AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



EXAM QUESTION PACK

4.6.2 ELECTROMAGNETIC WAVES (PACK 1)

SCORE	PERCENTAGE
/297	%

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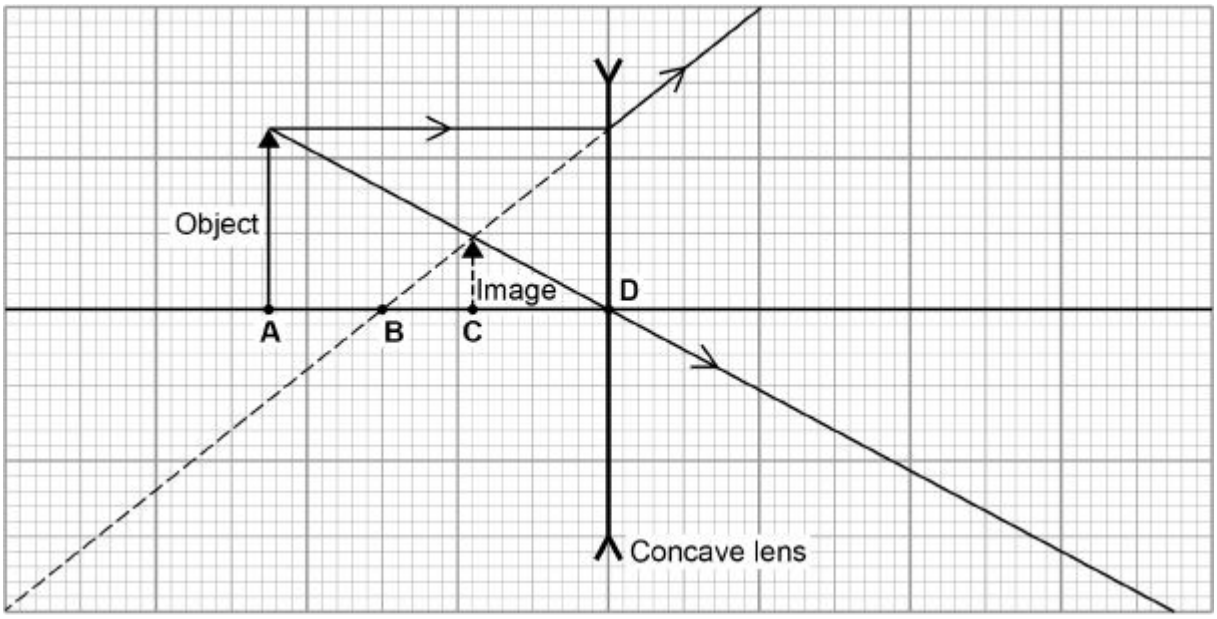
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Q1.

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.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

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

Tick **two** boxes.

Enlarged ☐

Inverted ☐

Real ☐

Upright ☐

Virtual ☐

(2)

(c) Calculate the magnification produced by the lens.

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Use the equation:

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

_____

_____

_____

_____

Magnification = _____

(4)

(d) Complete the sentence.

Choose an answer from the box.

decrease	**increase**	**not change**

As the object is moved further away from the lens, the size of the image will _____ .

(1)

(Total 8 marks)

Q2.

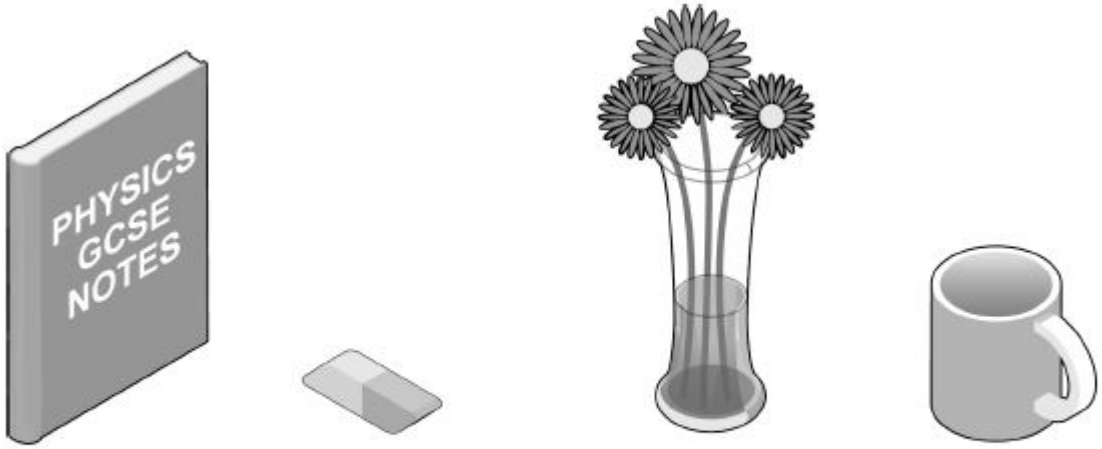
Some objects are transparent and some objects are opaque.

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

Tick **one** box.

Figure 1

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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.

_____

_____

_____

_____

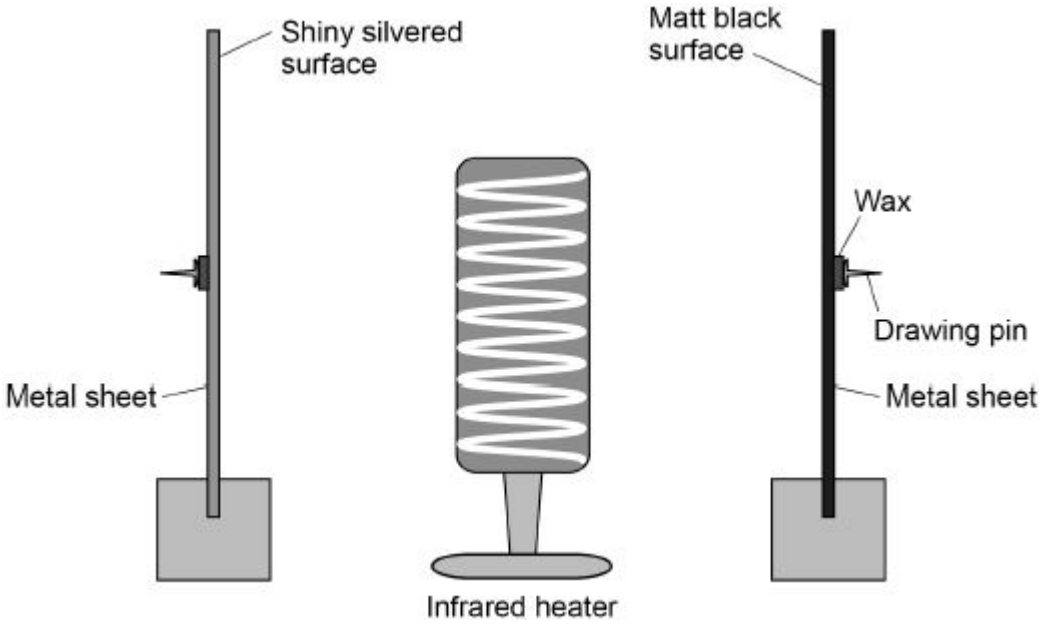
(2)

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

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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?

_____

_____

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(1)

(Total 9 marks)

Q3.

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

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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)

Q4.

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.

(a) Which statement describes a scientific model?

Tick **one** box.

A small scale version of a real object.	☐
A way of guessing what will happen.	☐
An idea used to explain observations and data.	☐

(1)

(b) Why do scientists sometimes have different models like the wave and particle models of light?

_____

_____

(1)

(c) 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.

_____

_____

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_____

_____

_____

_____

_____

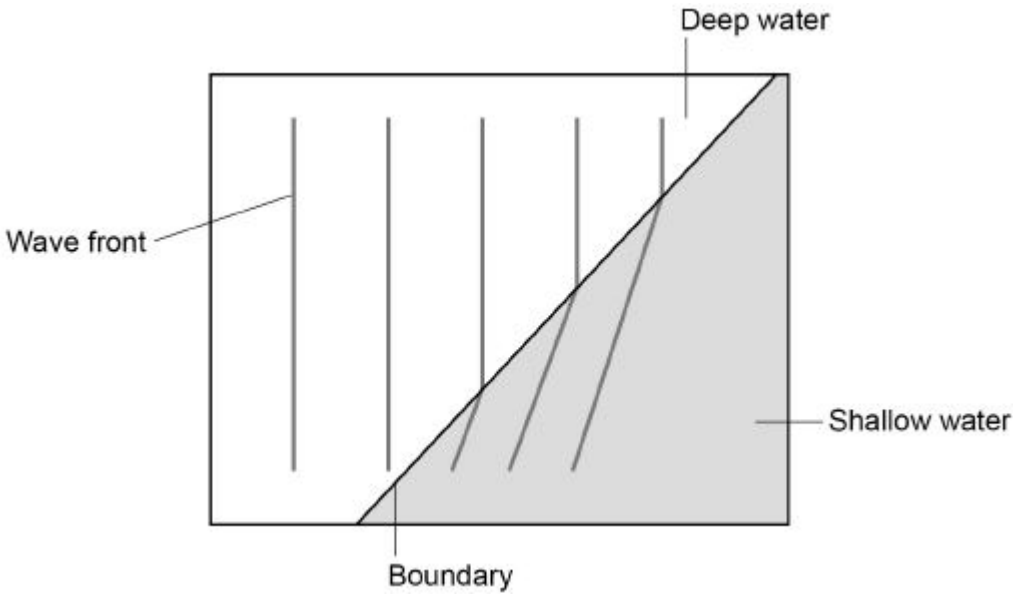
_____

(4)

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

(d) **Figure 1** shows what happens to the wave fronts as they pass the boundary between deep water and shallower water.

Figure 1



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

_____

_____

_____

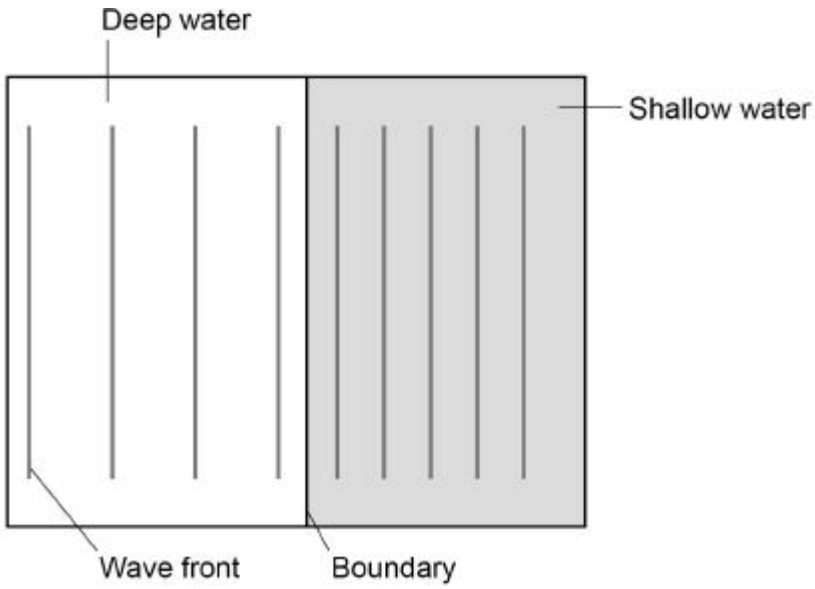
_____

(3)

(e) **Figure 2** shows the wave fronts travelling parallel to the boundary between deep water and shallower water.

Figure 2

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Explain why the wave fronts in **Figure 2** do not refract at the boundary.

_____

_____

_____

_____

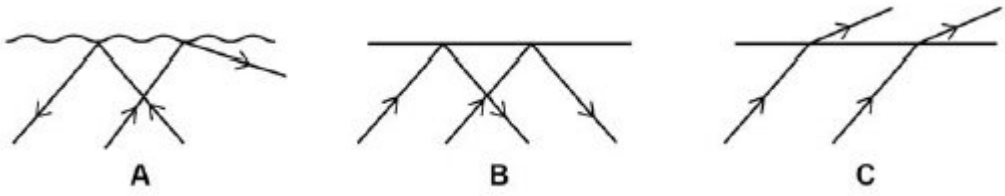
(2)

(Total 11 marks)

Q5.

(a) **Figure 1** shows what happens to rays of light incident on three different surfaces.

Figure 1



Which **one** of the diagrams shows diffuse reflection?

Tick **one** box.

