EXAM PAPERS PRACTICE

Electromagnetic Waves

These practice questions can be used by students and teachers and is

Suitable for GCSE AQA Physics Topic Question 8463

Level: GSCE AQA 8463

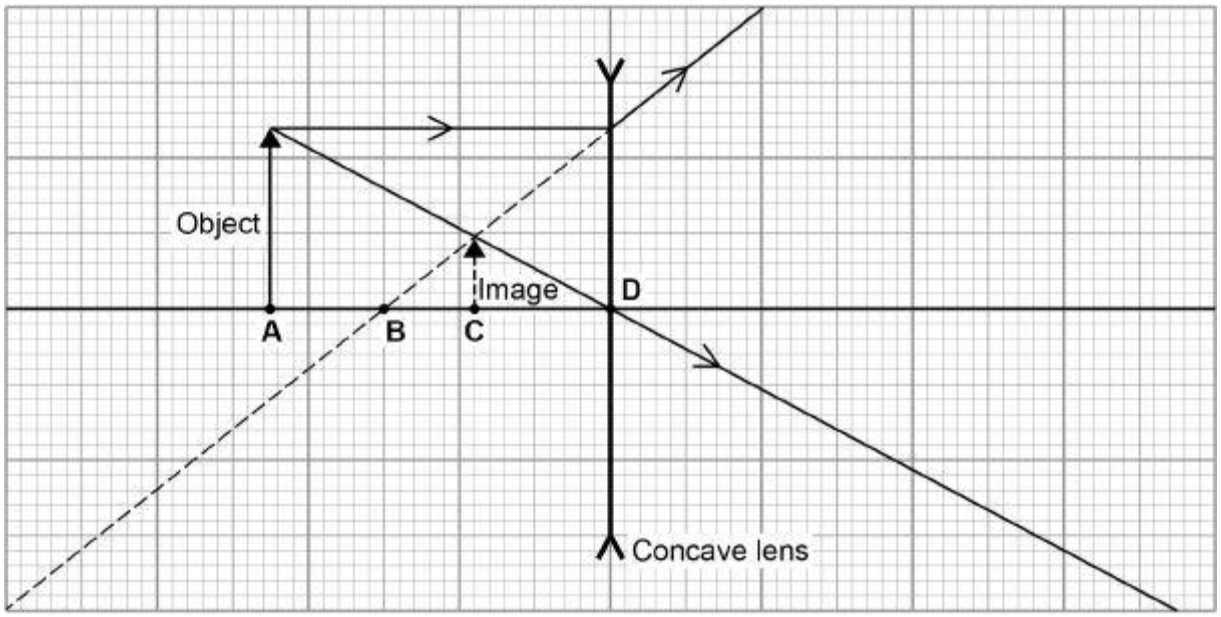
Subject: Physics

Exam Board: GCSE AQA

Topic: Electromagnetic Waves

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.

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)

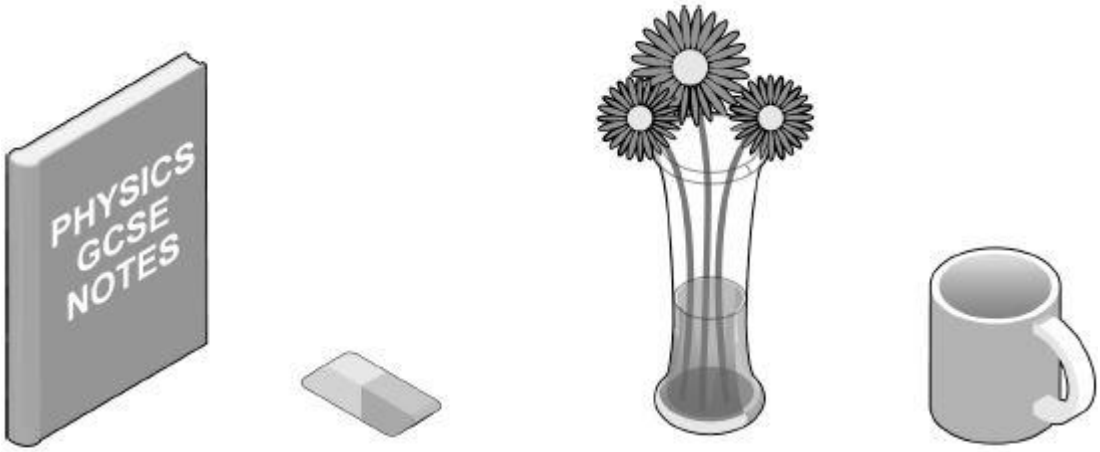
Q2.

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



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.

_____

_____

_____

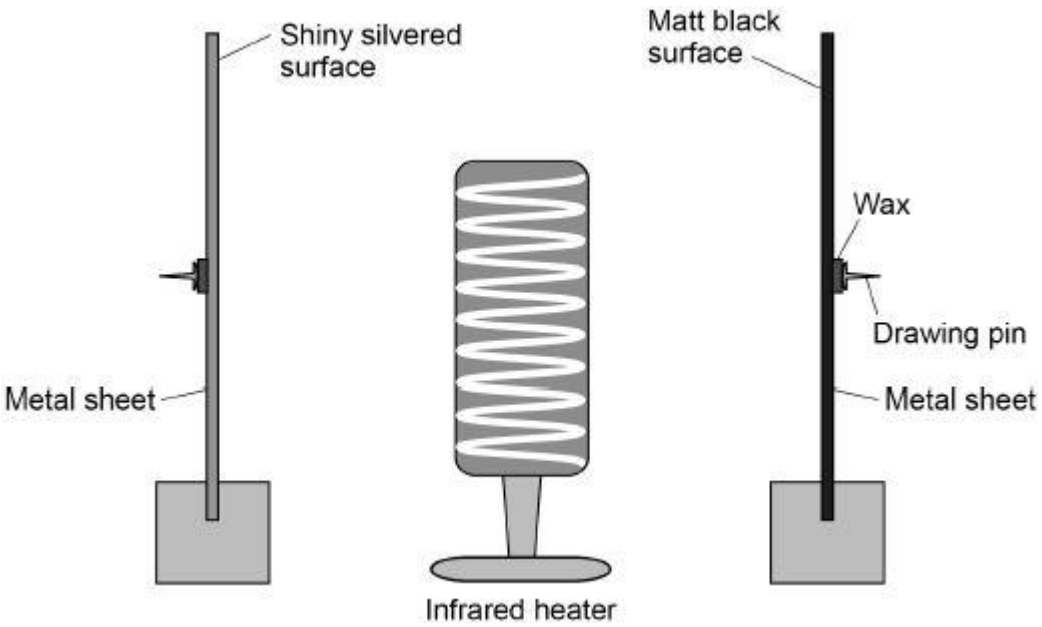
_____

(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)

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

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.

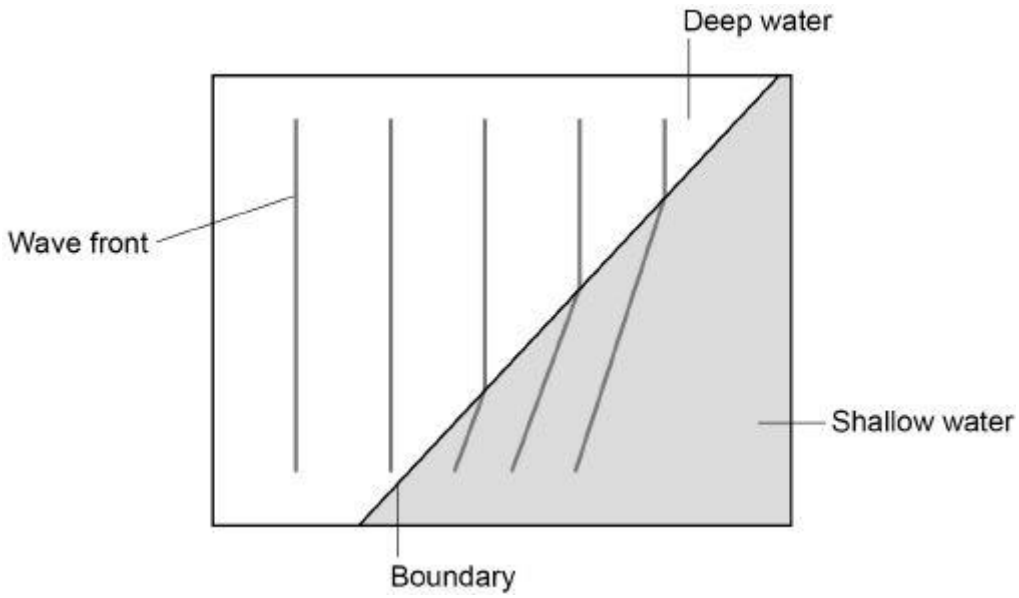
Include an example from Physics in your answer.

(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.

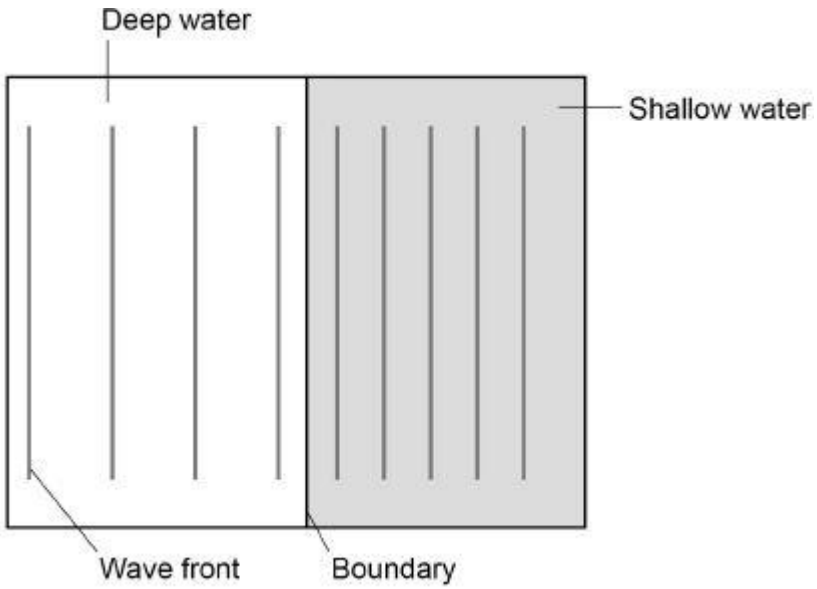
_____

_____

(3)

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

Figure 2



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

_____

_____

_____

_____

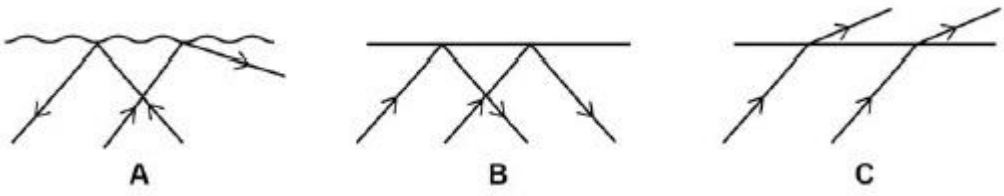
(2)

(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?

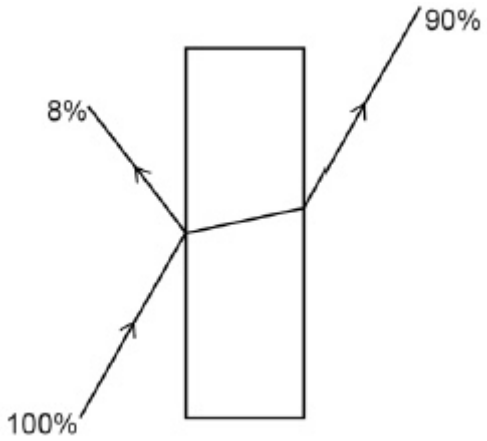
Tick **one** box.

