 marks)

4. The figure below shows an incomplete electromagnetic spectrum.

A	**microwaves**	**B**	**C**	**ultraviolet**	**D**	**gamma**

(a) What name is given to the group of waves at the position labelled **A** in the figure above?

Tick **one** box.

infrared ☐

radio ☐

visible light ☐

X-ray ☐

(1)

(b) Electromagnetic waves have many practical uses.

Draw **one** line from each type of electromagnetic wave to its use.

Electromagnetic wave	**Use**
	For fibre optic communications
Gamma rays	
	For communicating with a satellite
Microwaves	
	To see security markings
Ultraviolet	
	To sterilise surgical instruments

(3)

(c) Complete the sentence.

Use an answer from the box.

black body	**ionising**	**nuclear**

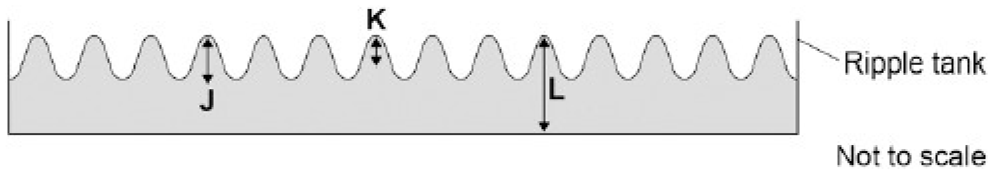
X-rays can be dangerous to people because X-rays are

____________________ radiation.

(1)
(Total 5 marks)

5. Small water waves are created in a ripple tank by a wooden bar. The wooden bar vibrates up and down hitting the surface of the water.

The figure below shows a cross-section of the ripple tank and water.



(a) Which letter shows the amplitude of a water wave?

Tick **one** box.

J ☐

K ☐

L ☐

(1)

(b) The speed of the wooden bar is changed so that the bar hits the water fewer times each second.

What happens to the frequency of the waves produced?

Tick **one** box.

Increases ☐

Does not change ☐

Decreases ☐

(1)

(c) Describe how the wavelength of the water waves in a ripple tank can be measured accurately.

____

____

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(2)

(d) The speed of a wave is calculated using the following equation.

wave speed = frequency × wavelength

The water waves in a ripple tank have a wavelength of 1.2 cm and a frequency of 18.5 Hz.

How does the speed of these water waves compare to the typical speed of a person walking?

____

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____

____

____

(4)

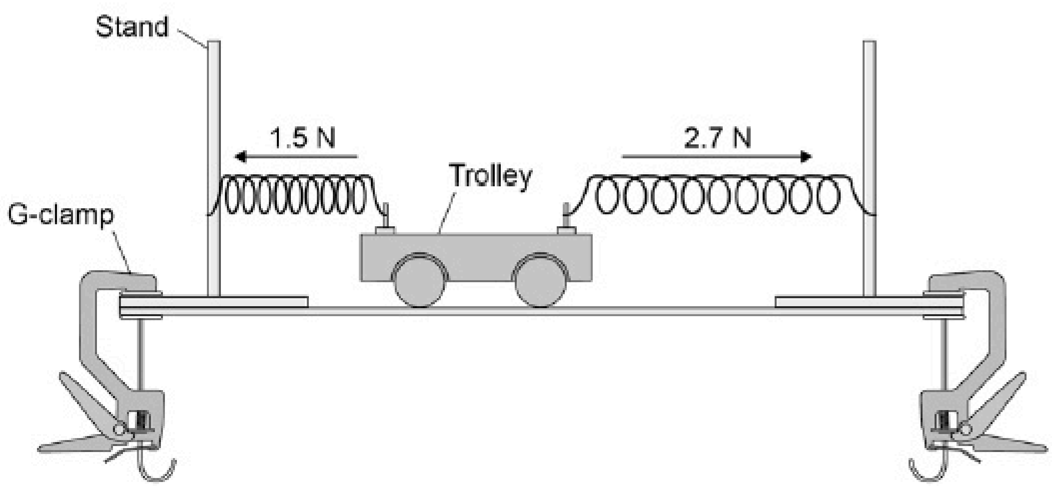
(Total 8 marks)

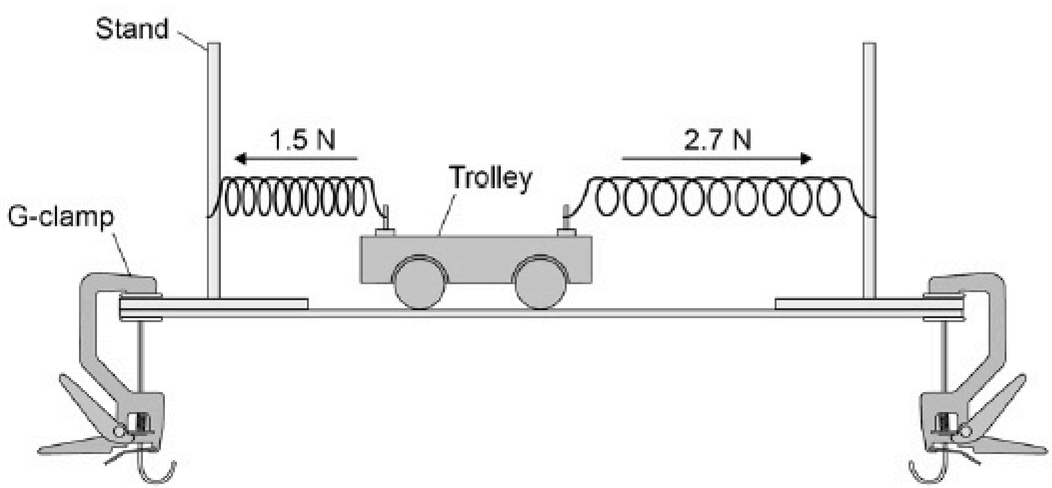
6. A trolley is attached to two identical springs.