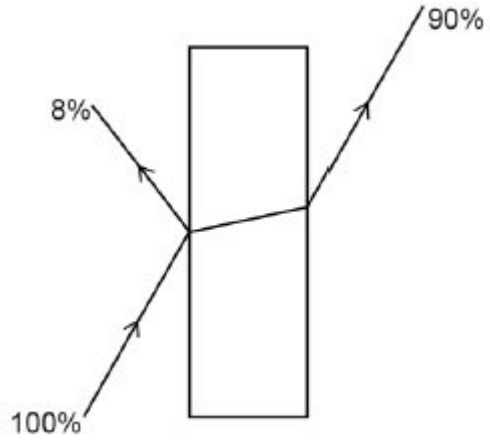
A ☐ B ☐ C ☐

(1)

(b) **Figure 2** shows what happens to the energy transferred by a ray of light when the ray of light hits a glass block.

Figure 2

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Calculate the percentage of the energy absorbed by the glass block.

_____

_____

Percentage of energy absorbed = _____ %

(1)

(c) Viewing an object through a colour filter may make the object look a different colour.

Complete the sentences.

Choose the answers from the box.

absorbs	**black**	**blue**
red	**reflects**	**transmits**

A red object viewed through a blue filter will look _____.

This is because the red object only _____ red light and the blue filter only _____ blue light.

(3)

(d) A white surface is viewed through a green filter.

What colour will the surface look?

_____

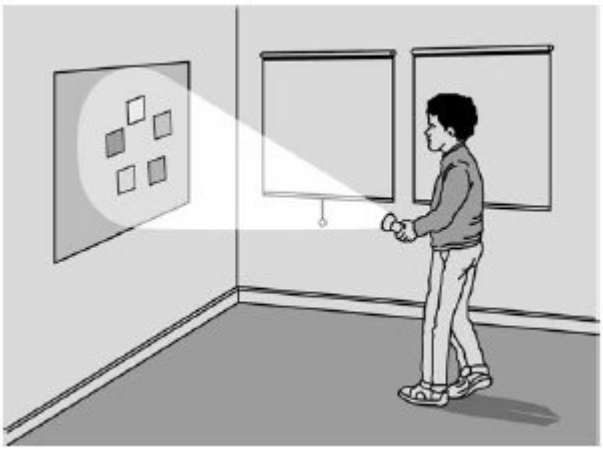
(1)

Cyclists often wear clothing that reflects a lot of light.

Figure 3 shows a student investigating which colours are best at reflecting light.

Figure 3

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This is the method used.

1. Small squares of different coloured material were stuck onto a piece of black paper at one end of a darkened laboratory.

2. The student switched on a torch and walked slowly towards the coloured squares.

3. The student stopped walking as soon as he could clearly see a coloured square.

4. The student measured the distance between the torch and the coloured square.

(e) Give a reason why it was important the student did the investigation in a darkened laboratory.

_____

_____

(1)

(f) Give a reason why it was important the area of each coloured square was the same.

_____

_____

(1)

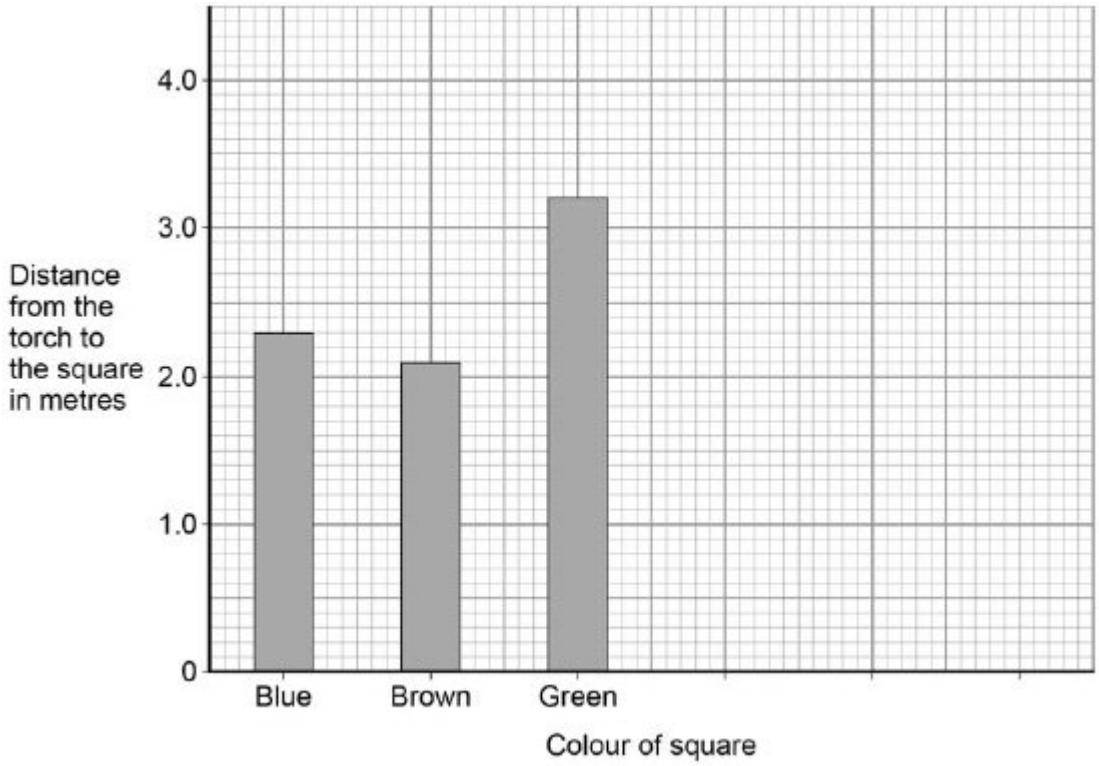
The table shows the student's results.

Colour of square	**Distance from the torch to the square in metres**
Blue	2.3
Brown	2.1
Green	3.2
Orange	3.4
Red	2.6

Figure 4 shows a bar chart with only three of the student's results.

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Figure 4



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

(3)

(h) Which colour clothing would be best for a cyclist to wear?

Use the data from the table.

Tick **one** box.

Blue ☐ Brown ☐ Green ☐ Orange ☐ Red ☐

Give a reason for your answer.

_____

_____

_____

(2)

(i) The student did the investigation again to obtain a second set of results.

The second set of results showed the same pattern as the first set.

Complete the sentence.

Choose the answer from the box.

accurate	**precise**	**repeatable**	**reproducible**

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The measurements taken by the student were _____ .

(1)

(Total 14 marks)

Q6.

(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.

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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)

Q7.

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(a) Which one of the following types of electromagnetic wave has the highest frequency?

Tick **one** box.

Gamma rays ☐

Infrared ☐

Microwaves ☐

Ultraviolet ☐

(1)

(b) What makes microwaves suitable for sending communications to a satellite in space?

_____

_____

(1)

(c) Scientists have detected short bursts of radio waves emitted from a distant galaxy.

The scientists think that the radio waves may have been emitted from a neutron star.

What event leads to a neutron star forming?

_____

_____

(1)

(d) Some of the radio waves from the distant galaxy have a frequency of 1.2 gigahertz (GHz).

Which of the following is the same as 1.2 GHz?

Tick **one** box.

1.2×10^3 Hz ☐

1.2×10^6 Hz ☐

1.2×10^9 Hz ☐

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1.2×10^{12} Hz ☐

(1)

(e) Radio waves travel through space at a speed of 3.0×10^8 m/s

Calculate the wavelength of the 1.2 GHz radio waves emitted from the distant galaxy.

_____

_____

_____

_____

_____

Wavelength = _____ m

(3)

(f) When radio waves are absorbed by an aerial they may create an alternating current in an electrical circuit.

If an alternating current is created what frequency would it have?

_____

_____

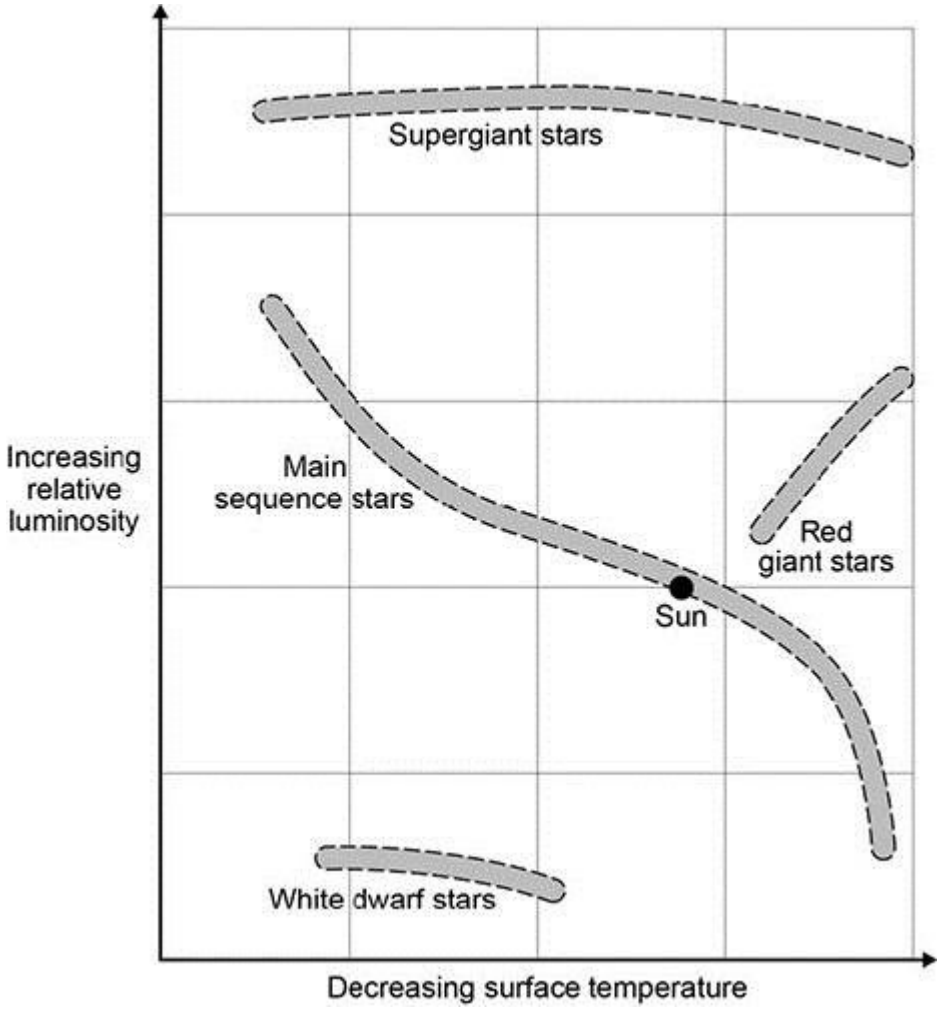
(1)

The diagram shows four groups of stars.

The surface temperature and relative luminosity determine which group a star is in.

A star with a relative luminosity of 1 emits the same amount of energy every second as the Sun.

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(g) The Sun is in the group of main sequence stars. These stars are stable.

Explain why a star remains stable.

_____

_____

_____

_____

(2)

(h) At different points in their lifecycle stars change from one group to another.

Describe what will happen to the Sun between it leaving the main sequence group and becoming a white dwarf.

Use information from the diagram.

_____

_____

_____

_____

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_____

_____

_____

_____

(4)

(Total 8 marks)

Q8.

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**
Gamma rays	For fibre optic communications
	For communicating with a satellite

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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)

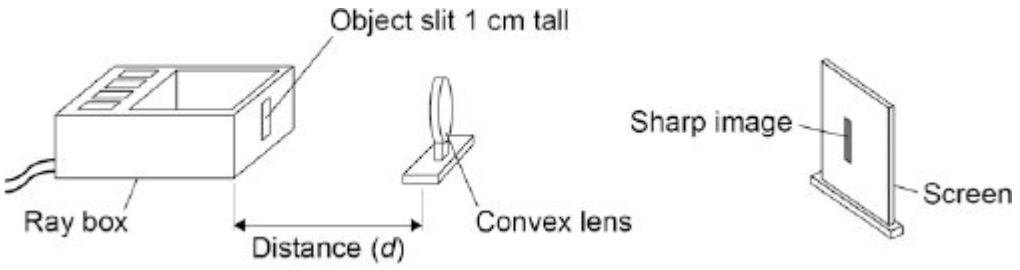
(Total 5 marks)

Q9.

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.