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



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?

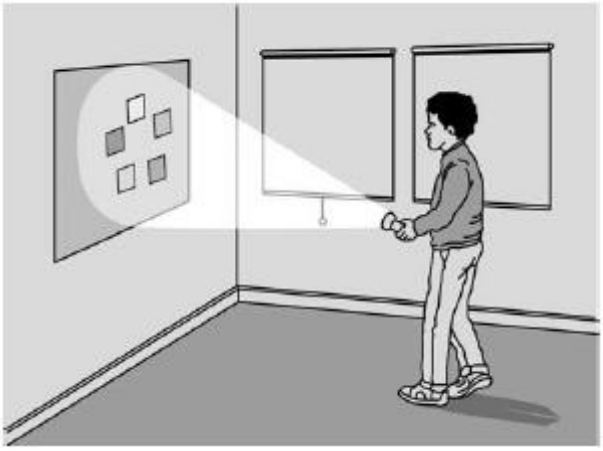
_____

(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



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)

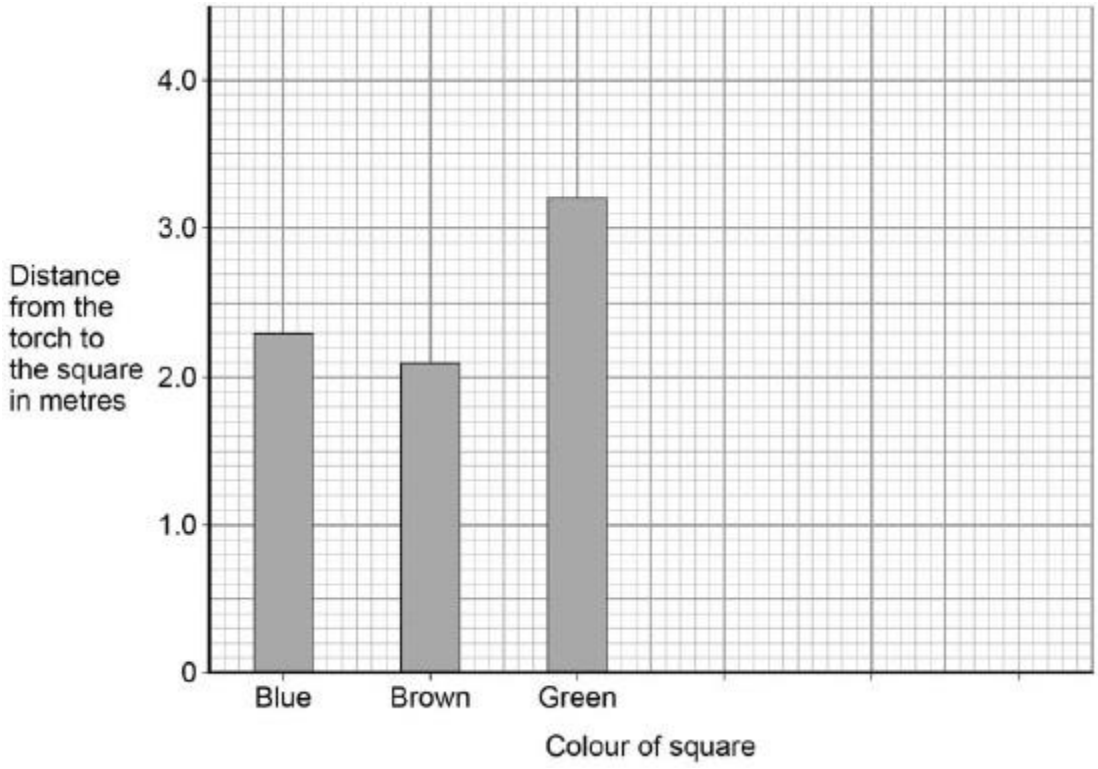
The table shows the student's results.

Colour of	**Distance from the**

square	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.

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**

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.

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.

(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 ☐

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?

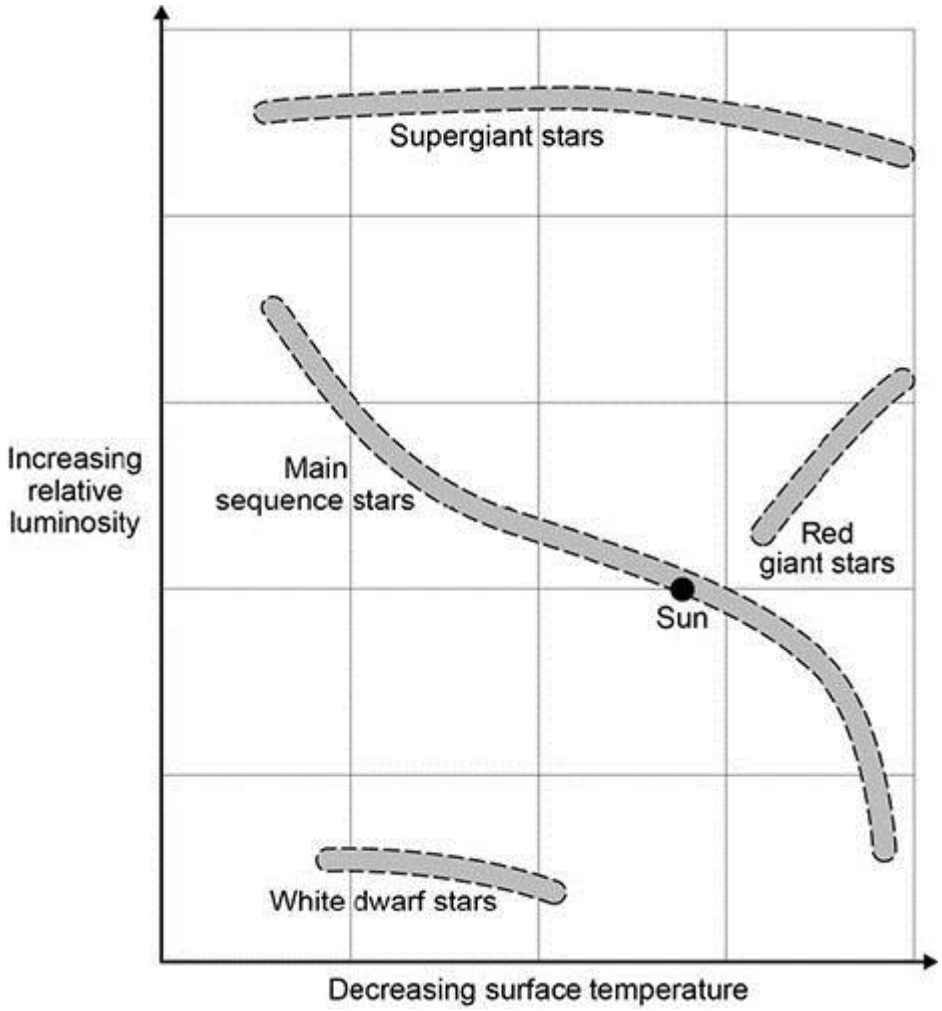
_____

(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.



(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.

_____

_____

_____

_____

_____

_____

_____

_____

(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
Microwaves	For communicating with a satellite
Ultraviolet	To see security markings
	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)

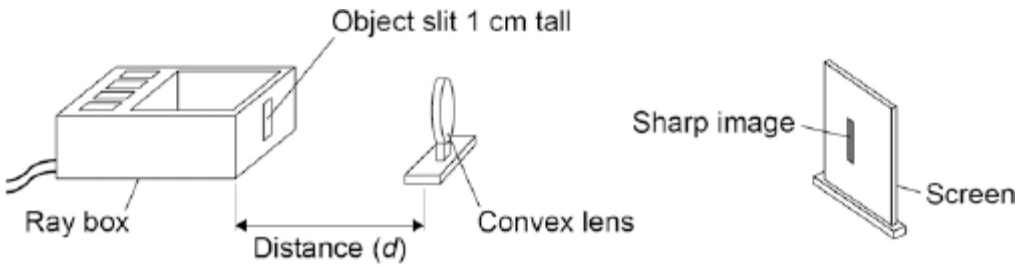
(Total 5 marks)

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.

(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

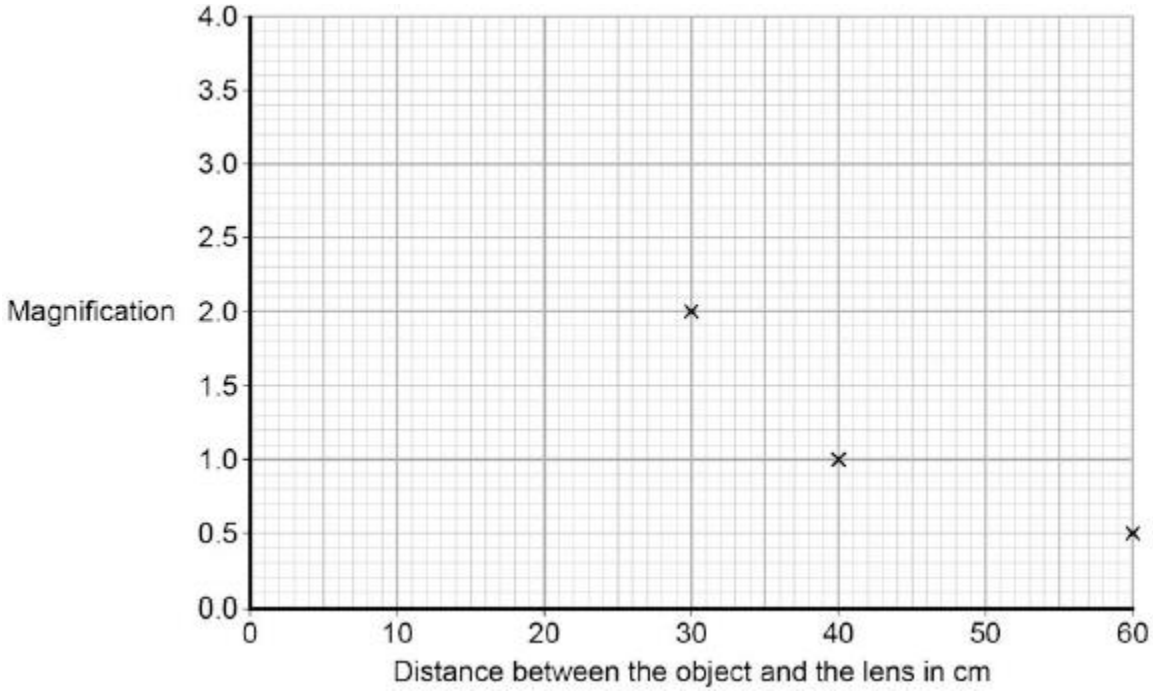
It would be difficult to obtain accurate magnification values for distances greater than 60 cm.

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



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.

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°
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.