The trolley is pushed to the left and then released.

Figure 1 shows the horizontal forces acting on the trolley just after it is released.

Figure 1





(a) Write the equation which links acceleration, mass and resultant force.

____

(1)

(b) The trolley has a mass of 0.75 kg Calculate the acceleration of the trolley just after it is released. Give the unit.

____

____

____

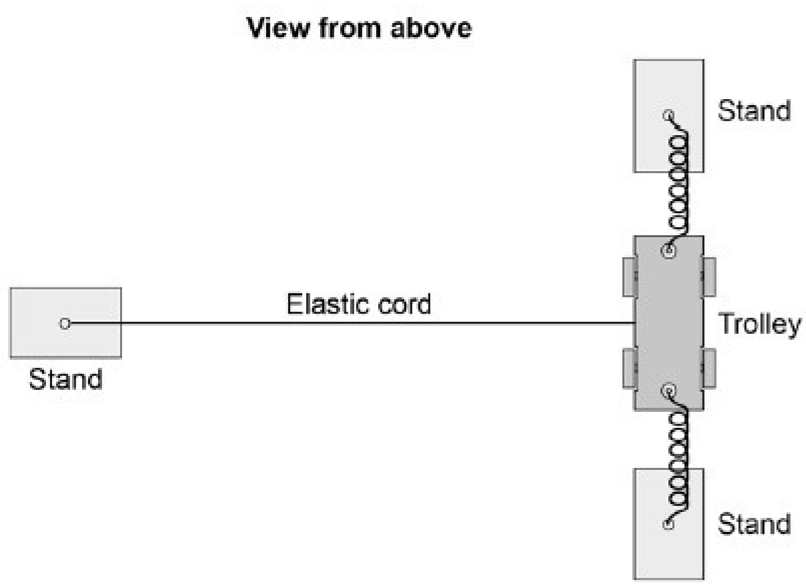
Acceleration = ____________________ Unit ____________________

(4)

An elastic cord is fixed to the trolley.

Figure 2 shows the arrangement viewed from above.

Figure 2



When the trolley is pushed and released a wave travels along the cord.

(c) What type of wave travels along the cord?

____

Give the reason for your answer.

____

____

(2)

(d) Suggest one change that could be made to the apparatus shown in **Figure 2** to produce a wave with a lower frequency.

____

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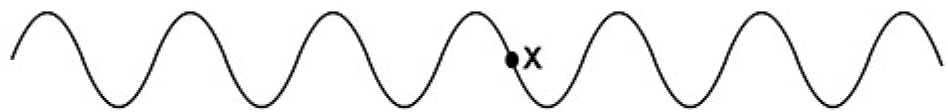
(1)

(Total 8 marks)

7. **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.

m2/s	**m/s**	**s2**

____

____

____

Wave speed = _______________ Unit __________

(3)

(d) What is transferred by all waves?

Tick (✓) **one** box.

Energy ☐

Information ☐

Water ☐

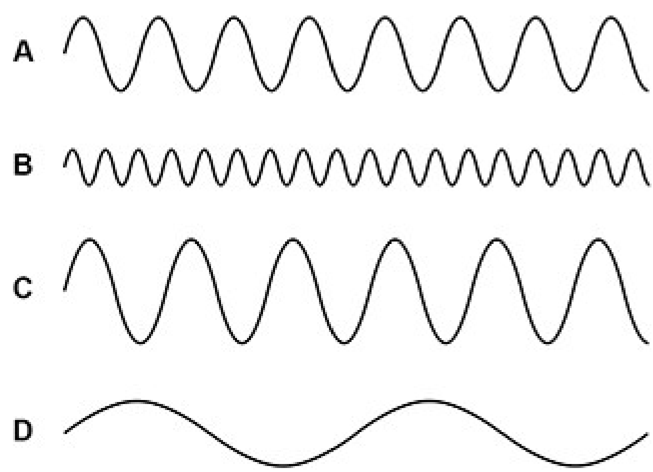
(1)

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?

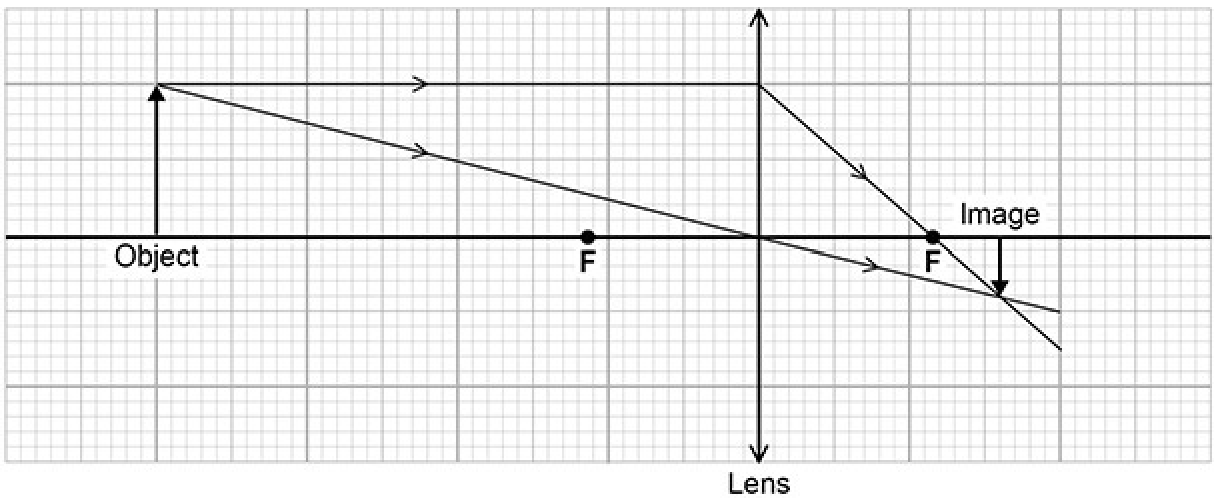
Tick (√) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(Total 8 marks)