_____

_____

_____

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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	Magnification
25	4.0
30	2.0
40	1.0
50	0.7
60	0.5

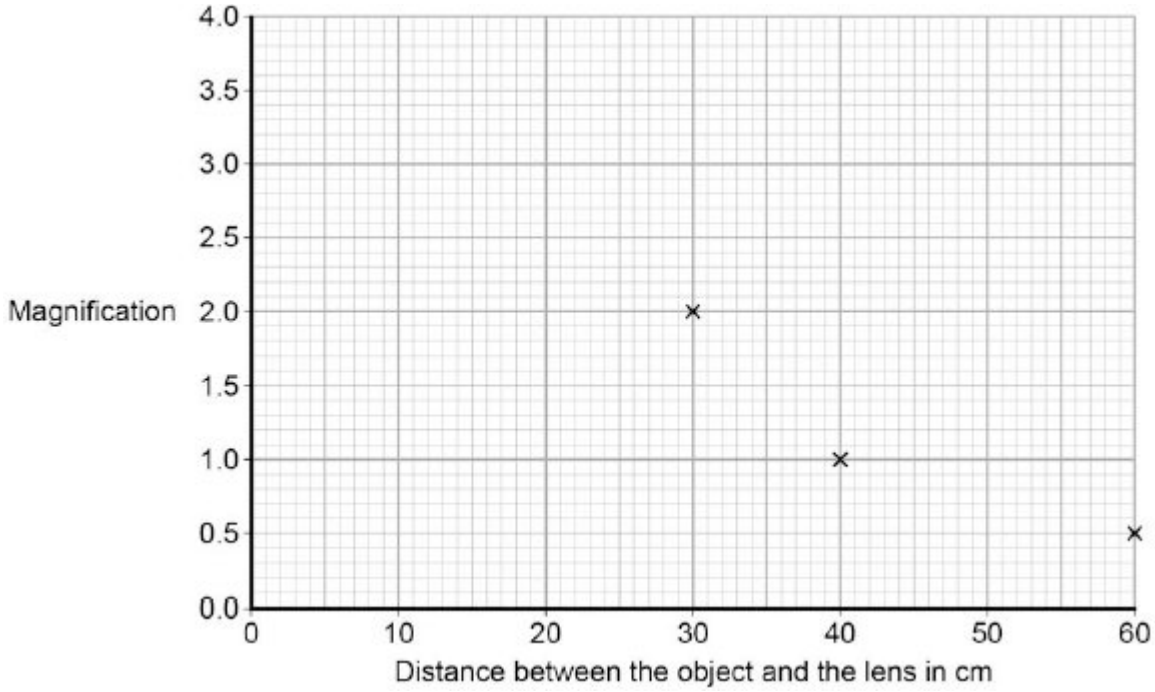
It would be difficult to obtain accurate magnification values for distances greater than 60 cm.

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

(1)

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

Figure 2



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

(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?

_____

_____

_____

(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	4.0
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)

(Total 9 marks)

Q10.

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

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

(a) 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.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(b) State the reason why light is refracted as it crosses from air into glass.

_____

_____

(1)

(Total 7 marks)

Q11.

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°

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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.

_____

_____

_____

_____

_____

_____

_____

_____

_____

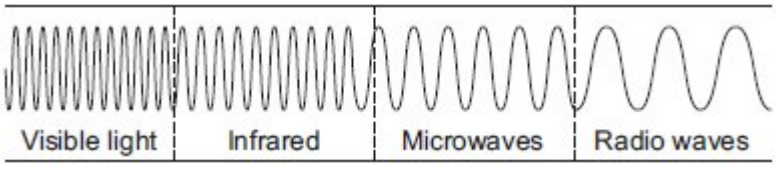
_____

(Total 6 marks)

Q12.

Infrared and microwaves are two types of electromagnetic radiation.

The diagram below shows the positions of the two types of radiation within part of the electromagnetic spectrum.



(a) Name **one** type of electromagnetic radiation which has more energy than infrared.

_____

(1)

(b) Use the correct answer from the box to complete each sentence.

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

greater than	**less than**	**the same as**

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The wavelength of infrared is _____ the wavelength of microwaves.

The frequency of microwaves is _____ the frequency of infrared.

The speed of microwaves in a vacuum is _____ the speed of infrared in a vacuum.

(3)

(Total 4 marks)

Q13.

Infrared and microwaves are two types of electromagnetic radiation.

(a) State **one** example of the use of each type of radiation for communication.

Infrared: _____

Microwaves: _____

(2)

(b) Some of the properties of infrared and microwaves are the same.

State **two** of these properties.

1. _____

_____

2. _____

_____

(2)

(Total 4 marks)

Q14.

Figure 1 shows an X-ray of an arm with a broken bone.

Figure 1



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(a) Complete the following sentence.

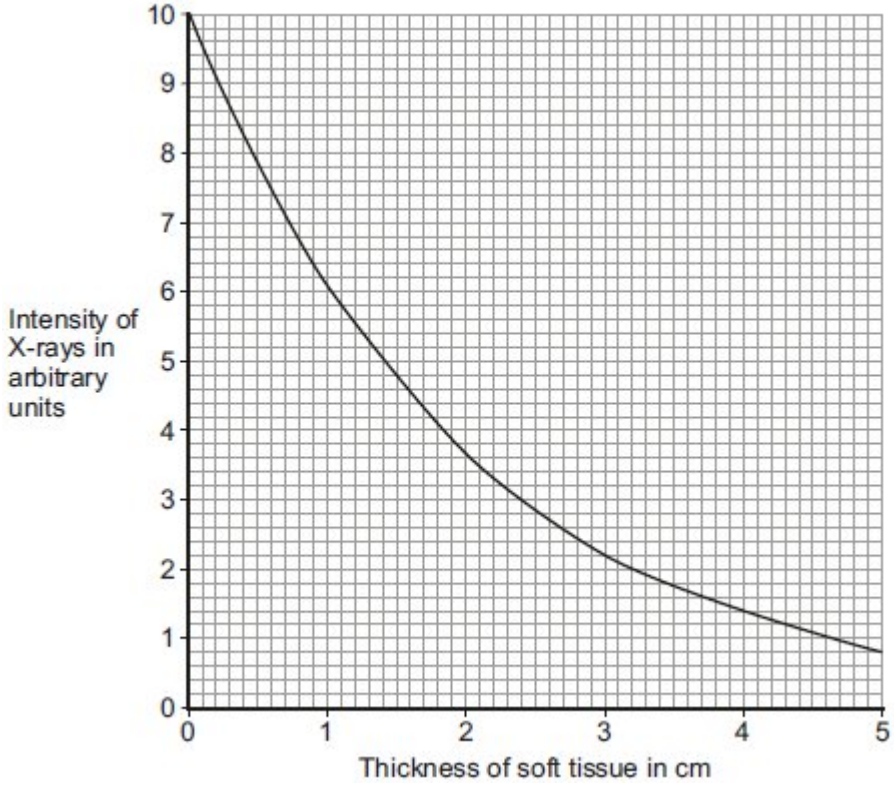
X-rays are part of the _____ spectrum.

(1)

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(b) **Figure 2** shows how the intensity of the X-rays changes as they pass through soft tissue and reach a detector.

Figure 2



(i) Use **Figure 2** to determine the intensity of X-rays reaching the detector for a 3 cm thickness of soft tissue.

Intensity of X-rays = _____ arbitrary units

(1)

(ii) Describe how the thickness of soft tissue affects the intensity of the X-rays.

_____

_____

_____

_____

(2)

(iii) The data in **Figure 2** are shown as a line graph and not as a bar chart.

Choose the reason why.

Tick (✔) **one** box.

Both variables are categoric ☐

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Both variables are continuous ☐

One variable is continuous and one is categoric ☐

(1)

(c) What happens to X-rays when they enter a bone?

_____

_____

(1)

(d) How are images formed electronically in a modern X-ray machine?

Tick (✔) **one** box.

With a charge-coupled device (CCD) ☐

With an oscilloscope ☐

With photographic film ☐

(1)

(e) Radiographers who take X-ray photographs may be exposed to X-rays.

(i) X-rays can increase the risk of the radiographer getting cancer.

Why can X-rays increase the risk of getting cancer?

Tick (✔) **one** box.

X-rays travel at the speed of light ☐

X-rays can travel through a vacuum ☐

X-rays are ionising ☐

(1)

(ii) What should the radiographer do to reduce the risk from X-rays?

_____

_____

(1)

(Total 9 marks)

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Q15.

X-rays and ultrasound can both be used for scanning internal organs.

(a) Ultrasound is used to scan unborn babies but X-rays are **not** used to scan unborn babies.

Explain why.

_____

_____

_____

_____

_____

_____

(3)

(b) The behaviour of ultrasound waves when they meet a boundary between two different materials is used to produce an image.

Describe how.

_____

_____

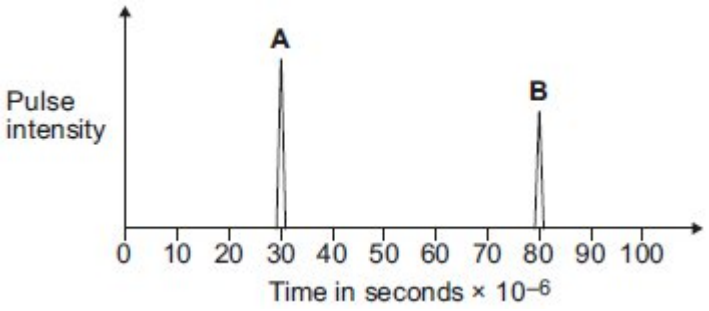
_____

_____

(2)

(c) **Figure 1** shows two pulses from a scan of an unborn baby. The emitted pulse is labelled **A**. The returning pulse picked up by the receiver is labelled **B**.

Figure 1



The closest distance between the unborn baby and the mother's skin is 4.0 cm. Use information from **Figure 1** to calculate the average speed of the pulse.

_____

_____

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_____

_____

_____

_____

Average speed = _____ m/s

(3)

(d) **Figure 2** shows an X-ray of an arm with a broken bone.

Figure 2



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(i) Describe how X-rays are able to produce an image of bones.

_____

_____

_____

_____

_____

_____

(3)

(ii) Complete the following sentence.

X-rays are able to produce detailed images because their wavelength

is very _____ .

(1)

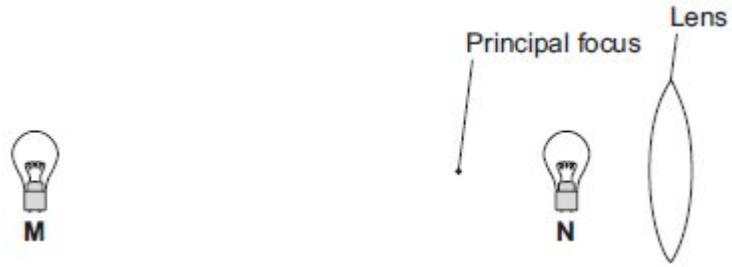
(Total 12 marks)

Q16.

(a) A light bulb is placed between a convex lens and the principle focus of this lens, at position **N** shown in **Figure 1**. The light bulb is then moved to position **M**, a large distance from the lens.

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Figure 1



Describe how the nature of the image formed changes as the light bulb is moved from position **N** to position **M**.

_____

_____

_____

_____

_____

_____

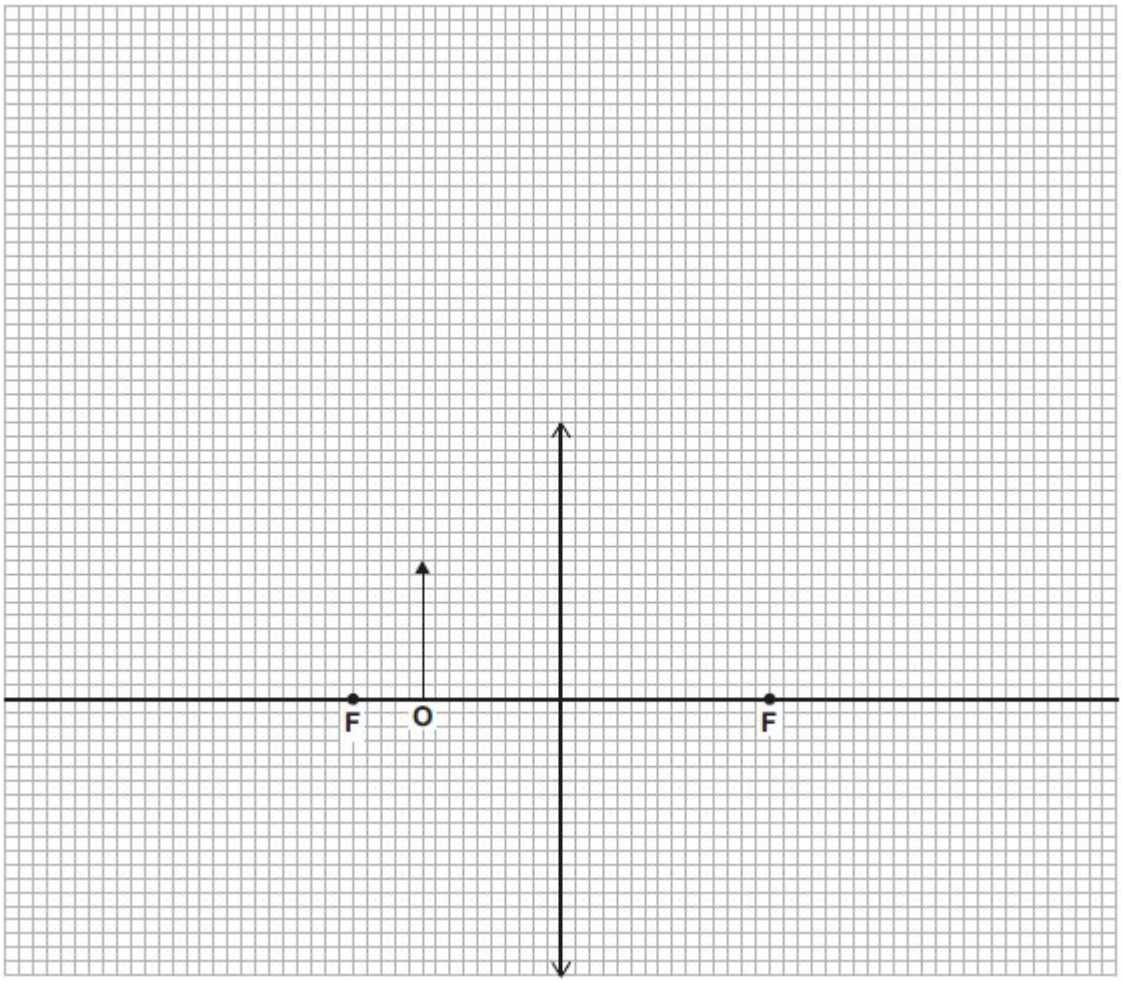
(3)

(b) An object, **O**, is very near to a convex lens, as shown in **Figure 2**.