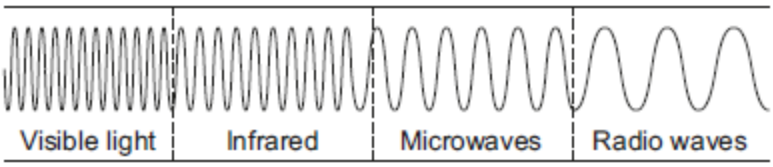
_____

(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**

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

© emmy-images/iStock

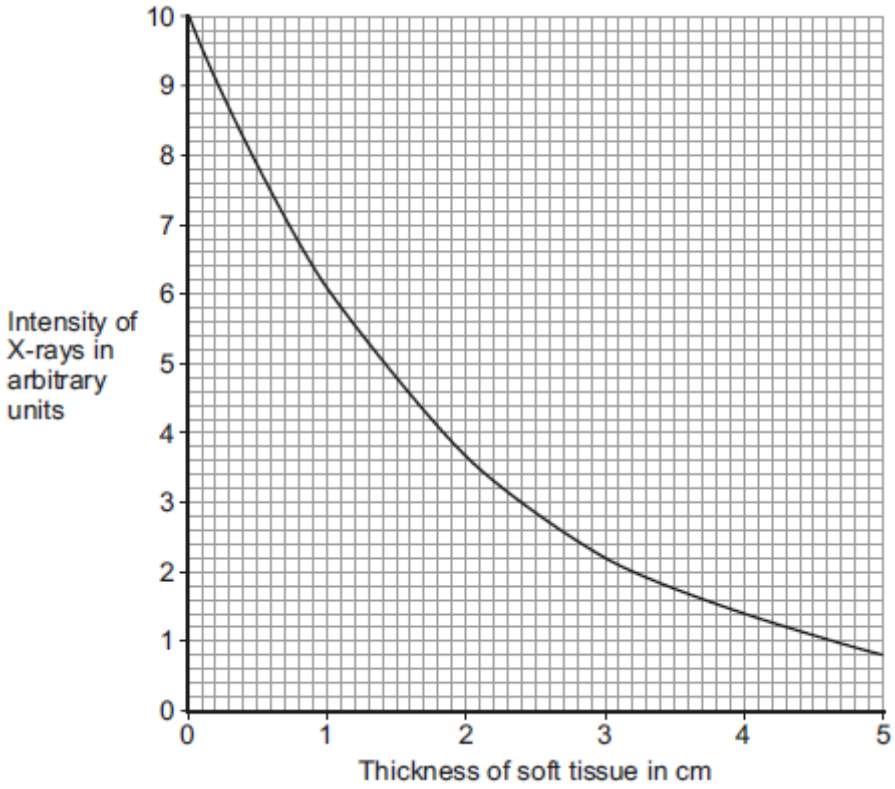
(a) Complete the following sentence.

X-rays are part of the _____ spectrum.

(1)

(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 ☐

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)

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.

_____

_____

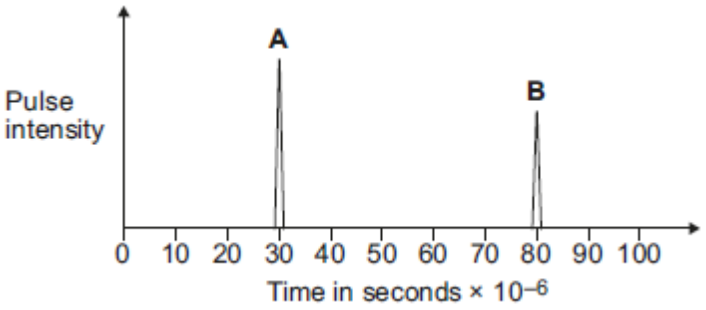
_____

_____

(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.

_____

_____

_____

_____

_____

_____

Average speed = _____ m/s

(3)

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

Figure 2

© emmy-images/iStock

(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 _____ .

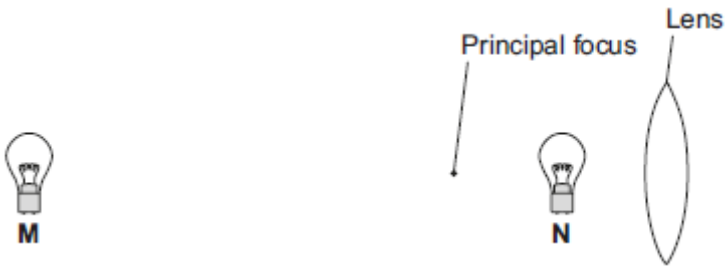
(1)

(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.

Figure 1



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

_____

_____

_____

_____

_____

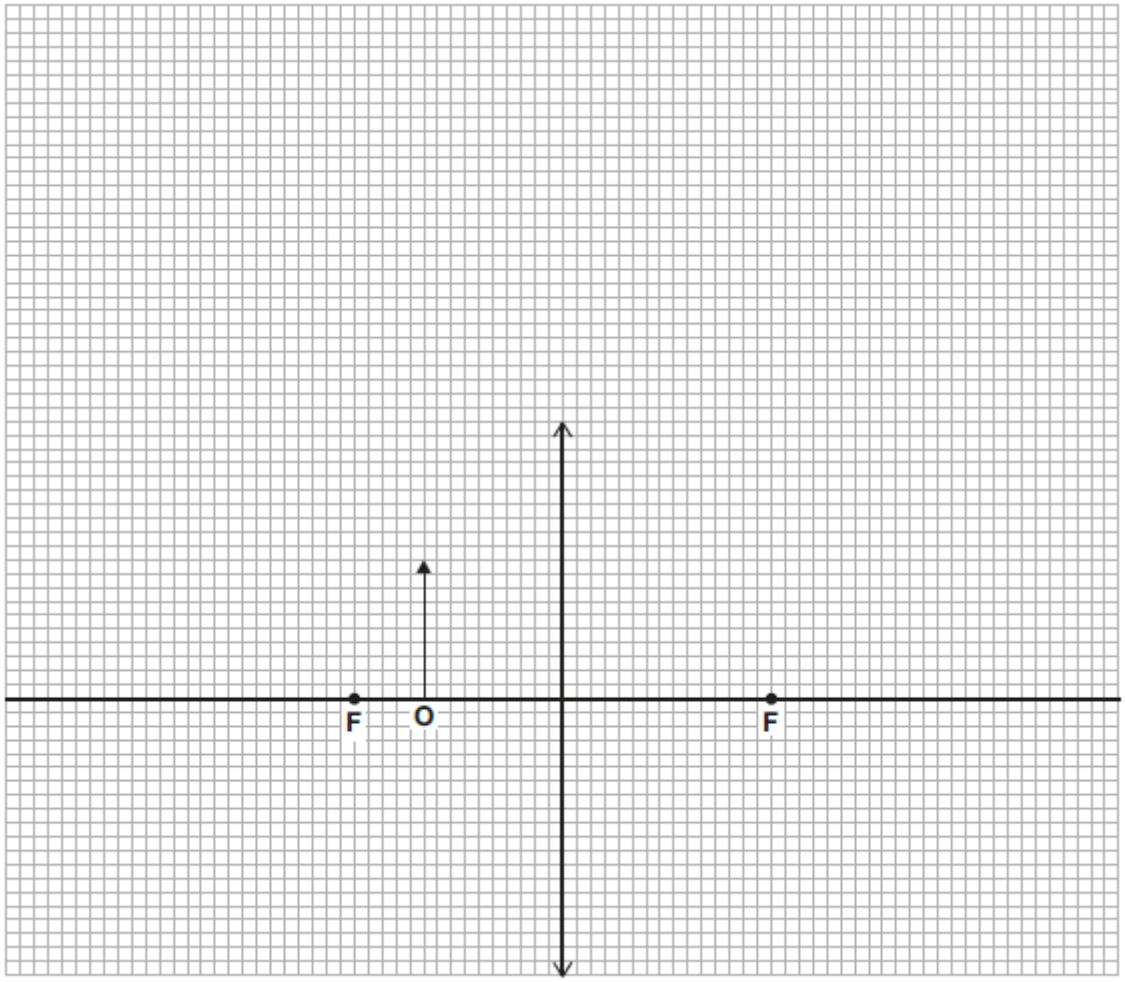
_____

(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

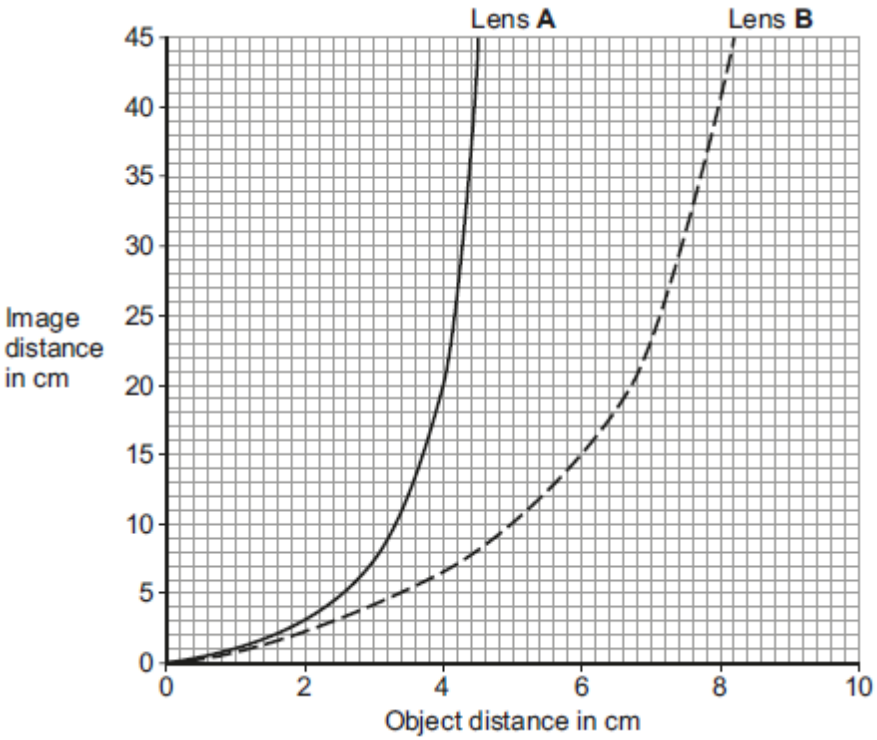


(3)

(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



(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)

(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**

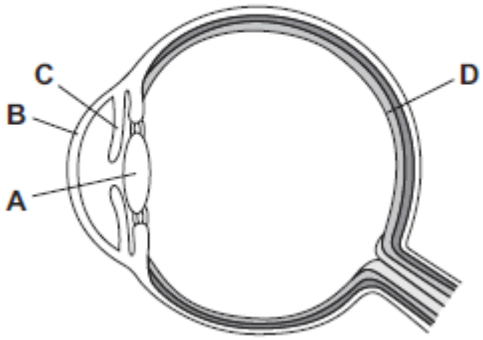
(1)

(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
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.

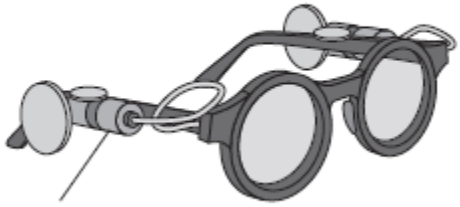
Two designs are:

- 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.