8. 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. (separate only)

Concave	☐
Convex	☐
Diverging	☐

(1)

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

Image height = __________ cm

Object height = __________ cm

(1)

(c) Calculate the magnification produced by the lens.
Use the equation:
(separate only)

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

____

____

____

Magnification = _______________

(2)

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

Tick (✓) **two** boxes. (separate only)

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. (separate only)

black	**blue**	**green**	**red**	**white**

Looking at the blue object through a green filter makes the object

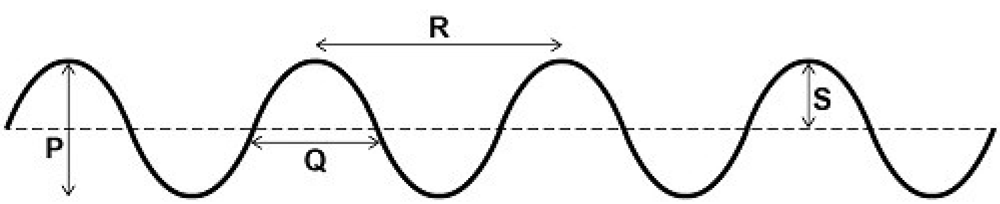
appear ________________.

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

(2)
(Total 8 marks)

9. **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. ☐

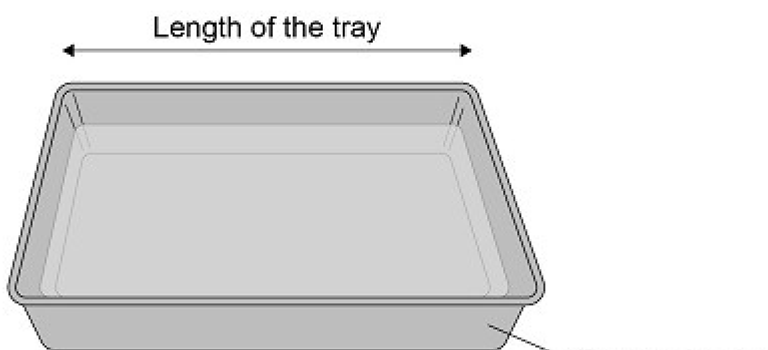
The wavelength stays the same. ☐

(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.

Figure 2



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?

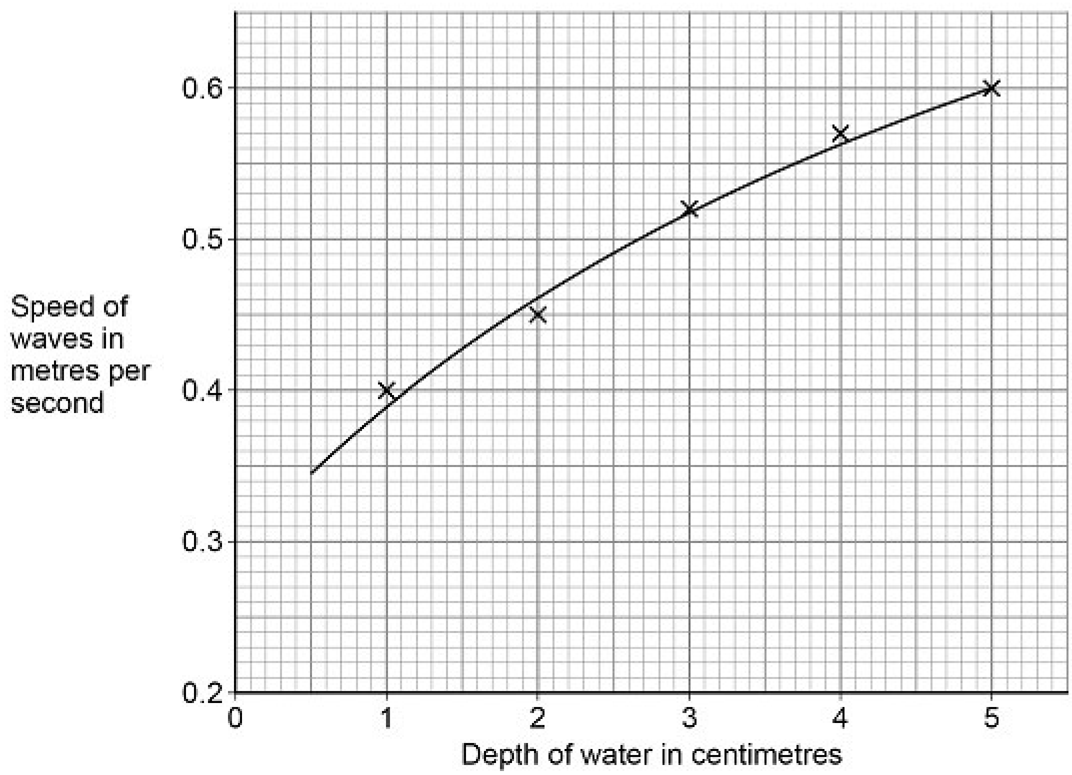
Depth of water ☐

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)

10. (a) Visible light is used for communications.