Complete **Figure 2** to show how rays of light from the object form an image.

Figure 2

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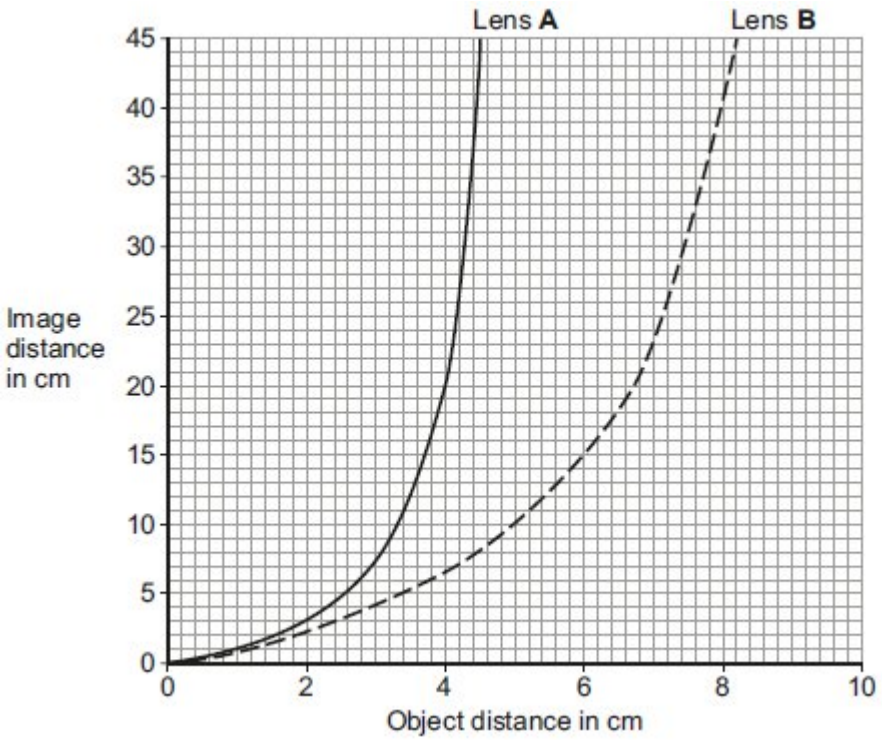
(3)

(c) The object distance is the distance from an object to the lens. The image distance is the distance from the lens to the image.

Figure 3 shows how the image distance changes with the object distance, for two identically shaped convex lenses, **A** and **B**. Each lens is made from a different type of glass.

Figure 3

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(i) When the object distance is 4 cm, the image distance for lens **A** is longer than for lens **B**.

State why.

_____

_____

(1)

(ii) When the object is moved between lens **B** and the principal focus, the image size changes. The table shows the magnification produced by lens **B** for different object distances.

Object distance in cm	Magnification
0.0	1
5.0	2
6.7	3
7.5	4
8.0	5

Using information from **Figure 3** and the table, describe the relationship between the **image** distance and the magnification produced by lens **B**.

_____

_____

_____

(2)

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(iii) A third convex lens, lens **C**, is made from the same type of glass as lens **B**, but has a shorter focal length than lens **B**.

Lens **B** is shown in **Figure 4**.

Complete **Figure 4** to show how lens **C** is different from lens **B**.

Figure 4



Lens **B** Lens **C**

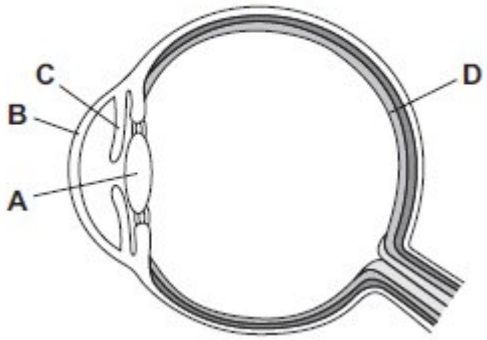
(1)

(Total 10 marks)

Q17.

(a) **Figure 1** shows a section through a human eye.

Figure 1



Write the correct letter, **A**, **B**, **C** or **D**, in each empty box to identify the parts of the eye labelled in **Figure 1**.

Part of the eye	A, B, C or D
Cornea	
Lens	
Retina	

(3)

(b) The table shows how the mass of 1 cm^3 of different materials varies with refractive index.

Material	Refractive index	Mass in g
Water	1.33	1.00

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Glass **X**	1.52	2.54
Glass **Y**	1.70	2.93
Glass **Z**	1.81	3.37

(i) Describe the pattern shown in above table.

_____

_____

(1)

(ii) Lenses used for correcting visual defects often have a low refractive index.

State **one** advantage and **one** disadvantage of using lenses with a high refractive index for correcting visual defects.

Advantage _____

Disadvantage _____

(2)

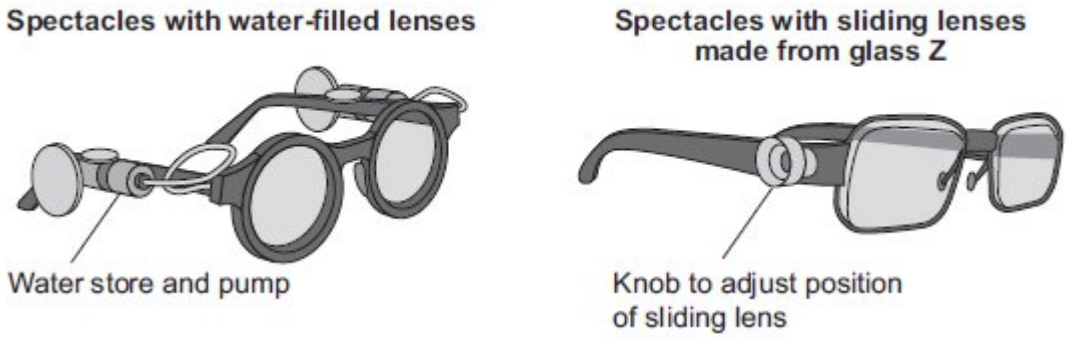
(iii) The eyesight of a person can change throughout their lifetime. Scientists have designed cheap spectacles that allow the wearer to change the focal length of the lenses as their eyesight changes.

Two designs are:

- using water-filled lenses where water is pumped in or out of the lens to change its shape
- using a pair of specially shaped lenses for each eye that are able to slide across each other.

Figure 2 shows these two designs.

Figure 2



Suggest **one** advantage and **one** disadvantage of each design.

_____

_____

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_____

_____

_____

_____

_____

_____

_____

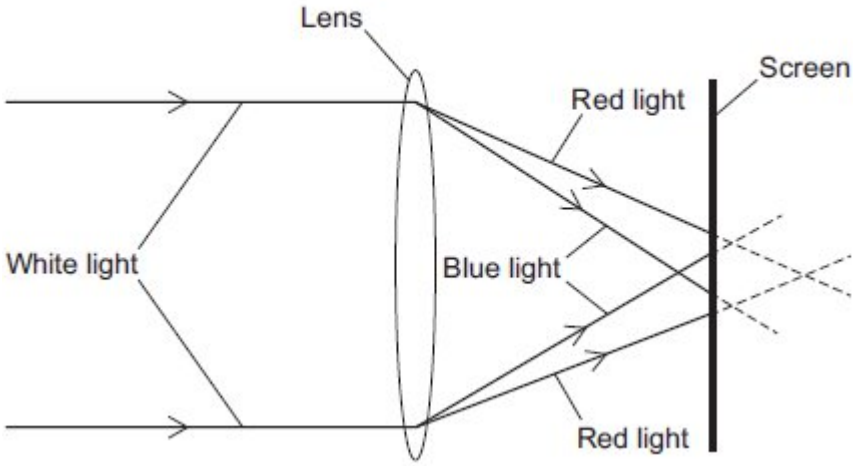
_____

(4)

(c) **Figure 3** shows parallel rays of white light from a distant point being refracted towards a screen by a lens.

The lens is made from a glass with a much greater refractive index than glass normally used for correcting visual defects.

Figure 3



What would you notice about the image on the screen?

State **two** observations.

1. _____

_____

2. _____

_____

(2)

(Total 12 marks)

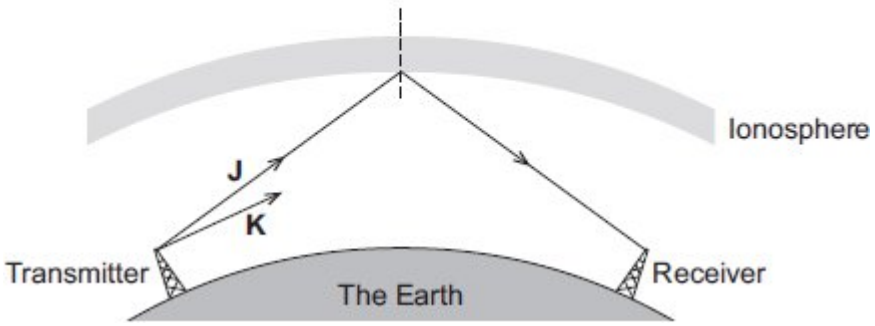
Q18.

Different parts of the electromagnetic spectrum are useful for different methods of communication.

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(a) **Figure 1** shows a transmitter emitting two electromagnetic waves, **J** and **K**.

Figure 1



Wave **J** is reflected by a layer in the atmosphere called the ionosphere.

(i) Wave **K** will also be reflected by the ionosphere.
On **Figure 1**, draw the path of wave **K** to show that it **does not** reach the receiver.

(2)

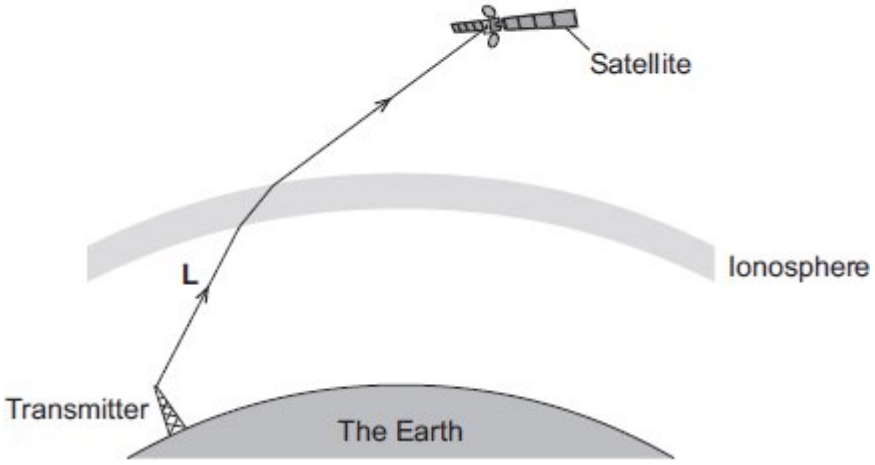
(ii) What is the name given to the dashed line in **Figure 1**?