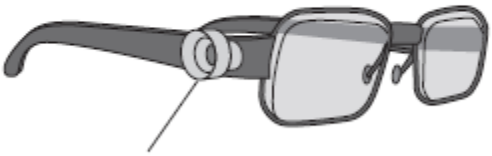
Figure 2

Spectacles with water-filled lenses



Water store and pump

Spectacles with sliding lenses made from glass Z



Knob to adjust position of sliding lens

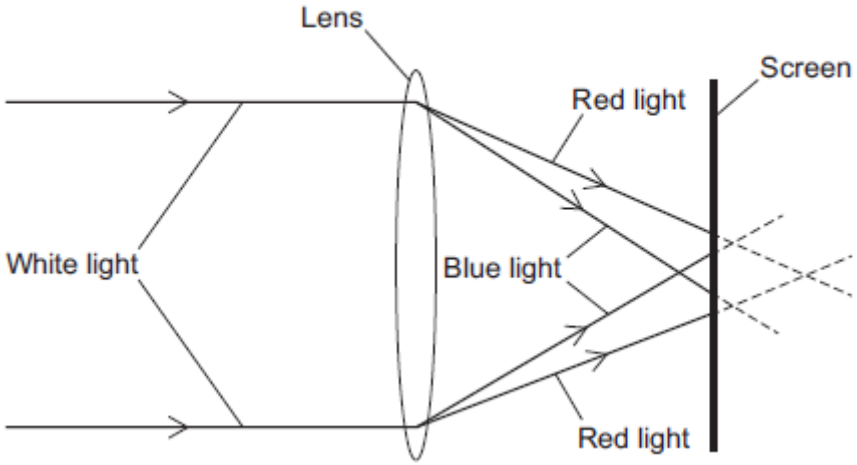
Suggest **one** advantage and **one** disadvantage of each design.

(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)

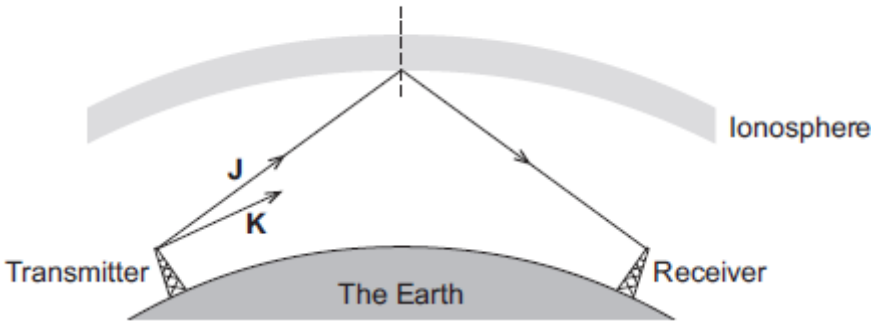
(Total 12 marks)

Q18.

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

(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)

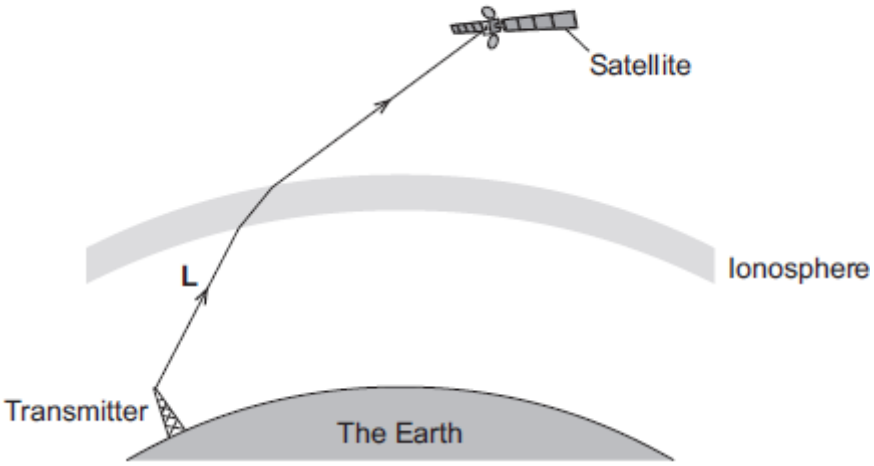
(ii) What is the name given to the dashed line in **Figure 1**?

_____

(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.

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.	

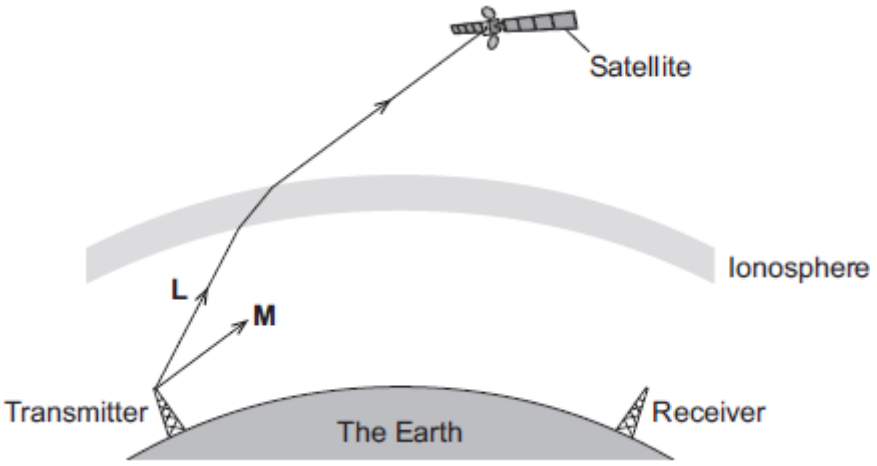
(2)

(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?

_____

(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. _____

_____

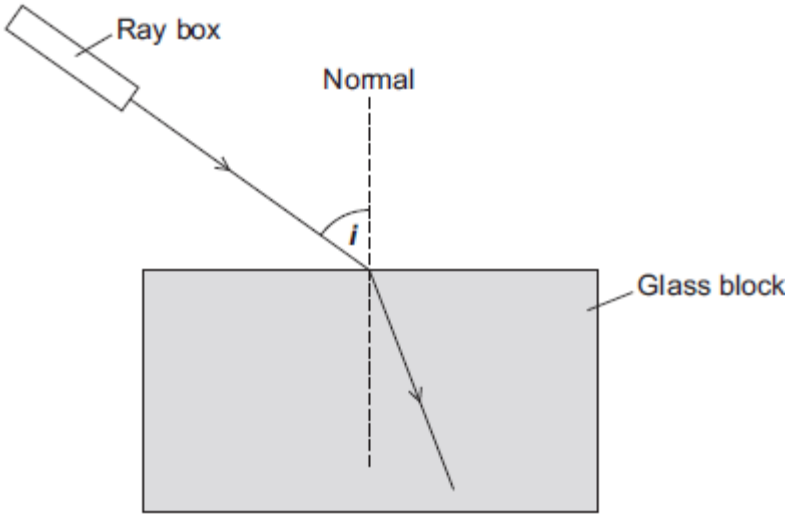
(2)

(Total 7 marks)

Q20.

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

Figure 1



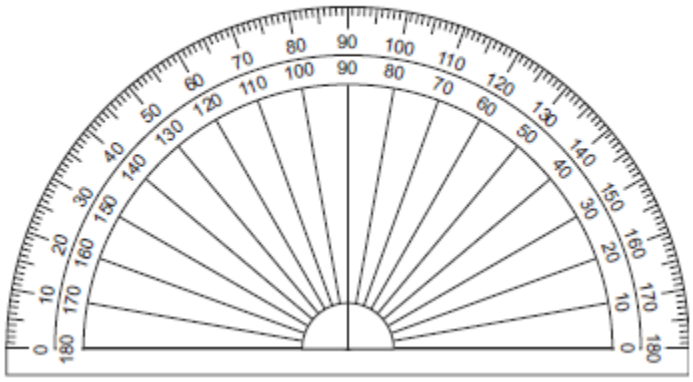
(i) The angle of incidence in **Figure 1** is labelled with the letter ***i***.

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***.

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.

_____

_____

_____

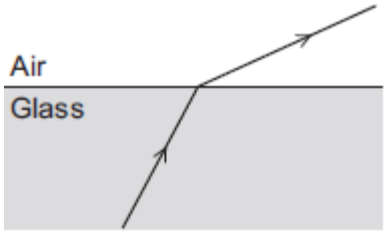
Refractive index = _____

(2)

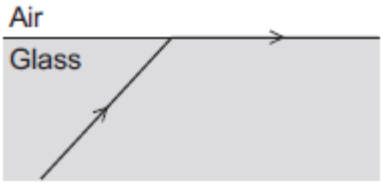
(b) The diagrams below show a ray of light moving through glass.

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

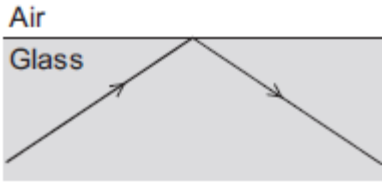
Tick (✓) **one** box.



☐



☐



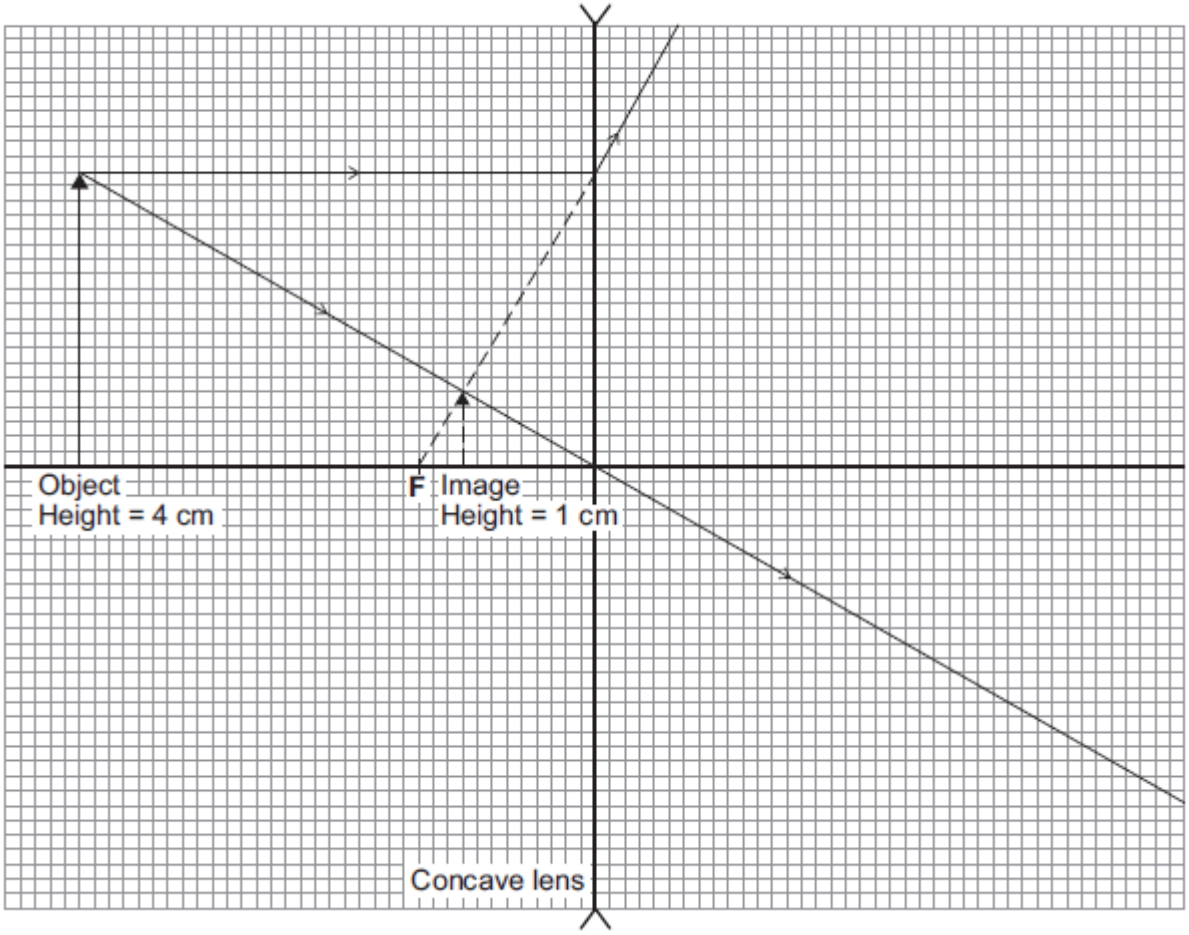
☐

(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.