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

Tick (√) **two** boxes.

Gamma rays ☐

Microwaves ☐

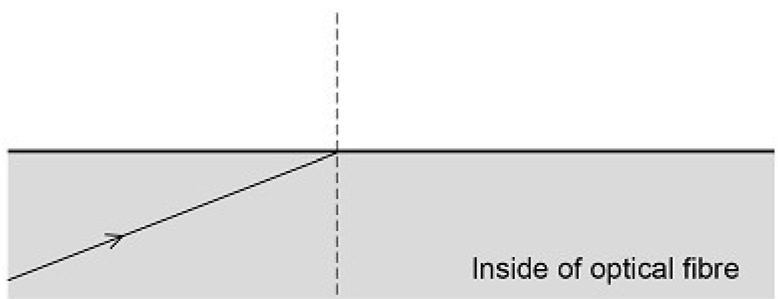
Radio waves ☐

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? (separate only)

____

(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.
(separate only)

(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.

(separate only)

____

____

(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. (separate only)

absorbed	**reflected**	**refracted**	**transmitted**

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)

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

A	Microwaves	B	Visible light	C	D	Gamma rays

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. (separate only)

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. (separate only)

____

_

____

_ Percentage = _______________ %

(2)

____ **(Total 7 marks)**

12. (a) **Figure 1** shows the position of three types of wave in the electromagnetic spectrum.

Figure 1

A	Microwaves	**B**	Visible light	**C**	**D**	Gamma rays

Which letter represents infrared in the electromagnetic spectrum?

Tick (√) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(b) What is infrared used for?

Tick (√) **one** box.

Electrical heating ☐

Energy efficient lamps ☐

Satellite communications ☐

Sun tanning ☐

(1)

An infrared camera produces a colour image. Different colours show different temperatures.

People emit infrared radiation. **Figure 2** shows how the colour of the image of a person on an infrared camera depends on the person's body temperature.

Figure 2

(c) Complete the sentence.

Choose the answer from the box.

orange	red	yellow

The image produced by an infrared camera of a person with a body temperature of

37 °C is mainly ________________________ .

(1)

(d) Rescue workers use infrared cameras to search for people trapped under rubble after an earthquake.

How does the image of a trapped person change if the person's body temperature drops from 37 °C to 33 °C?

____

____

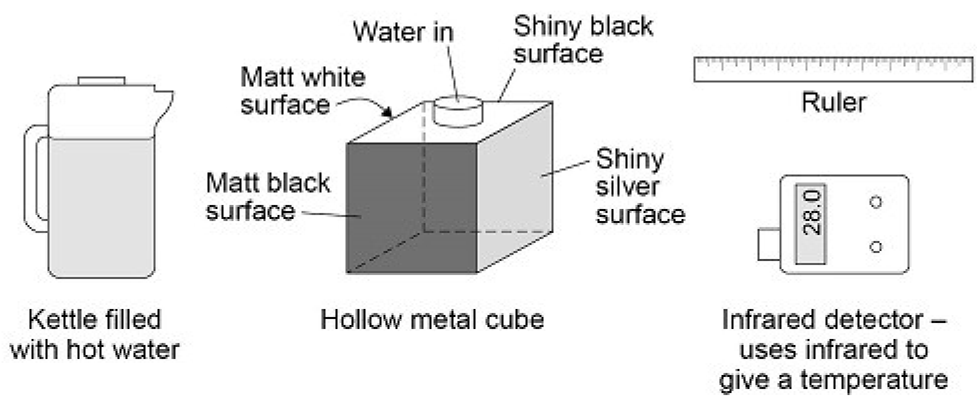
____

(1)

A student investigated how the type of surface affects the amount of infrared the surface radiates.

Figure 3 shows the equipment used.

Figure 3



(e) Complete the sentence.

Choose the answer from the box.

a control	the dependent	the independent

In this investigation the type of surface is ___________________________ variable.

(1)

(f) Describe how the equipment shown in **Figure 3** would be used to compare the infrared radiation emitted from the vertical surfaces of the cube.

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____

____

____

____

(3)

The table below shows the results.

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

(g) What is the resolution of the infrared detector?

Tick (√) **one** box.

0.1 °C ☐

1.0 °C ☐

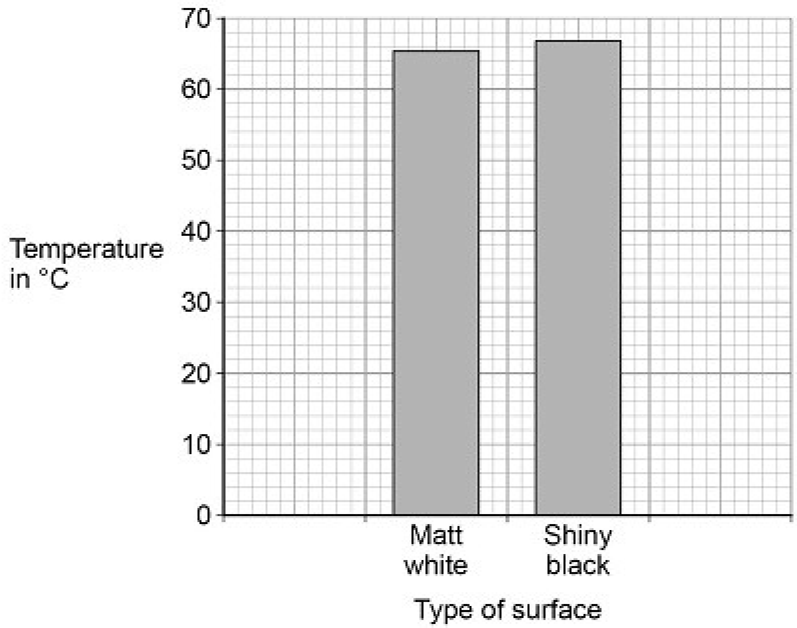
1.7 °C ☐

68.0 °C ☐

(1)

The bar chart in **Figure 4** shows two of the results.