_____

(1)

(b) **Figure 2** shows a transmitter sending a signal to a satellite orbiting the Earth.

Figure 2



(i) Which type of electromagnetic wave is used to send a signal to a satellite?

Draw a ring around the correct answer.

gamma **microwave** **ultraviolet**

(1)

(ii) What name is given to the process that occurs as wave **L** passes into the ionosphere?

Draw a ring around the correct answer.

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diffraction **reflection** **refraction**

(1)

(c) Waves **J**, **K** and **L** are electromagnetic waves.

What are **two** properties of **all** electromagnetic waves?

Tick (✓) **two** boxes.

Property	**Tick (✓)**
All electromagnetic waves are longitudinal.	
All electromagnetic waves are transverse.	
All electromagnetic waves are mechanical.	
All electromagnetic waves have the same speed in a vacuum.	
All electromagnetic waves have the same frequency.	

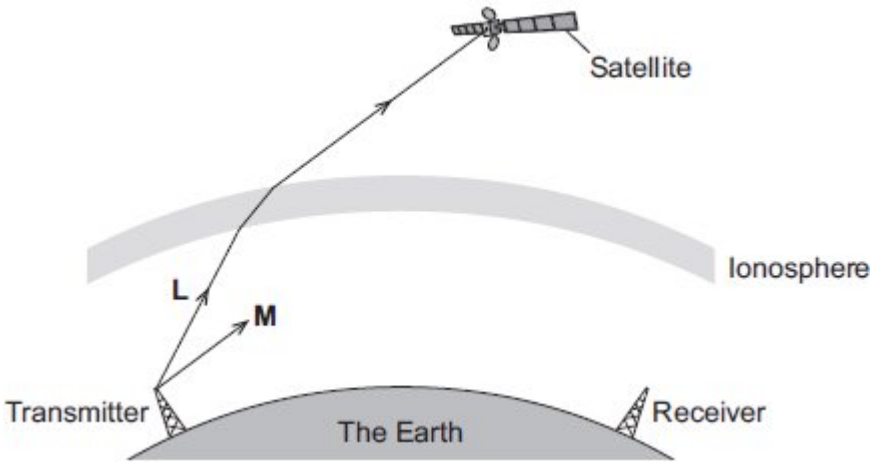
(2)

(Total 7 marks)

Q19.

Different parts of the electromagnetic spectrum are useful for different methods of communication.

The diagram shows a transmitter emitting two electromagnetic waves, **L** and **M**.



(a) (i) Wave **L** is used to send a signal to a satellite.
Which part of the electromagnetic spectrum does wave **L** belong to?

_____

(1)

(ii) What name is given to the process that occurs as wave **L** passes into the ionosphere?

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_____

(1)

(b) Wave **M** is **reflected** by the ionosphere.

(i) On the diagram above, draw the path of wave **M** until it reaches the receiver.

(2)

(ii) On the daigram above, draw a line to show the normal where wave **M** meets the ionosphere. Label the line **N**.

(1)

(c) Give **two** properties of all electromagnetic waves.

1. _____

_____

2. _____

_____

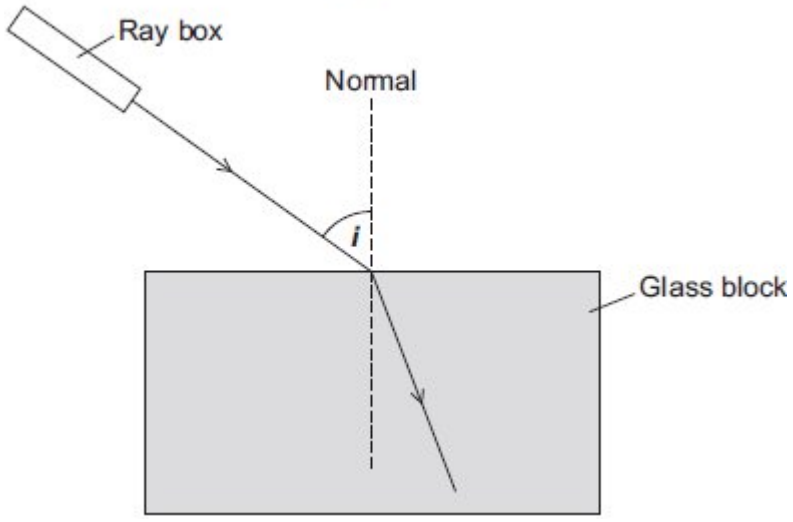
(2)

(Total 7 marks)

Q20.

(a) **Figure 1** shows a ray of light entering a glass block.

Figure 1



(i) The angle of incidence in **Figure 1** is labelled with the letter ***i***.

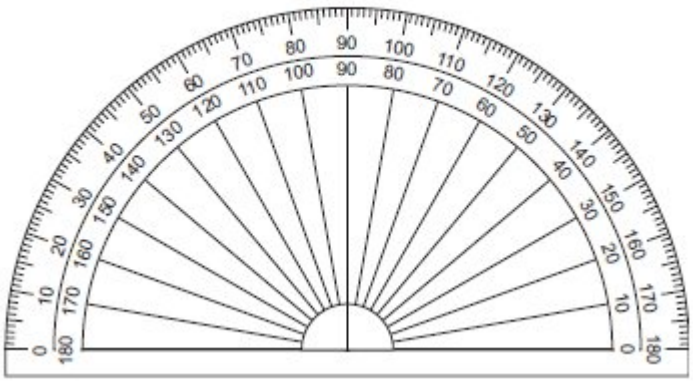
On **Figure 1**, use the letter ***r*** to label the angle of refraction.

(1)

(ii) **Figure 2** shows the protractor used to measure angles ***i*** and ***r***.

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Figure 2



What is the resolution of the protractor?

Tick (✓) **one** box.

1 degree ☐ 5 degrees ☐ 10 degrees ☐

(1)

(iii) The table shows calculated values for angle ***i*** and angle ***r*** from an investigation.

Calculated values
sin ***i*** = 0.80
sin ***r*** = 0.50

Use the values from the table to calculate the refractive index of the glass.

_____

_____

_____

Refractive index = _____

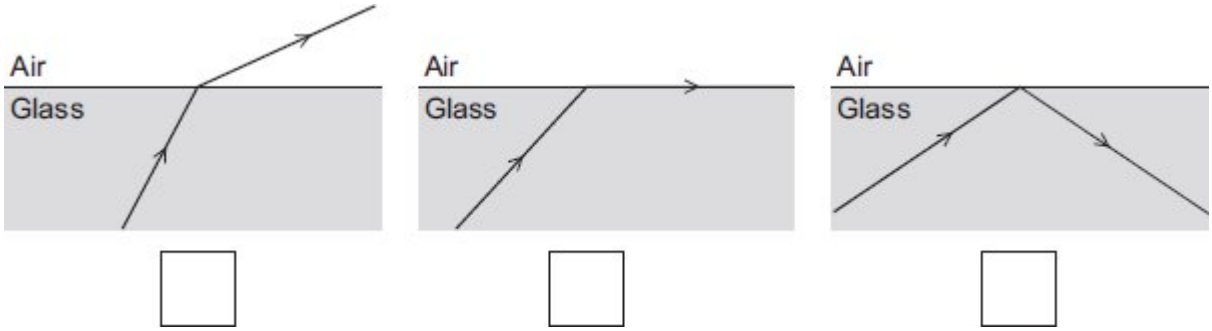
(2)

(b) The diagrams below show a ray of light moving through glass.

Which diagram correctly shows what happens when the ray of light strikes the surface of the glass at the critical angle?

Tick (✓) **one** box.

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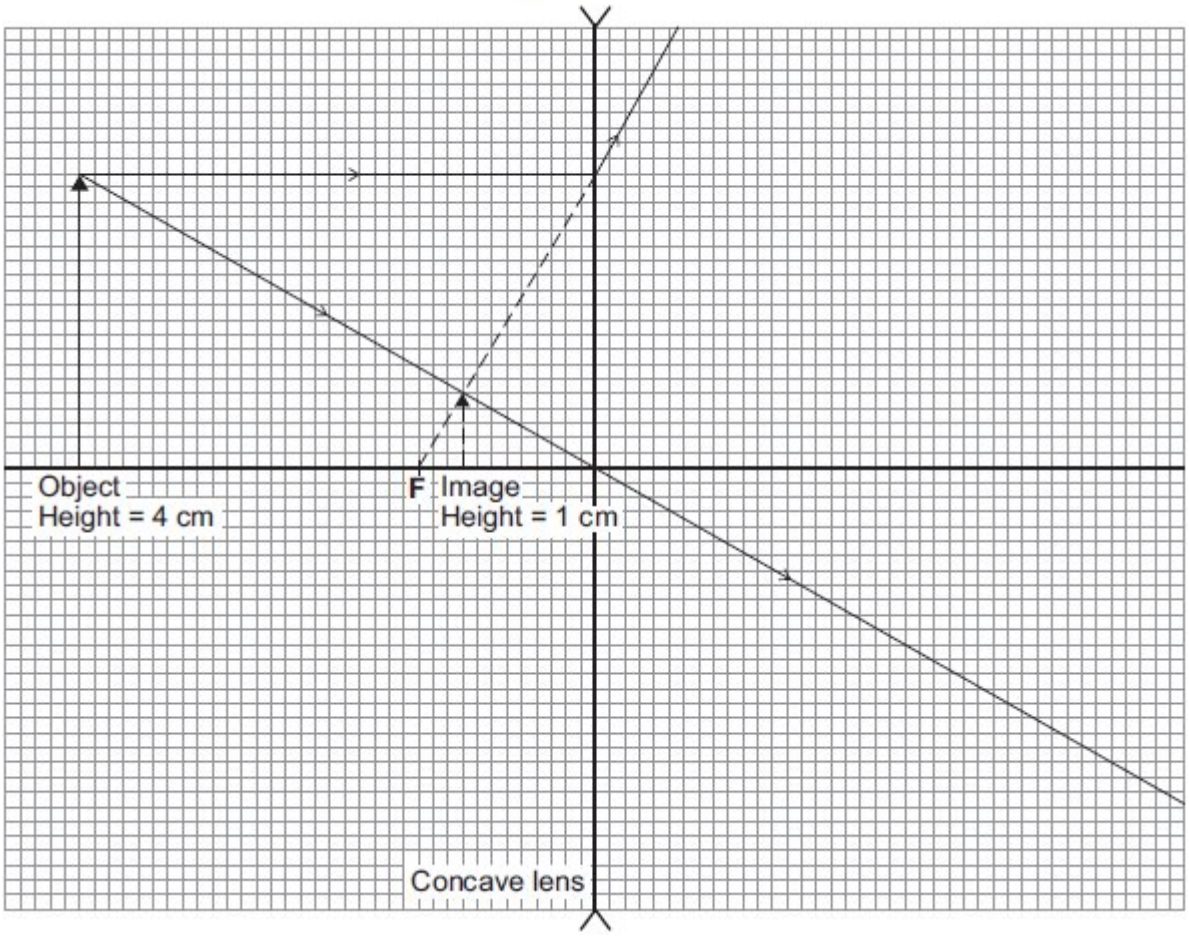


(1)

(c) A concave (diverging) lens is fitted into a door to make a security spyhole.

Figure 3 shows how this lens produces an image.

Figure 3



(i) State **one** word to describe the nature of the image in **Figure 3**.

_____

(1)

(ii) Use data from **Figure 3** to calculate the magnification of the image.

_____

_____

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_____

Magnification = _____

(2)

(iii) What is another use for a concave lens?

Tick (✓) **one** box.

A magnifying glass ☐

Correcting short sight ☐

To focus an image in a camera ☐

(1)

(Total 9 marks)

Q21.

(a) Complete the following sentences.

Ultrasound waves have a minimum frequency

of _____ hertz.

The wavelength of an X-ray is about the same as

the diameter of _____ .

(2)

(b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

The images show one medical use of ultrasound and one medical use of X-rays.



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Compare the medical uses of ultrasound and X-rays.