_____

_____

_____

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.

©monkeybusinessimages/iStock/Thinkstock

© targovecom/iStock/Thinkstock

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.

_____

_____

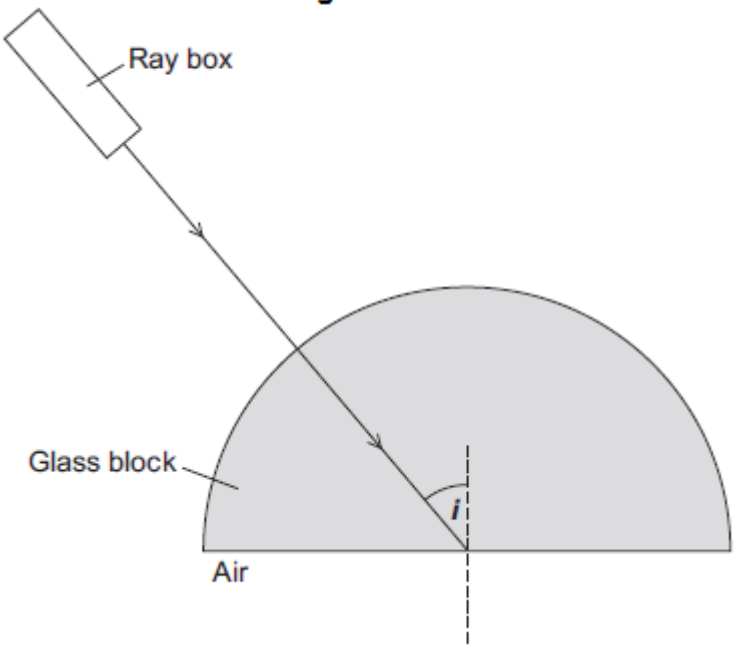
(6)

(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.

(1)

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

Calculate the refractive index of the glass.

_____

_____

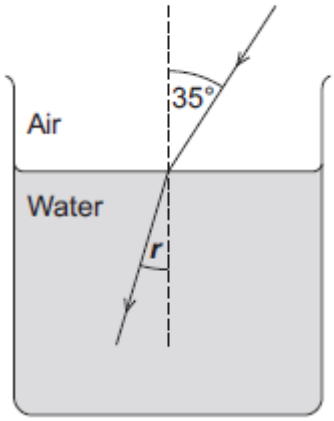
_____

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.

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

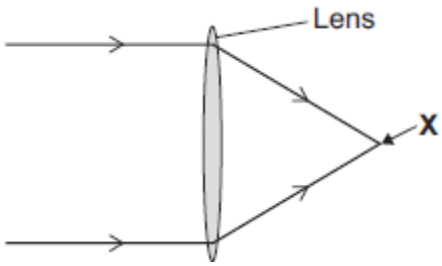
direction

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?

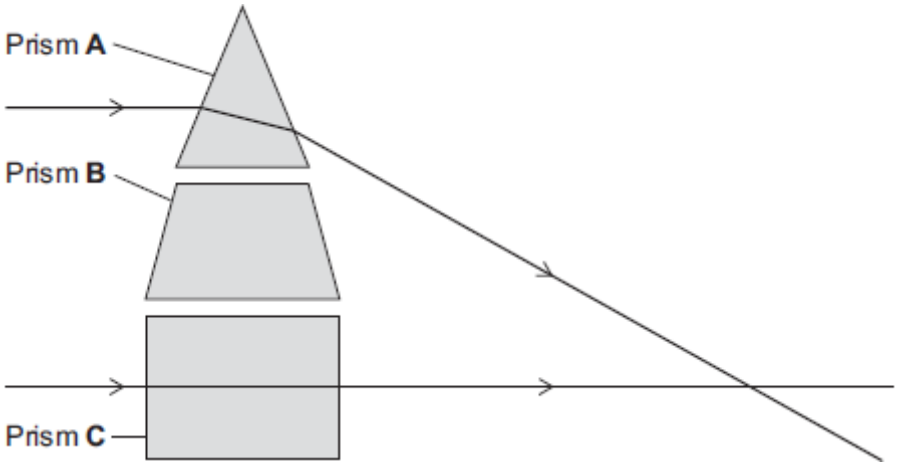
_____

(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



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

metres.

(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 body	X-ray dose in mSv	Time it would take to get the same 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)

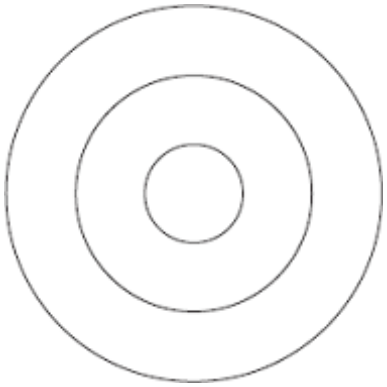
(Total 13 marks)

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



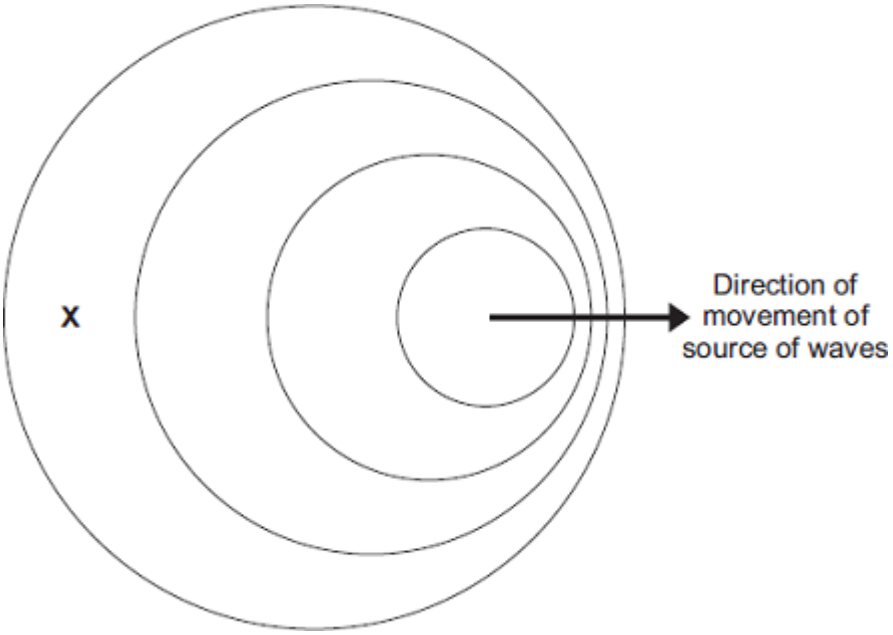
(a) Show on **Diagram 1** the wavelength of the waves.

(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)

(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)

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.

_____

_____

_____

_____

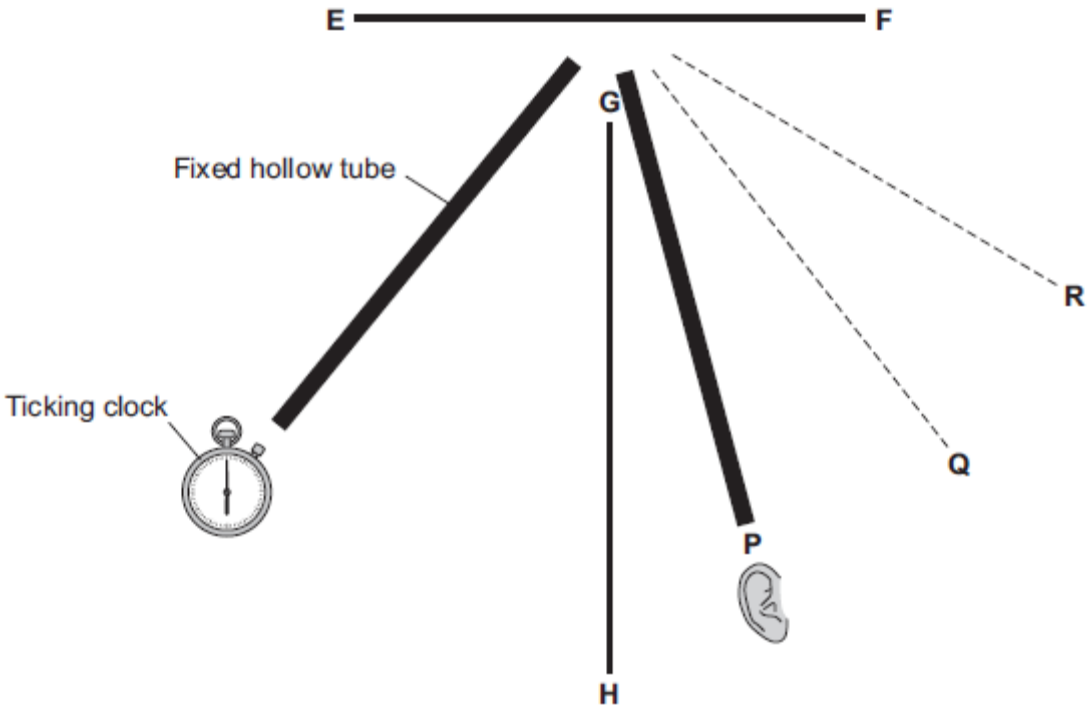
_____

_____

(3)

(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)

(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.

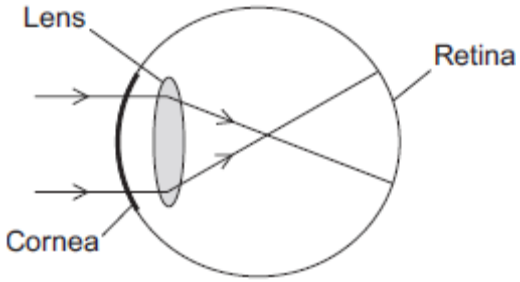
Lenses can be used to correct visual defects.

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

Figure 1

(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



(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
- wearing glasses to correct visual defects.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

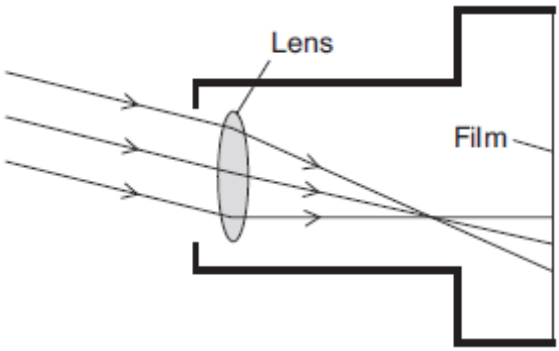
_____

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.