Figure 4



(h) Complete the bar chart to show all of the results.

(3)

(i) Give **one** conclusion that can be made from the results.

____

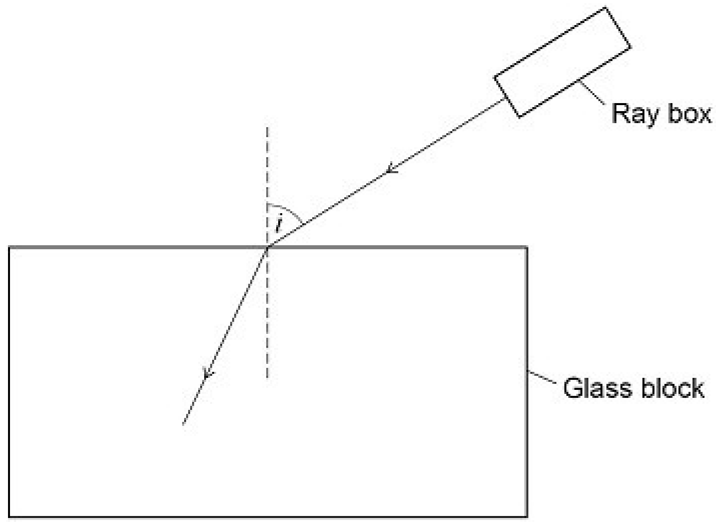
____

____

(1)
(Total 13 marks)

13. 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***. (separate only)

(1)

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

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. (separate only)

(3)

(d) Complete the sentence.

Choose an answer from the box. (separate only)

random	systematic	zero

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**
2	13
0	19
3	**X**
0	31
4	
0	
5	
0	

(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. (separate only)

____

____

X = __________________ °

(1)

(f) Complete the sentence.

Choose the answer from the box. (separate only)

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°? (separate only)

____

____

____

(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? (separate only)

____

____

(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. (separate only)

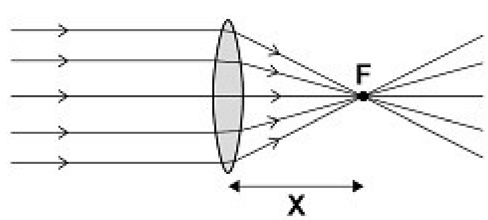
The angles of incidence tested	☐
The angles of refraction tested	☐
The number of results recorded	☐
The size of the two blocks	☐

(1)

(Total 11 marks)

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

Figure 1



What is distance **'X'** called?(separate only)

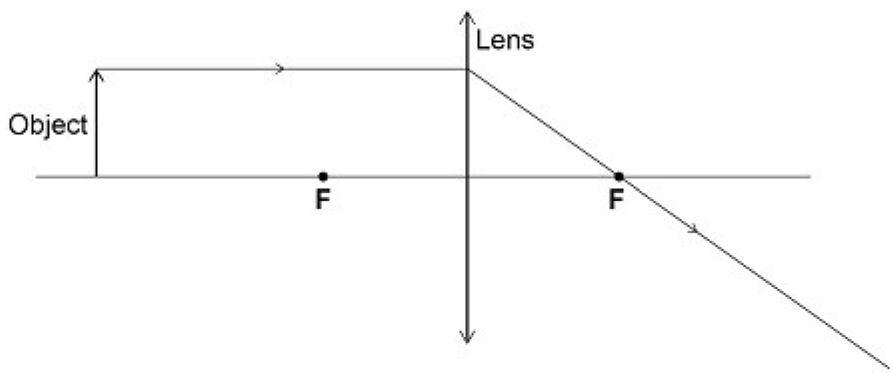
____

(1)

(b) 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.(separate only)

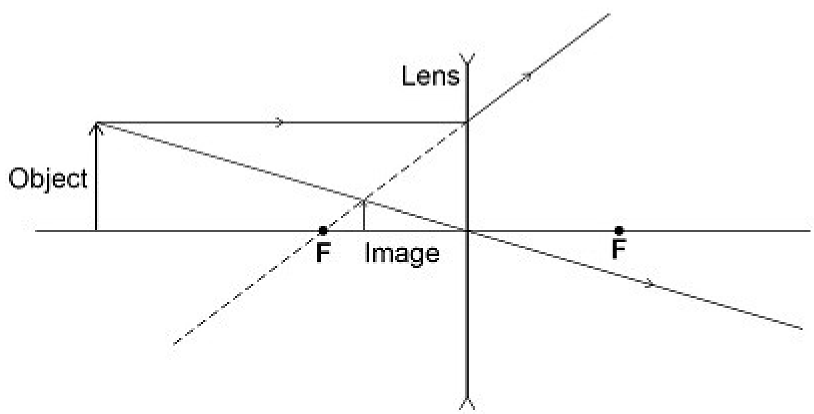
Figure 2



(2)

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

Figure 3



(c) Give **one** similarity and **one** difference between the image formed by the convex lens and the image formed by the concave lens.(separate only)

Similarity ____

____

Difference ____

____

(2)

(d) 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.