Your answer should include the risks, if any, and precautions, if any, associated with the use of ultrasound and X-rays.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

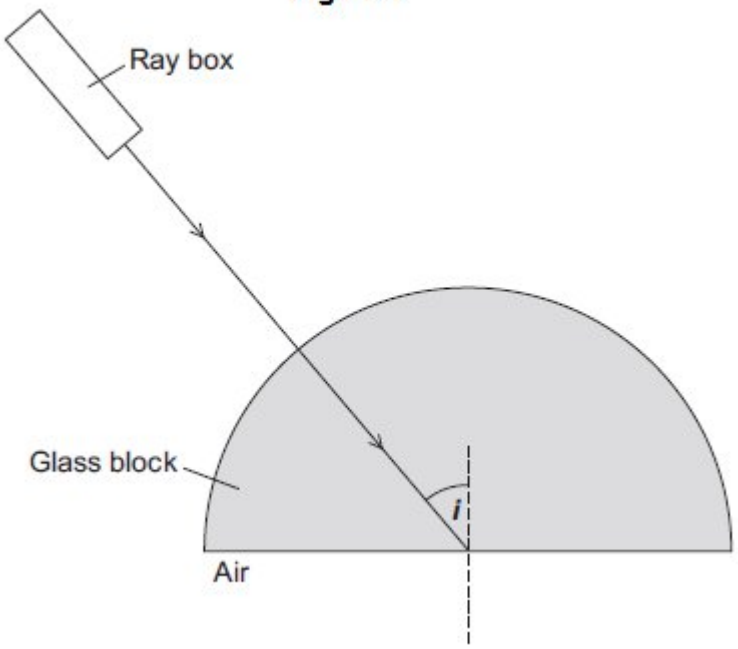
(6)

(Total 8 marks)

Q22.

Figure 1 shows a ray of light travelling through a semicircular glass block.
The angle of incidence is labelled ***i***.

Figure 1



(a) (i) The angle of incidence ***i*** equals the critical angle for the glass.

Complete **Figure 1** to show what happens to the ray of light at the glass-to-air boundary.

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(1)

(ii) The critical angle for the glass is 41°.

Calculate the refractive index of the glass.

_____

_____

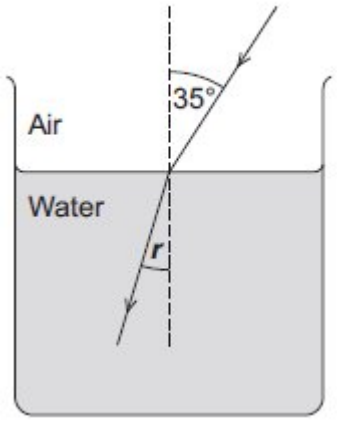
_____

Refractive index = _____

(2)

(b) **Figure 2** shows what happens to a ray of light as it meets the boundary between air and water.

Figure 2



Not to scale

The refractive index of the water is 1.3.

Calculate the angle of refraction ***r***.

_____

_____

_____

_____

_____

Angle of refraction = _____ degrees

(3)

(Total 6 marks)

Q23.

Light changes direction as it passes from one medium to another.

(a) Use the correct answer from the box to complete the sentence.

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diffraction	reflection	refraction

The change of direction when light passes from one medium to another is

called _____ .

(1)

(b) Draw a ring around the correct answer to complete the sentence.

When light passes from air into a glass block, it changes

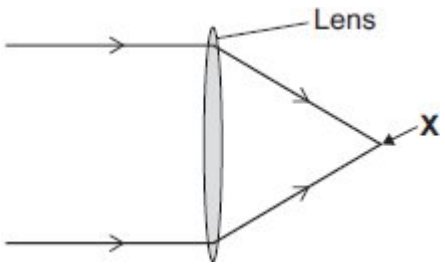
direction

away from the normal.
towards the normal.
to always travel along the normal.

(1)

(c) **Diagram 1** shows light rays entering and passing through a lens.

Diagram 1



(i) Which type of lens is shown in **Diagram 1**?

Draw a ring around the correct answer.

concave **convex** **diverging**

(1)

(ii) In **Diagram 1**, what is the point **X** called?

_____

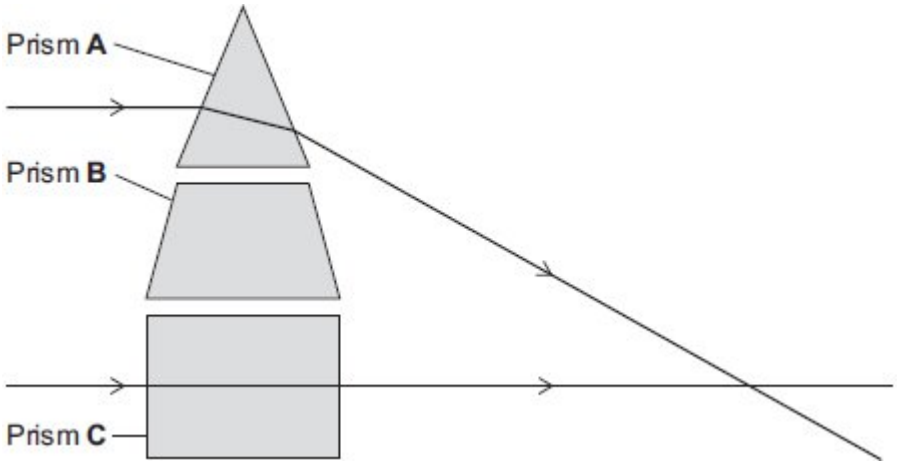
(1)

(d) A lens acts like a number of prisms.

Diagram 2 shows two parallel rays of light entering and passing through prism **A** and prism **C**.

Diagram 2

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Draw a third parallel ray entering and passing through prism **B**.

(4)

(e) What **two** factors determine the focal length of a lens?

1. _____

2. _____

(2)

(Total 10 marks)

Q24.

Different parts of the electromagnetic spectrum have different uses.

(a) The diagram shows the electromagnetic spectrum.

Radio waves	Microwaves	Infrared	Visible light	Ultraviolet	X-rays	Gamma rays



(i) Use the correct answers from the box to complete the sentence.

amplitude	**frequency**	**speed**	**wavelength**

The arrow in the diagram is in the direction of increasing _____

and decreasing _____ .

(2)

(ii) Draw a ring around the correct answer to complete the sentence.

The range of wavelengths for waves in the electromagnetic spectrum is approximately

10^{-15} to 10^{4}
10^{-4} to 10^{4}

metres.

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10^4 to 10^{15}

(1)

(b) The wavelength of a radio wave is 1500 m.
The speed of radio waves is 3.0×10^8 m / s.

Calculate the frequency of the radio wave.

Give the unit.

_____

_____

_____

Frequency = _____

(3)

(c) (i) State **one** hazard of exposure to infrared radiation.

_____

(1)

(ii) State **one** hazard of exposure to ultraviolet radiation.

_____

(1)

(d) X-rays are used in hospitals for computed tomography (CT) scans.

(i) State **one** other medical use for X-rays.

_____

_____

(1)

(ii) State a property of X-rays that makes them suitable for your answer in part **(d)(i)**.

_____

_____

(1)

(iii) The scientific unit of measurement used to measure the dose received from radiations, such as X-rays or background radiation, is the millisievert (mSv).

The table shows the X-ray dose resulting from CT scans of various parts of the body.

The table also shows the time it would take to get the same dose from background radiation.

Part of the	**X-ray dose**	**Time it would take to get the same**

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body	in mSv	dose from background radiation
Abdomen	9.0	3 years
Sinuses	0.5	2 months
Spine	4.0	16 months

A student suggests that the X-ray dose and the time it would take to get the same dose from background radiation are directly proportional.

Use calculations to test this suggestion and state your conclusion.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

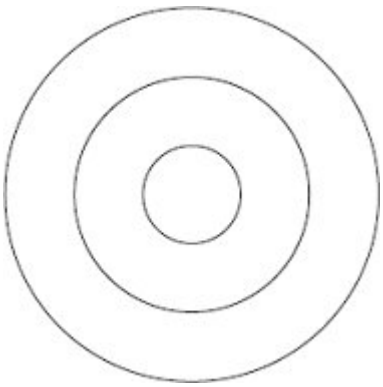
(Total 13 marks)

Q25.

A teacher demonstrates the production of circular waves in a ripple tank.

Diagram 1 shows the waves at an instant in time.

Diagram 1



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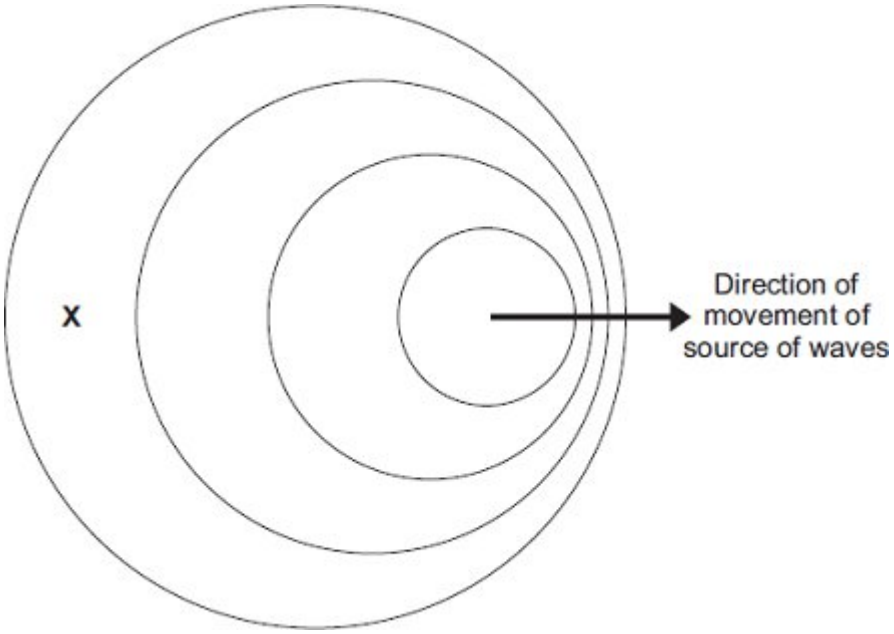
(a) Show on **Diagram 1** the wavelength of the waves.

(1)

(b) The teacher moves the source of the waves across the ripple tank.

Diagram 2 shows the waves at an instant in time.

Diagram 2
(Actual size)



(i) Use the correct answer from the box to complete each sentence.

decreased	**increased**	**stayed the same**

In **Diagram 2**, the observed wavelength of the waves at **X**

has _____ .

In **Diagram 2**, the frequency of the waves at **X**

has _____ .

(2)

(ii) Take measurements from **Diagram 2** to determine the wavelength of the waves received at **X**.

Give the unit.

_____

_____

Wavelength = _____

(3)

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(c) The teacher uses the waves in the ripple tank to model the changes in the wavelengths of light observed from distant galaxies.

When observed from the Earth, there is an increase in the wavelength of light from distant galaxies.

(i) State the name of this effect.

_____

(1)

(ii) What does this increase in wavelength tell us about the movement of most galaxies?

_____

_____

(1)

(iii) Explain how this observation supports the Big Bang theory of the formation of the Universe.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(iv) State **one** other piece of evidence that supports the Big Bang theory of the formation of the Universe.

_____

_____

(1)

(Total 13 marks)

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Q26.

(a) Radio waves, microwaves and visible light are all electromagnetic waves that are used for communication.

(i) Name another electromagnetic wave that is used for communication.

_____

(1)

(ii) Name an electromagnetic wave which is **not** used for communication.

State a use for this electromagnetic wave.

Electromagnetic wave _____

Use _____

_____

(2)

(b) The table below shows the wavelengths for some electromagnetic waves, **A**, **B**, **C** and **D**.

Wave	Wavelength
A	1000 m
B	100 m
C	10 m
D	3 cm

A teacher is going to demonstrate diffraction of waves through a gap. She will carry out the demonstration in a classroom.

The teacher is able to generate waves **A**, **B**, **C** and **D**.

Which wave, **A**, **B**, **C** or **D**, would she use? ☐

Explain your answer.