(2)

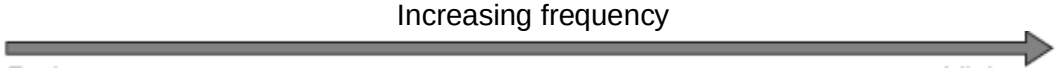
(Total 11 marks)

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

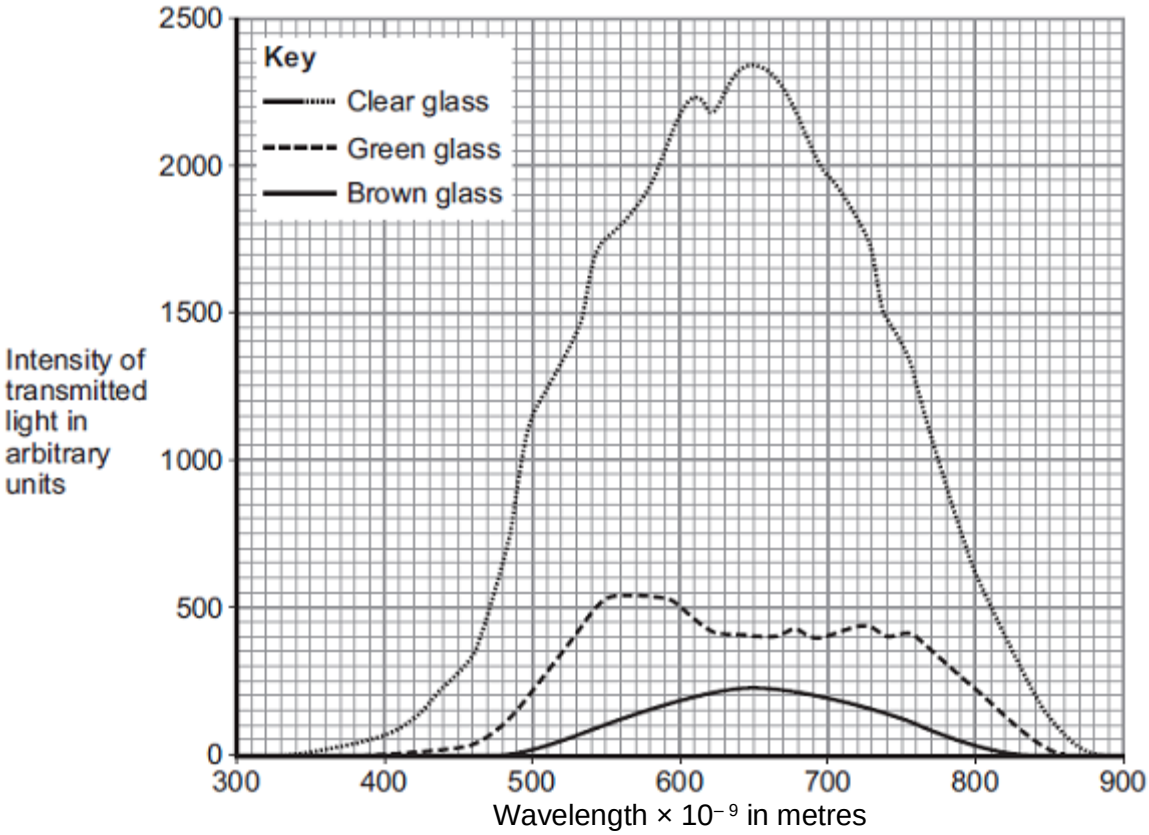
the energy of the light waves _____ .

(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



(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.

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.

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

Tick (✓) **one** box.

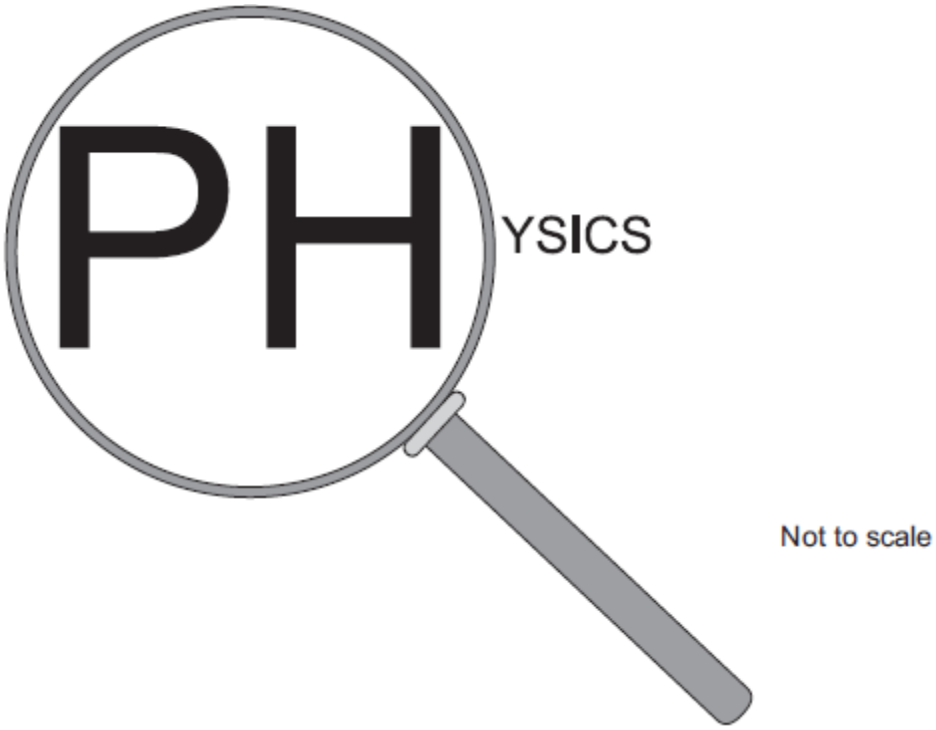
Cauterising open blood vessels ☐

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.

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.

_____

_____

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?

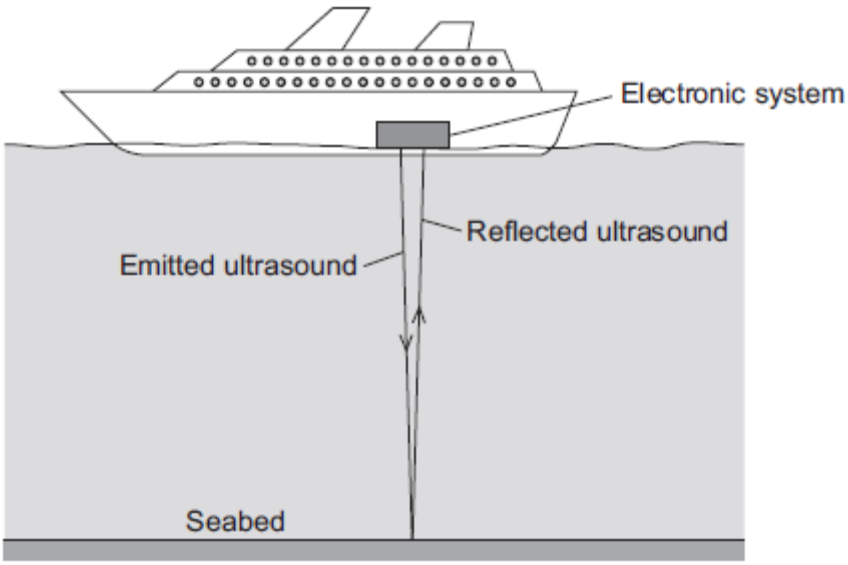
_____

_____

(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.

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 _____

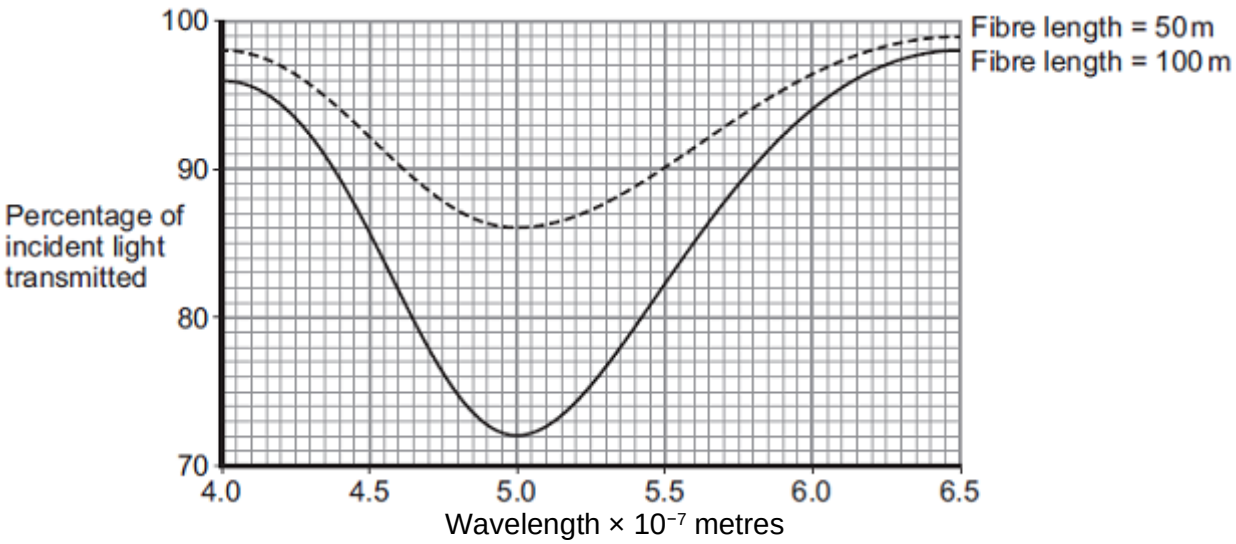
(2)

(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.

(3)

(b) Radio waves are electromagnetic waves.

Describe how radio waves are different from sound waves.

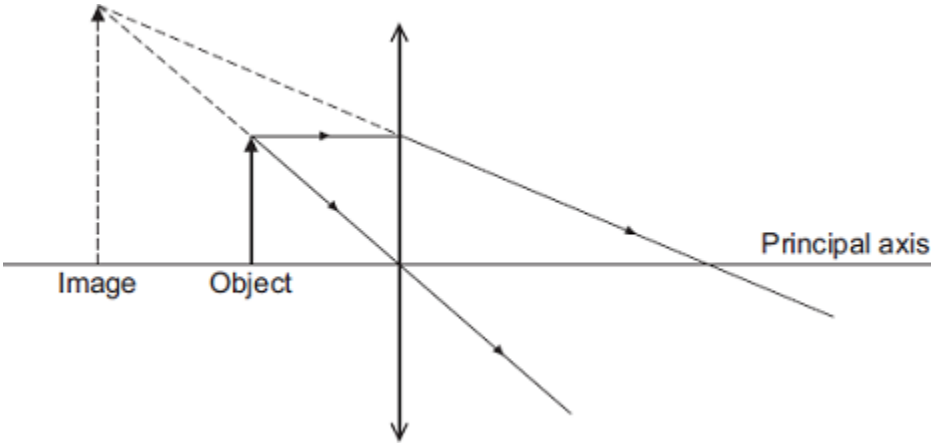
(4)

(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.



(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)

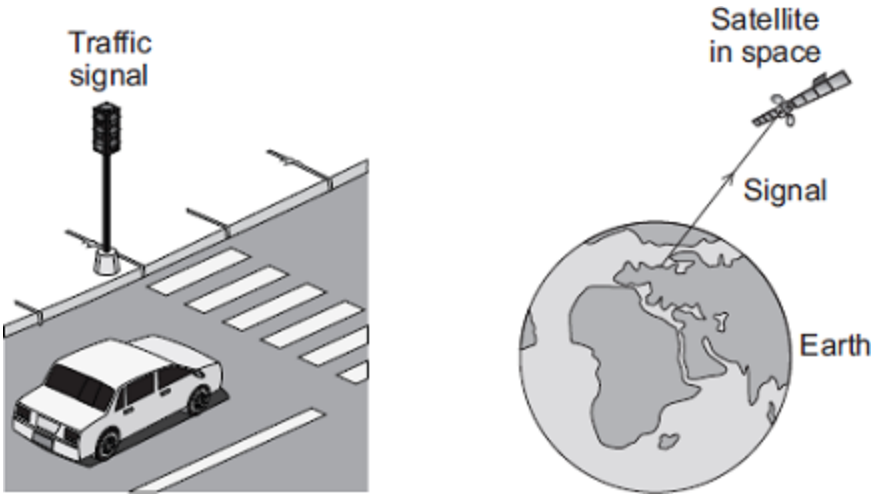
Q35.