(separate only)

____

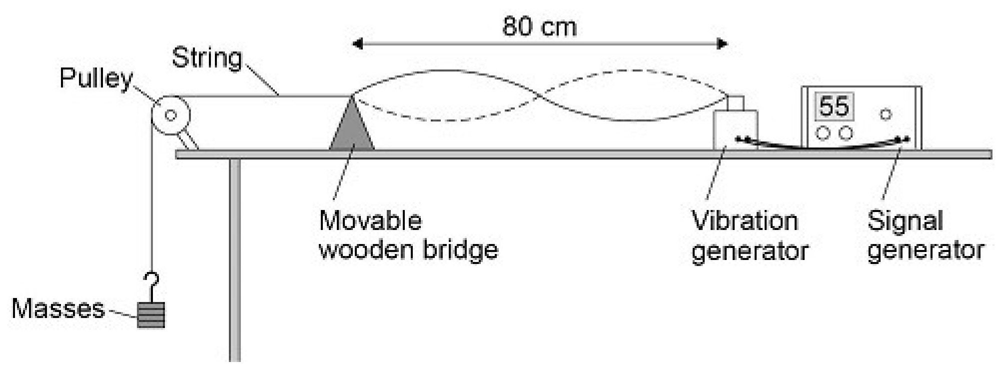
____

Height = ______________________ mm

(3)

(Total 8 marks)

15. The following figure shows the apparatus used to investigate the waves in a stretched string.



The frequency of the signal generator is adjusted so that the wave shown in the figure is seen.

At this frequency the string vibrates between the two positions shown in the figure.

(a) The wavelength of the wave shown in the figure above was measured as 80 cm

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

____

(1)

(b) Write down the equation which links frequency, wavelength and wave speed.

____

(1)

(c) The string in the figure above vibrates at 55 Hz

Calculate the wave speed of the wave shown in the figure. Use data given in the figure.

____

____

Wave speed = _________________________ m/s

____

(3)

(d) 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)

____

(e) 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 the figure above. Describe a method the student could use for this investigation.

____

____

____

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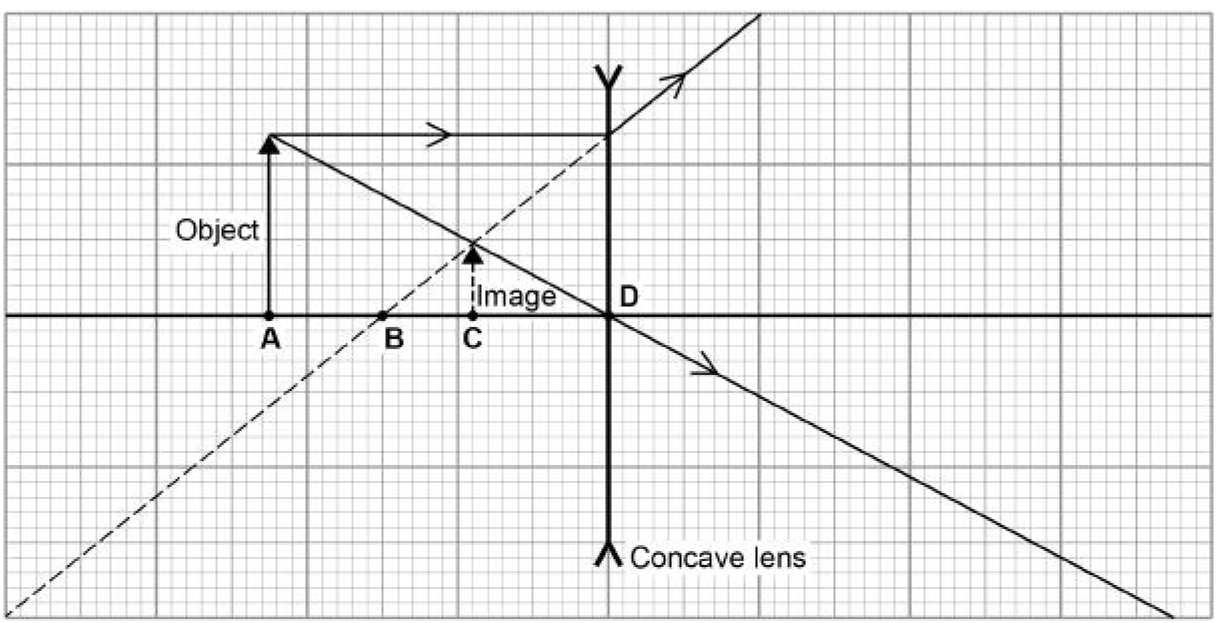
____

____

(4)
(Total 11 marks)

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



(a) Which point on the graph above marks the position of the principal focus of the lens?

Tick **one** box. (separate only)

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(b) Which **two** words describe the image?