_____

_____

_____

_____

_____

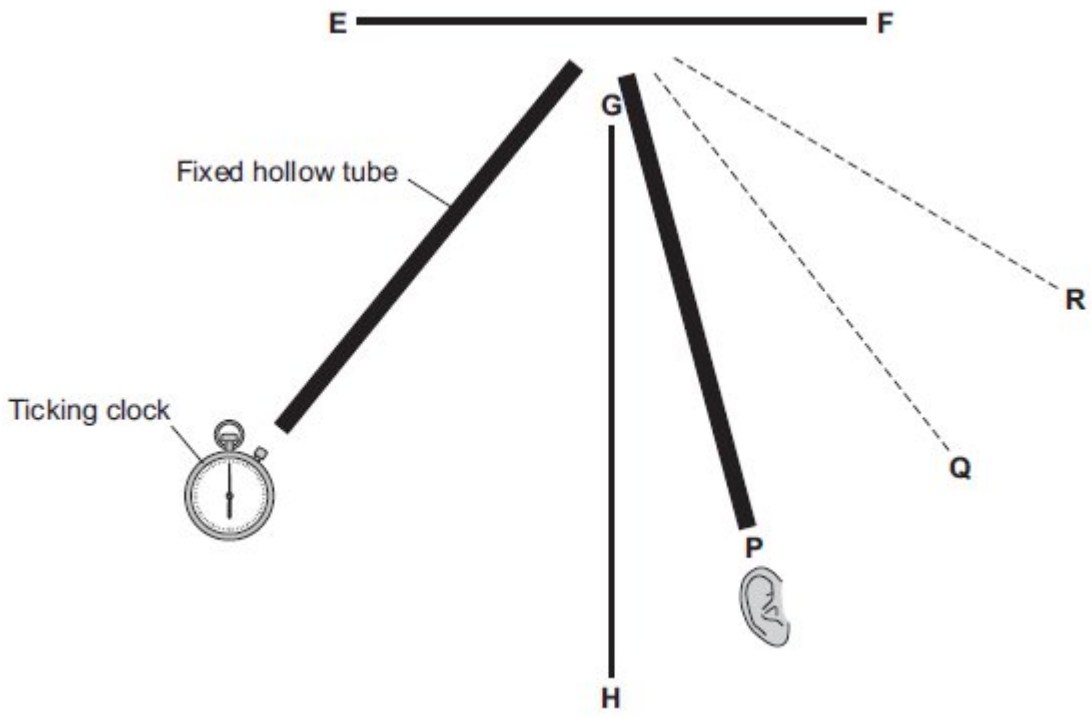
_____

(3)

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(c) In another demonstration, a teacher used a loud ticking clock as a source of sound, two hollow tubes and two smooth surfaces, **EF** and **GH**.

The figure below shows one of the hollow tubes fixed in position with a ticking clock at one end.



A student placed his ear at one end of the other hollow tube in position **P**. He moved this hollow tube, in turn, to positions **Q** and **R**.

(i) At which position, **P**, **Q** or **R**, did he hear the loudest sound? ☐

(1)

(ii) Explain your answer to part **(i)**.

_____

_____

_____

_____

_____

_____

(3)

(iii) Suggest why smooth surface **GH** in the figure above was needed.

_____

_____

(1)

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(iv) The frequency of a sound wave is 15 Hz.

The speed of sound is 330 m / s.

Calculate the wavelength of the sound wave.

_____

_____

Wavelength = _____ m

(2)

(v) Give a reason why it would **not** be possible to do the demonstration in the figure above using sound waves with a frequency of 15 Hz.

_____

_____

(1)

(Total 14 marks)

Q27.

Lenses can be used to correct visual defects.

Figure 1 shows a child wearing glasses.
Wearing glasses allows a lens to correct a visual defect.

Figure 1

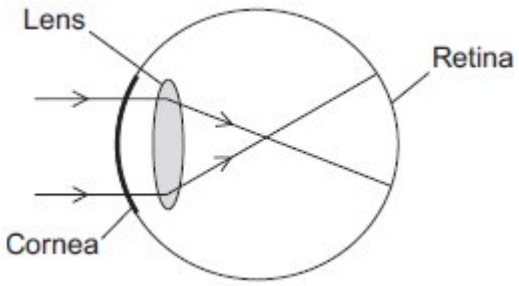


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(a) **Figure 2** shows rays of light entering a child's eye and being focused at a point.
This point is not on the retina so the child sees a blurred image.

Figure 2

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(i) What is the visual defect of this eye?

_____

_____

(1)

(ii) Use the correct answer from the box to complete the sentence.

converging	convex	diverging

The type of lens used to correct this visual defect is a _____ lens.

(1)

(b) Visual defects may be corrected with eye surgery. A laser may be used in eye surgery.

Use the correct answer from the box to complete the sentence.

light	sound	X-rays

A laser is a concentrated source of _____ .

(1)

(c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Lasers can be used to correct a visual defect by changing the shape of the cornea.

A knife is used to cut a flap in the cornea. The laser vaporises a portion of the cornea and permanently changes its shape. The flap is then replaced.

Most patients are back at work within a week. Driving may be unsafe for one to two weeks. Tinted glasses with ultraviolet protection are needed when out in the sun for the first three months.

Many people in their mid-40s need reading glasses. This is because the eye lens becomes less flexible with age. Laser surgery cannot cure this.

Laser surgery for both eyes costs £1000. A pair of glasses costs £250.

Describe the advantages and disadvantages of:

- having laser surgery to correct visual defects

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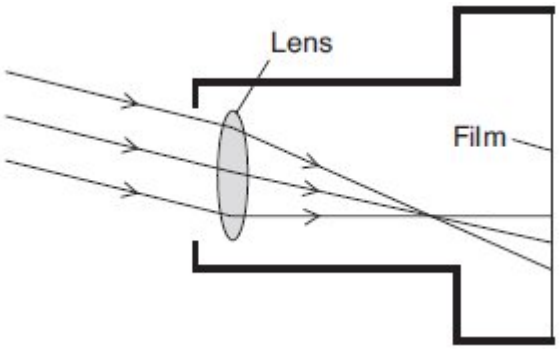
- wearing glasses to correct visual defects.

Extra space

(6)

(d) **Figure 3** shows parallel rays of light, from a point on a distant object, entering a camera.

Figure 3



Describe the adjustment that has to be made to focus the image on the film.

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_____

_____

(2)

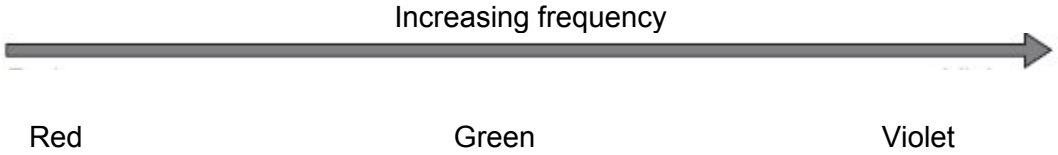
(Total 11 marks)

Q28.

(a) The visible light spectrum has a range of frequencies.

Figure 1 shows that the frequency increases from red light to violet light.

Figure 1



Use the correct answers from the box to complete the sentence.

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

As the frequency of the light waves increases, the wavelength

of the light waves _____ and

the energy of the light waves _____ .

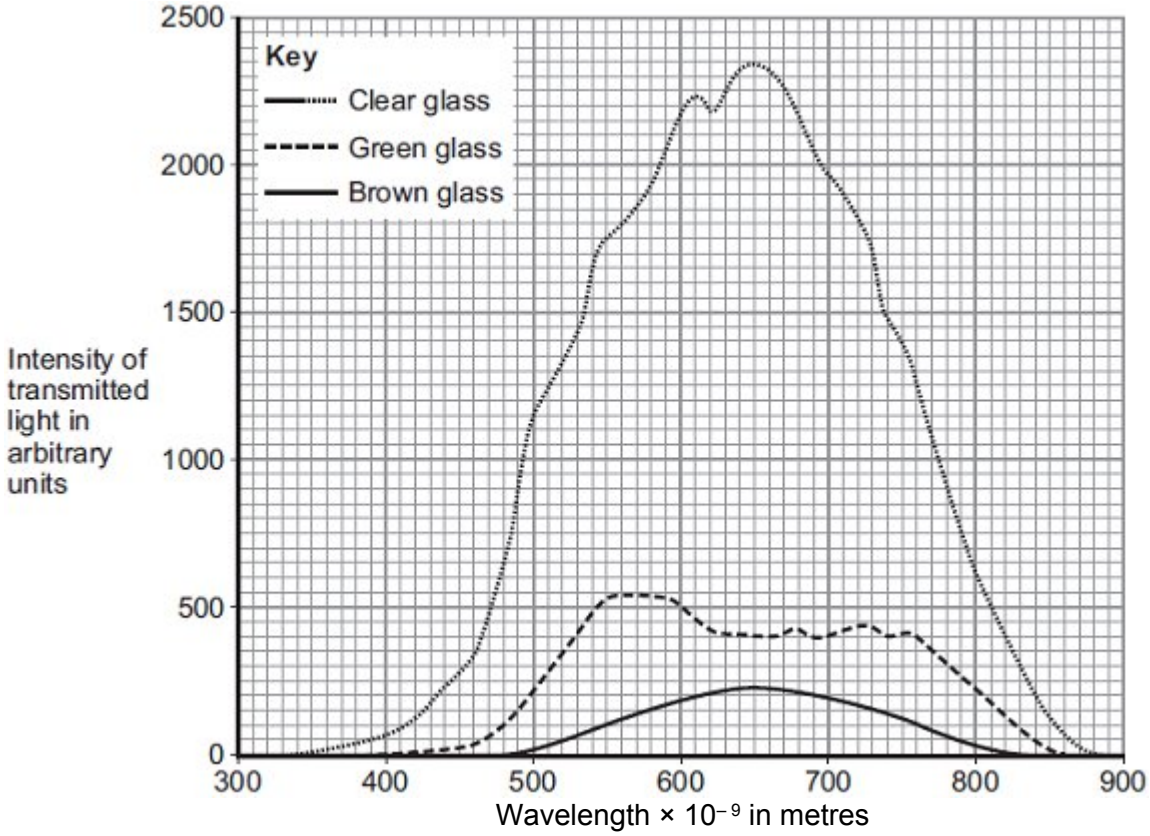
(2)

(b) Bottled beer will spoil if the intensity of the light passing through the glass bottle into the beer is too high.

Figure 3 shows the intensity of the light that is transmitted through three different pieces of glass.

Figure 3

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(i) The pieces of glass all had the same thickness.

Suggest why.

_____

_____

(1)

(ii) Bottles made of brown glass are suitable for storing beer.

Suggest why.

_____

_____

(1)

(Total 4 marks)

Q29.

(a) Some humans are short-sighted.

Complete the following sentence.

Short sight can be caused by the eyeball being too _____ .

(1)

(b) Spectacles can be worn to correct short sight.

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The table below gives information about three different lenses that can be used in spectacles.

	Lens feature		
	Material	**Mass in grams**	**Type**
Lens A	Plastic	5.0	Concave (diverging)
Lens B	Glass	6.0	Convex (converging)
Lens C	Glass	5.5	Convex (converging)

Which lens from **Table 2** would be used to correct short sight?

Draw a ring around the correct answer.

Lens A **Lens B** **Lens C**

Give the reason for your answer.

_____

_____

(2)

(c) Every lens has a focal length.

Which factor affects the focal length of a lens?

Tick (✓) **one** box.

The colour of the lens ☐

The refractive index of the lens material ☐

The size of the object being viewed ☐

(1)

(d) A lens has a focal length of 0.25 metres.

Calculate the power of the lens.

_____

_____

_____

Power of lens = _____ dioptres

(2)

(e) Laser eye surgery can correct some types of eye defect.

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Which of the following is another medical use for a laser?

Tick (✓) **one** box.

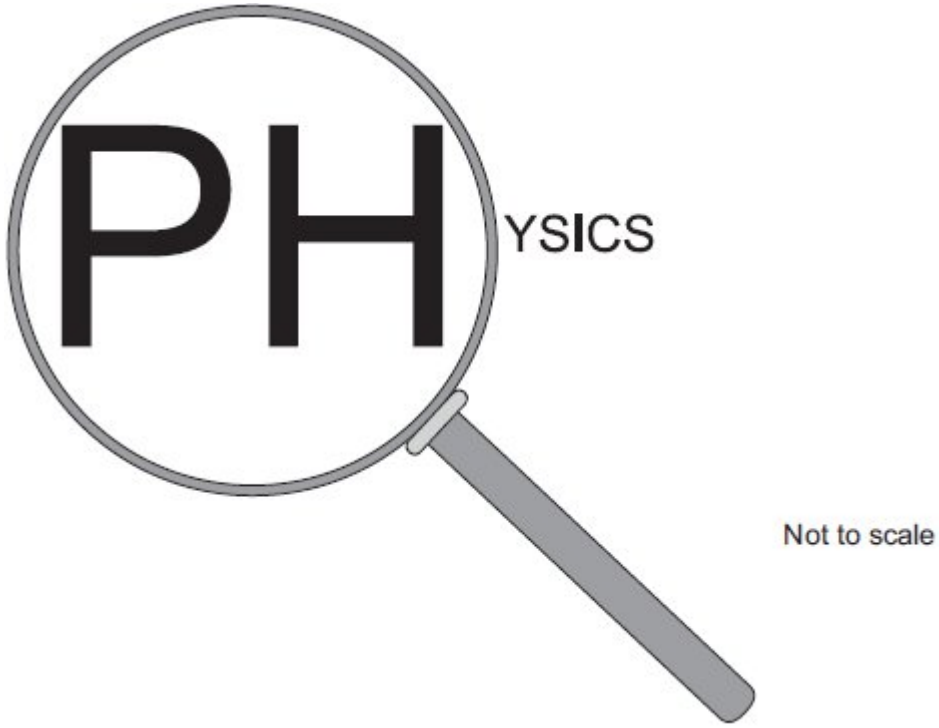
Cauterising open blood vessels ☐

Detecting broken bones ☐

Imaging the lungs ☐

(1)

(f) The figure shows a convex lens being used as a magnifying glass.