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.



(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?

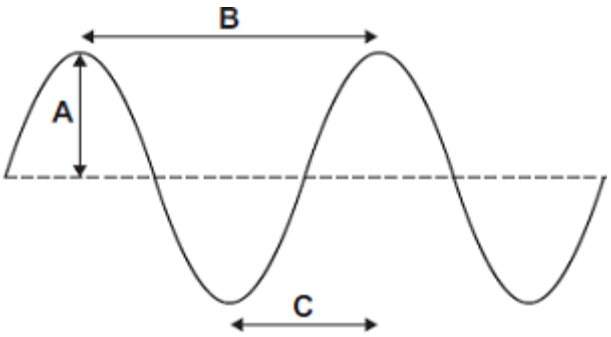
Draw a ring around the correct answer.

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)

(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)

Mark schemes

Q1.

(a) B

1

(b) upright

1

virtual

1

(c) image height = 9.5(mm)

allow any value between 9 and 10 inclusive
allow 5 (squares)

1

object height = 24(mm)

allow 12 (squares)

1

$$\text{magnification} = \frac{9.5}{24}$$

or

$$\frac{\text{their image height}}{\text{their object height}}$$

1

magnification = 0.4

allow an answer that rounds to 0.4 provided both object height and image height are correct

or

$$\frac{\text{their image height}}{\text{their object height}}$$

ignore any units

correctly calculated

1

*an answer of 0.4 scores **4** marks*

(d) decrease

1

[8]

Q2.

(a) glass vase

1

(b) transmit

1

(c) the T-shirt reflects all wavelengths / colours of light (equally)

allow T-shirt reflects (white / all) light

1

(d) changes from red to black

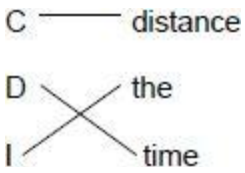
it appears black
it is darker is insufficient

1

as the cap absorbs (all) the (blue) light
or
as the cap does not reflect the (blue) light

1

(e)



all 3 lines correct

*allow **1** mark for 1 line correct*

if more than one line drawn from a variable all of those lines do not score

2

(f) the (infrared) heater

allow infrared (radiation)

*do **not** accept answers where burning yourself is given as the hazard*

1

(g) answer must be a comparison, e.g. the matt / black surface is the better absorber (of infrared radiation)

matt black is a good absorber is insufficient

1

[9]

Q3.

(a) C

1

(b) radio waves have a longer wavelength than ultraviolet

1

(c) (risk of) skin cancer

cancer is insufficient

or

(prematurely) ageing skin

skin damage is insufficient
ignore kills skin cells

1

(d) risk is higher (for X-ray of uds than X-ray of chest)

1

by a factor of 50

or

risk calculated for each type of X-ray
chest X-ray = 1:200 000 (1)
uds = 1:4000 (1)

1

[5]

Q4.

(a) an idea used to explain observations and data

1

(b) different models may be appropriate in different situations

allow one particular model may not be able to explain all observations

1

(c) new (experimental) evidence / data

1

evidence cannot be explained using an existing model
or
predictions made using old model are shown to be incorrect

allow old model based on data now shown to be incorrect

1

new model explains new evidence
or
predictions made with new model are shown to be correct

1

a suitable example given
e.g. nuclear model of the atom replacing the plum pudding model

allow tectonic plates replacing static land masses

big bang theory replacing other theories for the creation of the universe

allow heliocentric model of solar system replacing geocentric model

1

(d) velocity / speed is slower in shallow water

1

so edge of wave (front) entering shallow water slows down

1

but the part of the wave (front) in deeper water continues at a higher speed

(leading to a change in direction of the wave fronts)

allow one part of the wave (front) changes speed before other parts

allow an answer in terms of wave (front) travelling from shallow to deep water

1

(e) every point on the wave (front) enters / hits the shallow water at the same time

1

and so every point slows down at the same time

allow changes speed for slows down

allow an answer in terms of wave (front) travelling from shallow to deep water

1

[11]

Q5.

(a) **A**

1

(b) 2 (%)

1

(c) black

correct order only

1

reflects

1

transmits

1

(d) green

1

(e) without a darkened laboratory would not be able to see reflected light

allow would see all squares all of the time

1

(f) so same 'amount' of light is incident on each square

a fair test is insufficient

control variable is insufficient

1

(g) two bars drawn at the correct height

*allow **1** mark for 1 correct bar*

2

both bars correctly labelled

1

(h) orange

reason only scores if orange chosen

1

can be seen from the furthest away

allow it reflects the most light

1

(i) repeatable

1

[14]

Q6.

(a) sound

1

(b) (visible) light

1

(c) cooking food

1

(d) 1.2 gigahertz

1

(e) 300 000 × 1000 = 300 000 000 m/s

1

(f) wave speed = frequency × wavelength

allow v = f λ

1

(g) 300 000 000 = 1200 000 000 × λ

*an answer of 0.25 scores **3** marks*

1

$$\lambda = \frac{300\,000\,000}{1\,200\,000\,000}$$

*allow ecf from **(e)***

1

λ = 0.25 (m)

1

[10]

Q7.

(a) gamma rays

1

(b) can travel through the atmosphere

1

(c) explosion of a red super giant

or

a supernova

1

(d) 1.2×10^9 Hz

1

(e) $3.0 \times 10^8 = 1.2 \times 10^9 \times \lambda$

*an answer of 0.25 (m) scores **3** marks*

*allow ecf from **(d)***

1

$$\lambda = \frac{3.0 \times 10^8}{1.2 \times 10^9}$$

1

$\lambda = 0.25$ (m)

1

(g) same as the radio wave

1

(f) expansion due to fusion energy

1

in equilibrium with gravitational collapse

*forces acting inwards equal forces acting outwards gains **1** mark*

1

(h)

Level 2: Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	3-4
Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1-2
No relevant content	0
Indicative content • Sun goes from main sequence to red giant • then from red giant to white dwarf • when the Sun changes to a red giant the surface temperature will decrease • and the relative luminosity will increase • when changing from a red giant to a white dwarf the surface temperature increases • and the relative luminosity decreases	

4

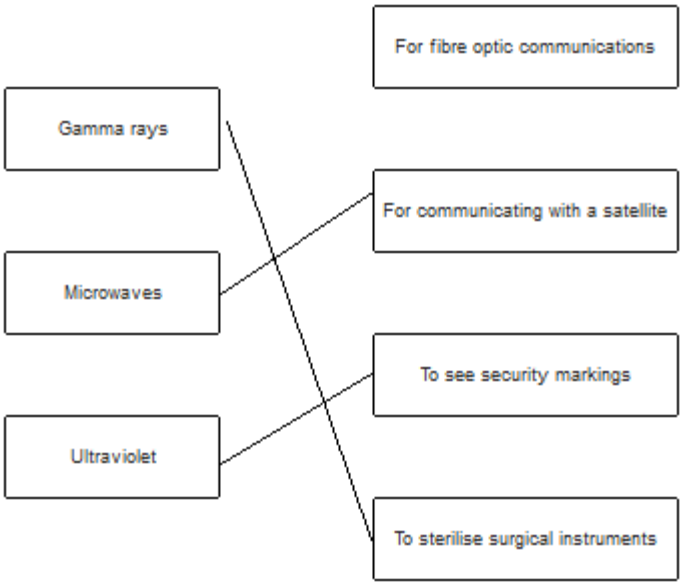
[14]

Q8.

(a) radio

1

(b)



*award **1** mark for each correct line*

if more than one line is drawn from any em wave then none of those lines gain credit

3

(c) ionising

1

[5]

Q9.

(a) magnification = $\frac{\text{image height}}{\text{object height}}$

1

dividing by an object height of 1 cm gives the same (numerical) value

1

(b) accept anything practical that would work eg:

use a taller object

use a (travelling) microscope

attach a scale to the screen and use a magnifying glass

1

(c) both points plotted correctly

1

correct line of best fit drawn

a curve passing through all points (within ½ square), judge by

eye

1

(d) values of 1.4 and 0.6 extracted from the graph

1

2.33 times bigger

accept any number between 2.3 and 2.5 inclusive

1

(e) by dividing the distance between the lens and the image by the distance between the lens and the object

1

at least one correct calculation and comparison eg 100÷25 = 4 which is the same as the measured magnification

1

[9]

Q10.

(a) **Level 3 (5–6 marks):**
A detailed and coherent plan covering all the major steps is provided. The steps in the method are logically ordered. The method would lead to the production of valid results.

A source of inaccuracy is provided.

Level 2 (3–4 marks):
The bulk of a method is described with mostly relevant detail. The method may not be in a completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):
Simple statements are made. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:
No relevant content.

Indicative content

place a glass block on a piece of paper

draw around the glass block and then remove from the paper

draw a line at 90° to one side of the block (the normal)

use a protractor to measure and then draw a line at an angle of 20° to the normal

replace the glass block

using a ray box and slit point the ray of light down the drawn line

mark the ray of light emerging from the block

remove the block and draw in the refracted ray

measure the angle of refraction with a protractor

repeat the procedure for a range of values of the angle of incidence

possible source of inaccuracy

the width of the light ray

which makes it difficult to judge where the centre of the ray is

6

(b) velocity / speed of the light decreases

allow velocity / speed of the light changes

1

[7]

Q11.

Level 3 (5–6 marks):
A detailed and coherent plan covering all the major steps is provided. The steps in the method are logically ordered. The method would lead to the production of valid results.

A source of inaccuracy is provided.

Level 2 (3–4 marks):
The bulk of a method is described with mostly relevant detail. The method may not be in a completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):
Simple statements are made. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:
No relevant content.

Indicative content

place a glass block on a piece of paper

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mark the ray of light emerging from the block

remove the block and draw in the refracted ray

measure the angle of refraction with a protractor

repeat the procedure for a range of values of the angle of incidence

possible source of inaccuracy

the width of the light ray

which makes it difficult to judge where the centre of the ray is

[6]

Q12.

(a) any **one** from:

- (visible) light
- UV / ultra violet
- X-ray
- gamma / γ-ray

1

(b) less than

1

less than

1

the same as

1

[4]

Q13.

(a) **use of infrared:**
remote controls
fibre optic (communications)

1

use of microwaves:
mobile/cell phones

accept mobiles

accept phone signals

satellite (communications/TV)
wi-fi
Bluetooth

1

(b) any **two** from

- same speed
  or
  travel at the speed of light (in a vacuum)
- transverse

  accept a full description of a transverse wave
- transfer energy (from one place to another)
- can be reflected

- can be refracted
- can be diffracted
- can be absorbed / transmitted
- can travel through a vacuum/space
- can be polarised

travels in straight lines is insufficient

2

[4]

Q14.

(a) electromagnetic

accept e.m.

1

(b) (i) 2.2 (arbitrary units)

allow an answer between 2.1 and 2.3

1

(ii) the thicker the tissue the lower the intensity

accept more intensity is needed to pass through thicker tissue

1

the relationship is not linear

accept the line is not straight

*allow for **1** mark*

it still goes through with thicker tissue

or

intensity does not reach zero

or

at 5 cm X rays still pass through

1

(iii) Both variables are continuous

1

(c) (they are) absorbed

accept (they are) stopped

1

(d) With a charge-coupled device (CCD).