Tick **two** boxes. (separate only)

Enlarged	☐
Inverted	☐
Real	☐
Upright	☐
Virtual	☐

(2)

(c) Calculate the magnification produced by the lens. (separate only)

Use the equation:

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

____

____

Magnification = ____________________

(4)

____

(d) Complete the sentence.
Choose an answer from the box.
(separate only)

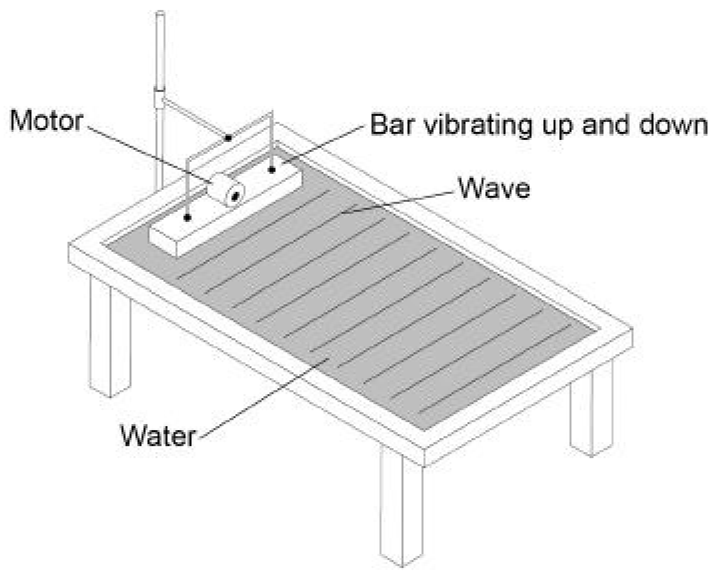
decrease	increase	not change

As the object is moved further away from the lens, the size of

the image will ___________________________ .

(1)
(Total 8 marks)

17. The diagram below shows a ripple tank that a student used to investigate water waves.



(a) The student adjusted the speed of the motor so that the bar hit the water more times each second.

What happened to the frequency of the waves produced?

Tick **one** box.

Decreased	☐
Did not change	☐
Increased	☐

(1)

(b) Describe how the frequency of the water waves in the ripple tank can be measured.

____

____

____ **(2)**

(c) The student measured the frequency of the water waves as 5 hertz.

Calculate the period of the water waves.

Use the equation:

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

Choose the unit.

metres	**metres / second**	**seconds**

____

____

____

____

Period = ____________________ Unit = ____________________

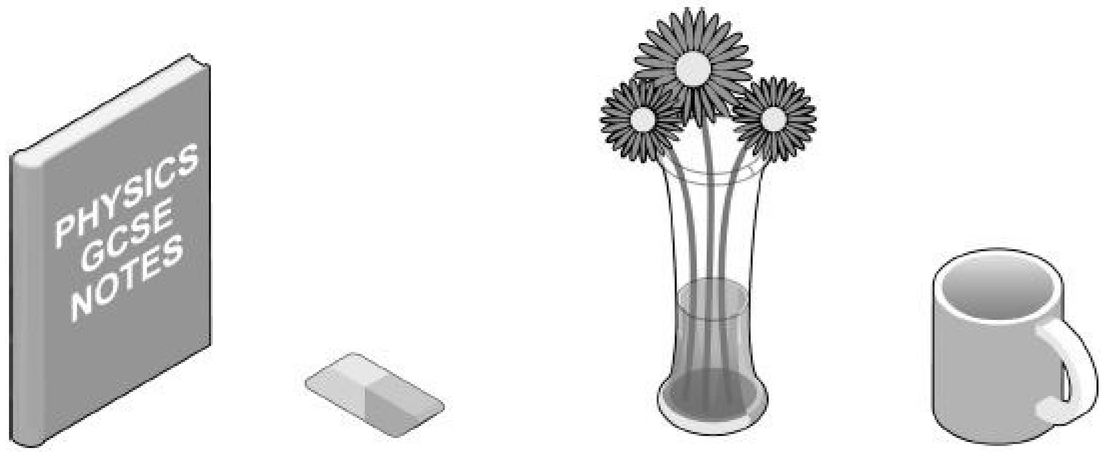
(3)
(Total 6 marks)

18. Some objects are transparent and some objects are opaque.

(a) Which **one** of the objects in **Figure 1** is transparent?

Tick **one** box.

Figure 1



Book	Pencil rubber	Glass vase	Ceramic mug
☐	☐	☐	☐

(1)

(b) Complete the sentence.

Choose an answer from the box.

absorb	reflect	transmit

An opaque object does not ____________________________ light.

(1)

A student wears a white T-shirt and a red baseball cap to a party.

(c) Why does the T-shirt look white in white light?

____

_

____

_

(1)

(d) Explain how the colour of the baseball cap appears to change when the room lights at the party change from white to blue.

____

____

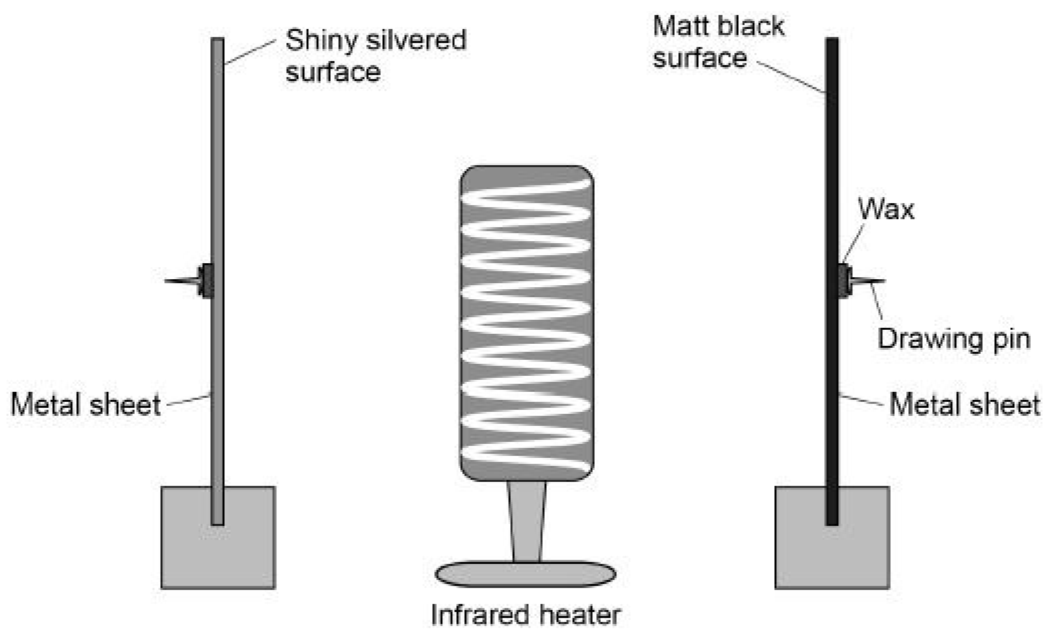
____

____ **(2)**

A student investigated how the type of surface affects the amount of infrared radiation the surface absorbs.