An object of height 14 mm is viewed through a magnifying glass.

The image height is 70 mm.

Calculate the magnification produced by the lens in the magnifying glass.

_____

_____

_____

Magnification = _____

(2)

(Total 9 marks)

Q30.

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The figure below shows an X-ray image of a human skull.



Stockdevil/iStock/Thinkstock

(a) Use the correct answers from the box to complete the sentence.

absorbs	**ionises**	**reflects**	**transmits**

When X-rays enter the human body, soft tissue _____

X-rays and bone _____ X-rays.

(2)

(b) Complete the following sentence.

The X-rays affect photographic film in the same way that _____ does.

(1)

(c) The table below shows the total dose of X-rays received by the human body when different parts are X-rayed.

Part of body X-rayed	**Dose of X-rays received by human body in arbitrary units**
Head	3
Chest	4
Pelvis	60

Calculate the number of head X-rays that are equal in dose to one pelvis X-ray.

_____

_____

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Number of head X-rays = _____

(2)

(d) Which **one** of the following is another use of X-rays?

Tick (✓) **one** box.

Cleaning stained teeth ☐

Killing cancer cells ☐

Scanning of unborn babies ☐

(1)

(Total 6 marks)

Q31.

(a) What is ultrasound?

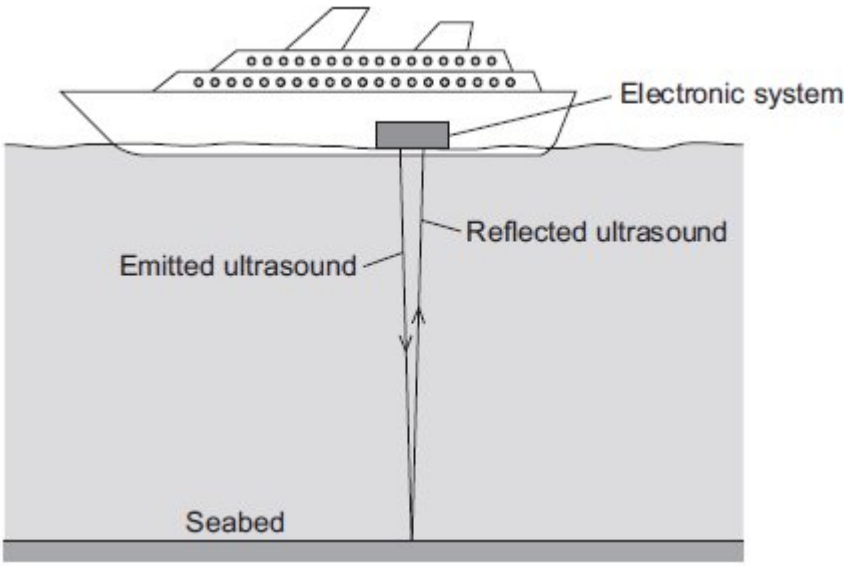
_____

_____

(1)

(b) **Figure 1** shows how ultrasound is used to measure the depth of water below a ship.

Figure 1



A pulse of ultrasound is sent out from an electronic system on-board the ship.

It takes 0.80 seconds for the emitted ultrasound to be received back at the ship.

Calculate the depth of the water.

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Speed of ultrasound in water = 1600 m / s

_____

_____

_____

_____

Depth of water = _____ metres

(3)

(c) Ultrasound can be used in medicine for scanning.

State **one** medical use of ultrasound scanning.

_____

(1)

(d) Images of the inside of the human body can be made using a Computerised Tomography (CT) scanner. The CT scanner in **Figure 2** uses X-rays to produce these images.

Figure 2



monkeybusinessimages/iStock/Thinkstock

State **one** advantage and **one** disadvantage of using a CT scanner, compared with ultrasound scanning, for forming images of the inside of the human body.

Advantage of CT scanning _____

_____

_____

Disadvantage of CT scanning _____

_____

_____

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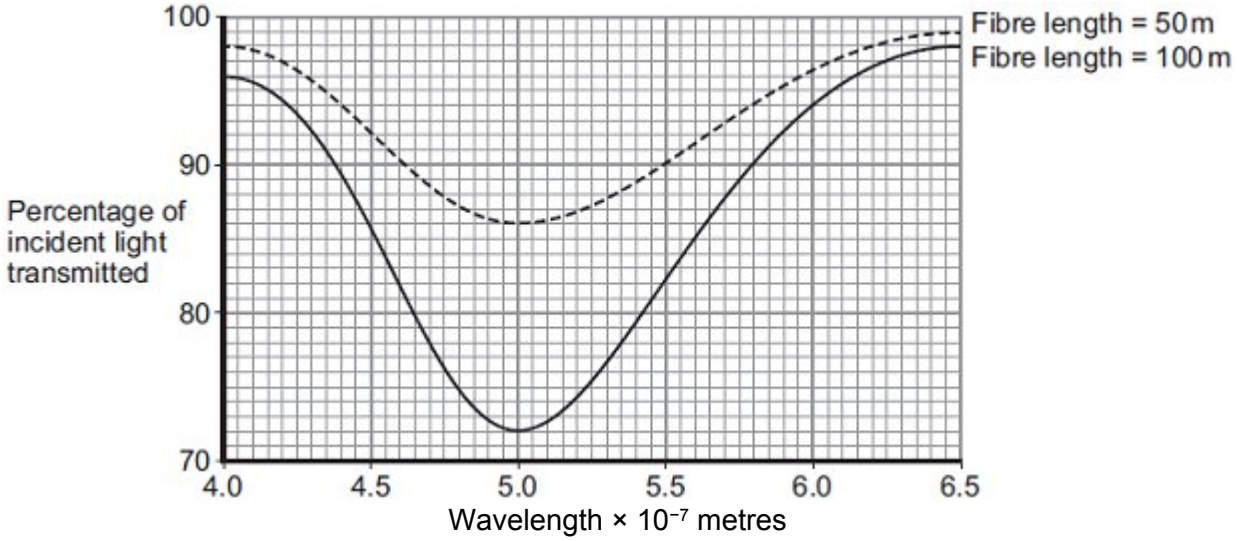
(2)

(Total 7 marks)

Q32.

Different wavelengths of light can be used to transmit information along optical fibres.

The graph below shows how the percentage of incident light transmitted through a fibre varies with the wavelength of light and the length of the fibre.



Compare the percentages of incident light transmitted through the two different fibres over the range of wavelengths shown.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(Total 3 marks)

Q33.

Waves may be longitudinal or transverse.

(a) Describe the differences between longitudinal waves and transverse waves.

_____

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_____

_____

_____

_____

_____

_____

_____

(3)

(b) Radio waves are electromagnetic waves.

Describe how radio waves are different from sound waves.

_____

_____

_____

_____

_____

_____

_____

_____

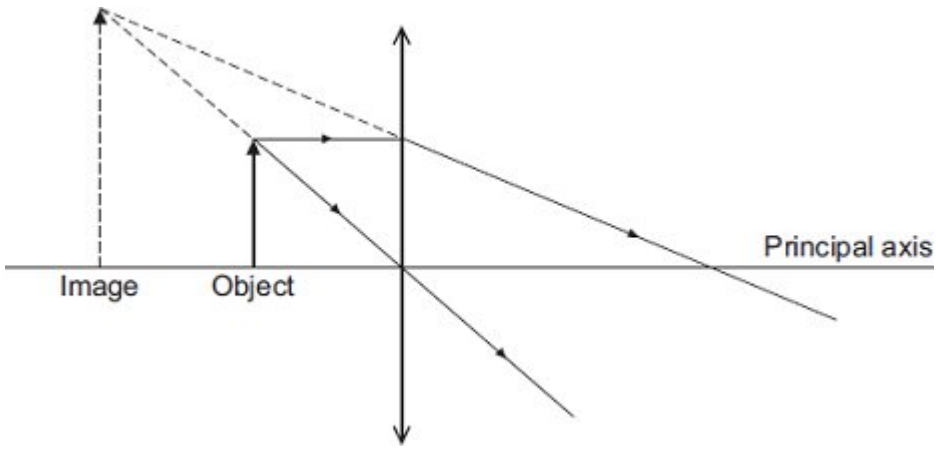
(4)

(Total 7 marks)

Q34.

(a) The diagram shows how a convex lens forms an image of an object.

This diagram is **not** drawn to scale.



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

Draw a ring around each correct answer.

diminished **inverted** **magnified** **real** **upright**

(2)

(ii) The object is 4 cm from the lens. The lens has a focal length of 12 cm.

Calculate the image distance.

_____

_____

_____

Image distance = _____ cm

(3)

(b) What does a minus sign for an image distance tell us about the nature of the image?

_____

(1)

(Total 6 marks)

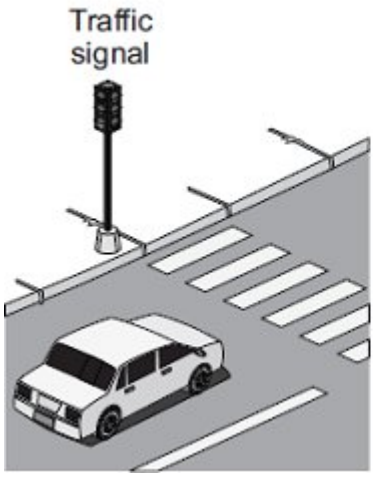
Q35.

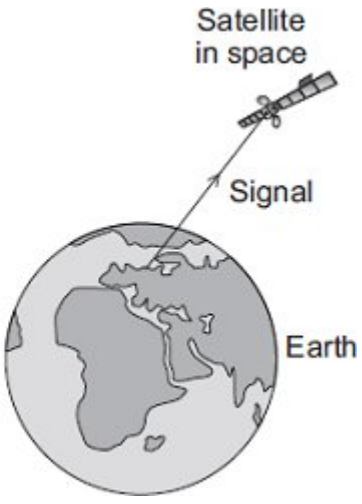
Diagram 1 shows four of the seven types of wave in the electromagnetic spectrum.

Diagram 1

J	**K**	**L**	Visible light	Infrared	Microwaves	Radio waves

(a) The **four** types of electromagnetic wave named in **Diagram 1** above are used for communication.





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(i) Which type of electromagnetic wave is used when a traffic signal communicates with a car driver?

_____

(1)

(ii) Which type of electromagnetic wave is used to communicate with a satellite in space?

_____

(1)

(b) Gamma rays are part of the electromagnetic spectrum.

Which letter, **J**, **K** or **L**, shows the position of gamma rays in the electromagnetic spectrum?

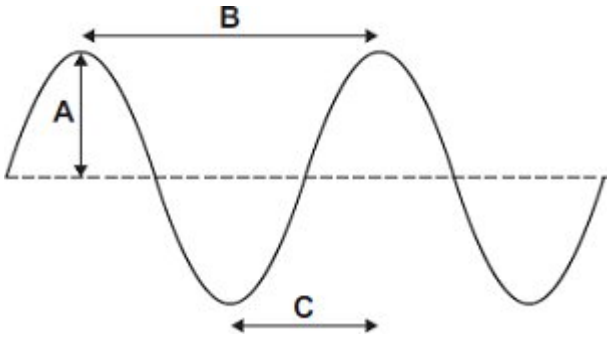
Draw a ring around the correct answer.

J **K** **L**

(1)

(c) **Diagram 2** shows an infrared wave.

Diagram 2



(i) Which **one** of the arrows, labelled **A**, **B** or **C**, shows the wavelength of the wave?

Write the correct answer, **A**, **B** or **C**, in the box. ☐

(1)

(ii) Draw a ring around the correct answer to complete the sentence.

The wavelength of infrared waves is [shorter than / the same as / longer than] the wavelength of radio waves.

(1)

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(d) Mobile phone networks send signals using microwaves. Some people think the energy a person's head absorbs when using a mobile phone may be harmful to health.

(i) Scientists have compared the health of people who use mobile phones with the health of people who do not use mobile phones.

Which **one** of the following statements gives a reason why scientists have done this?

Tick (✓) **one** box.

To find out if using a mobile phone is harmful to health. ☐

To find out if mobile phones give out radiation. ☐

To find out why some people are healthy. ☐

(1)

(ii) The table gives the specific absorption rate (SAR) value for two different mobile phones.

The SAR value is a measure of the maximum energy a person's head absorbs when a mobile phone is used.

Mobile Phone	SAR value in W/kg
X	0.28
Y	1.35

A parent buys mobile phone **X** for her daughter.

Using the information in the table, suggest why buying mobile phone **X** was the best choice.

_____

_____

_____

_____

(2)

(Total 8 marks)

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