Figure 2 shows the equipment that the student used.

Figure 2



The metal sheets absorb infrared radiation. The wax melts and the drawing pins fall off the surfaces.

(e) In the investigation there are several variables.
Draw **one** line from each variable to the correct description of that variable.

Variable	**Description**
Control	Distance from the metal sheets to the infrared heater.
Dependent	The surface colour of the metal sheets.
Independent	Time taken for the drawing pins to fall off.

(2)

(f) What is the main hazard in this investigation?

____

____

(1)

(g) The drawing pin attached to the matt black metal sheet fell off first.

What can be concluded from this result?

____

_

____

(1)

(Total 9 marks)

19. The diagram below shows the position of three types of wave in the electromagnetic spectrum.

Radio waves	**A**	**B**	**C**	Ultraviolet	X-rays	**D**

(a) Which position shows where visible light is in the spectrum?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(b) Which **one** of the statements about electromagnetic waves is correct?

Tick **one** box.

Radio waves have a higher frequency than X-rays. ☐

Radio waves have a longer wavelength than ultraviolet. ☐

X-rays have a longer wavelength than radio waves. ☐

X-rays travel faster through the air than ultraviolet. ☐

(1)

(c) Give **one** possible danger of exposing your skin to ultraviolet radiation.

____

____

(1)

(d) Having an X-ray taken exposes a person to ionising radiation.
The table below gives the average radiation dose for an X-ray of the chest and an X-ray of the upper digestive system.

Part of the body	Radiation dose in millisieverts (mSv)
Upper digestive system	5.0
Chest	0.1

The risk of an X-ray causing cancer is about 1 in 20 000 for each mSv of radiation received.

Compare the risk of developing cancer from having an X-ray of the upper digestive system with the risk from having an X-ray of the chest.

Use the data in the table.

____

____

____

____

(2)
(Total 5 marks)

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

(a) Which **one** of the statements about P-waves and S-waves is correct?

Tick **one** box.(separate only)

P-waves and S-waves are transverse. ☐

P-waves and S-waves are longitudinal. ☐

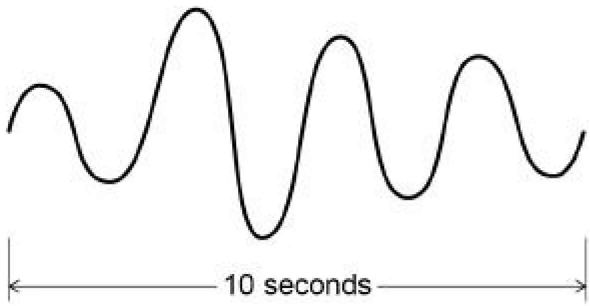
P-waves are transverse and S-waves are longitudinal. ☐

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

(1)

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

The diagram below shows the vibration recorded by a seismometer for one P-wave.



(b) Calculate the frequency of the P-wave shown in the diagram above.

____

____

Frequency = _____________________ Hz

(1)

(c) Write down the equation which links frequency, wavelength and wave speed.

____

(1)

(d) The P-wave shown in the diagram above is travelling at 7200 m/s.

Calculate the wavelength of the P-wave.

____

____

____

____

Wavelength = _____________________ m

(3)

(e) Explain why the study of seismic waves provides evidence for the structure of the Earth's core. (separate only)

____

____

____

____

(2)
(Total 8 marks)

21. (a) Which one of the following is not an electromagnetic wave?

Tick **one** box.

Gamma rays ☐

Sound ☐

Ultraviolet ☐

X-rays ☐

(1)

(b) What type of electromagnetic wave do our eyes detect?

____

(1)

(c) What is a practical use for infrared waves?

Tick **one** box.

Cooking food ☐

Energy efficient lamps ☐

Medical imaging ☐

Satellite communications ☐

(1)

Scientists have detected radio waves emitted from a distant galaxy.

Some of the radio waves from the distant galaxy have a frequency of 1 200 000 000 hertz.

(d) Which is the same as 1 200 000 000 hertz?

Tick **one** box.

1.2 gigahertz ☐

1.2 kilohertz ☐

1.2 megahertz ☐

1.2 millihertz ☐

(1)

(e) Radio waves travel through space at 300 000 kilometres per second (km/s).

How is 300 000 km/s converted to metres per second (m/s)?

Tick **one** box.

300 000 ÷ 1000 = 300 m/s	☐
300 000 × 1000 = 300 000 000 m/s	☐
300 000 + 1000 = 301 000 m/s	☐
300 000 – 1000 = 299 000 m/s	☐

(1)

(f) Write the equation which links frequency, wavelength and wave speed.

____

(1)

(g) Calculate the wavelength of the radio waves emitted from the distant galaxy. Give your answer in metres.

____

____

wavelength = ____________________ m

(3)

____

(Total 9 marks)