1

(e) (i) X-rays are ionising

1

(ii) stand behind a (protective) screen

accept leave the room

accept wear a lead apron

1

[9]

Q15.

(a) ultrasound is not ionising

allow ultrasound does not harm the (unborn) baby

1

but X-rays are ionising

1

so X-rays increase the health risk to the (unborn) baby

accept specific examples of health risks, eg cancer, stunted growth, impaired brain function etc

X-rays are dangerous is insufficient

1

(b) ultrasound/waves are partially reflected

(when they meet a boundary) (between two different media / substances / tissues)

must be clear that not all of the wave is reflected

1

the time taken is measured (and is used to determine distances)

1

(c) 1600 (m/s)

*800 (m/s) gains **2** marks*

*160 000 (m/s) gains **2** marks*

*0.0016 (m/s) gains **2** marks*

*allow **2** marks for*

$$\frac{0.04}{25 \times 10^{-6}}$$

or

$$\frac{0.08}{50 \times 10^{-6}}$$

*80 000 (m/s) gains **1** mark*

*0.0008 (m/s) gains **1** mark*

*allow **1** mark for*

$$\frac{0.04}{25}$$

or

$$\frac{0.08}{50}$$

*allow **1** mark for evidence of doubling the distance or halving the time*

3

(d) (i) they are absorbed by bone

allow stopped for absorbed

X-rays are reflected negates this mark

1

they are transmitted by soft tissue

allow pass through for transmitted

allow flesh / muscle / fat

accept less (optically) dense material for soft tissue

1

(the transmitted) X-rays are detected

1

(ii) short

accept small

1

[12]

Q16.

(a) the image would decrease in size

1

the image would change (from virtual) to real

accept that the image (of bulb M) can be projected on to a screen

1

the image would change (from non-inverted) to inverted

1

(b) a ray through the centre of the lens

rays should be drawn with a ruler

ignore arrows

1

a ray parallel to the principal axis and passing through the principal focus to the right of lens

accept solid or dashed lines

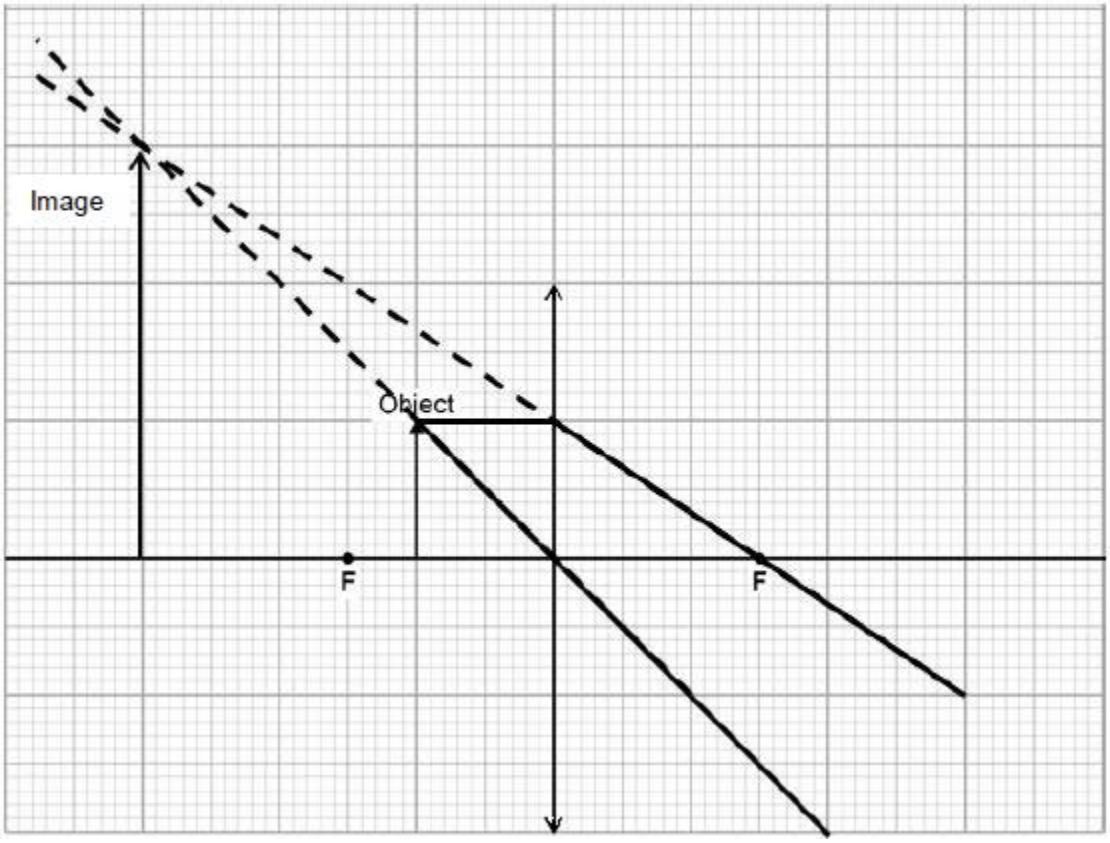
accept a ray drawn as if from the principal focus to the left of the lens, emerging parallel to the principal axis

1

image drawn where rays cross

image should be to left of the lens

1



(c) (i) (because the glass in) lens A has a greater refractive index

accept lens A is more powerful

accept lens A has a shorter focal length

1

(ii) when the magnification increases by 1, the image distance increases by 10 cm

*accept for **1** mark it is a linear pattern*

or

as the image distance increases, the magnification increases

*do **not** accept directly proportional*

2

(iii) diagram showing the surfaces of a convex lens C having greater curvature than lens B

the size of the lens drawn is not important

1

[10]

Q17.

(a) B

must be in correct order

1

A

1

D

1

(b) (i) mass increases as refractive index increases

accept weight / density increases as refractive index increases

1

(ii) thinner

accept thin

1

heavier

accept heavy

1

(iii) maximum one advantage and one disadvantage of each design

water-filled

advantages:

- lenses are light
- wide range of focal length
- allows fine adjustment
- allows lenses to be altered independently.

1

disadvantages:

- unattractive
- lens might burst
- lens might leak
- uncomfortable.

1

sliding lenses

advantages:

- hard-wearing
- look like conventional glasses
- easy to adjust
- allows lenses to be altered independently.

1

disadvantages:

- heavy
- might slide out of position
- might get dirt between the lenses.

1

(c) any two from:

the image is

- blurred
- coloured
- inverted
- diminished.

accept not focussed

1
1

[12]

Q18.

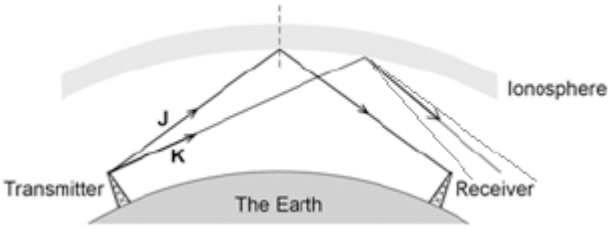
(a) (i) reflection of wave **K** at or within the ionosphere

allow dashed lines

1

angle i = angle r

'judge by eye'



tolerance for the reflected ray is between the first e and last r

ignore arrows

a reflected ray to the receiver doesn't score 2nd mark

additional rays shown don't score 2nd mark

1

(ii) normal

1

(b) (i) microwave

1

(ii) refraction

1

(c) All electromagnetic waves are transverse.

1

All electromagnetic waves have the same speed in a vacuum.

1

[7]

Q19.

(a) (i) microwave

1

(ii) refraction

1

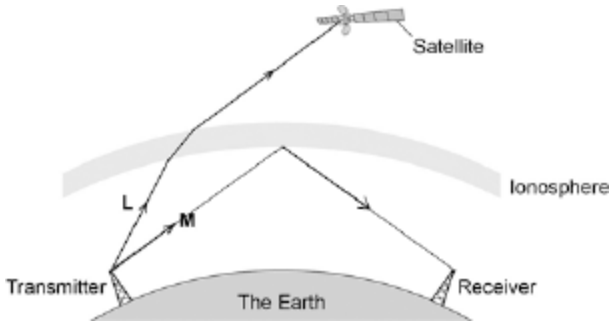
(b) (i) wave M continues as a straight line to the ionosphere and shown reflected

accept reflection at or within the ionosphere

1

correctly reflected wave shown as a straight line reaching the top of the receiver

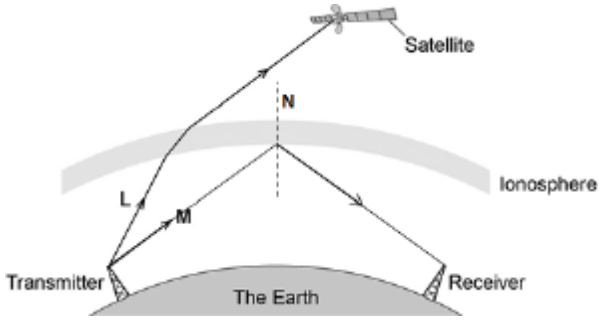
if more than 2 rays shown 1 mark maximum



ignore arrows

1

(ii) normal drawn at point where their **M** meets the ionosphere



1

(c) any **two** from:

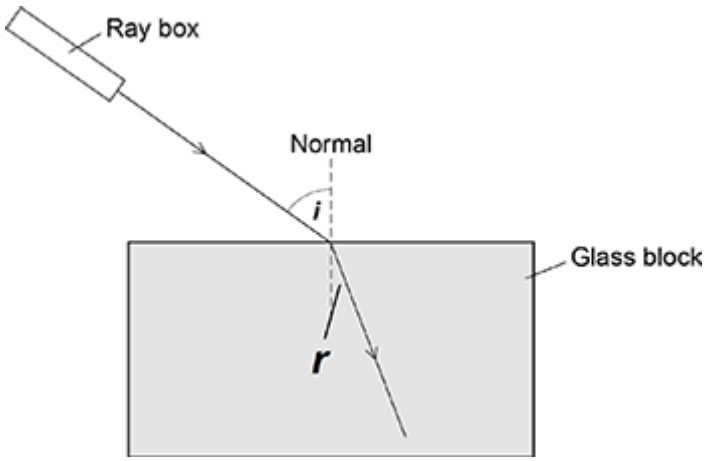
- transverse
- same speed (through air)
  *accept speed of light **or** 3 × 10^8 m / s*
- can be reflected
- can be refracted
- can be diffracted
- can be absorbed
- transfer energy
- can travel through a vacuum
  *an answer travel at the same speed though a vacuum scores **2** marks*
- can be polarised
- show interference.
  travel in straight lines is insufficient

2

[7]

Q20.

(a) (i)



1

(ii) 1 degree

1

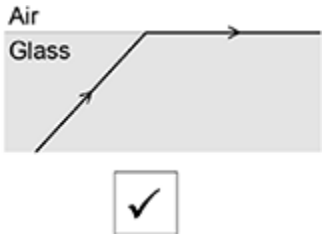
(iii) 1.6

*allow **1** mark for correct substitution, ie 0.80 / 0.5 provided no subsequent step shown*

working showing 1.59(9…..) scores zero

2

(b) 2nd diagram ticked



✓

1

(c) (i) any **one** correct description:

- upright
- virtual
- diminished.

treat multiple words as a list

1

(ii) 0.25

*allow **1** mark for correct substitution, ie 1 / 4 or 5 / 20 provided no subsequent step shown*

ignore any unit

2

(iii) Correcting short sight

1

[9]

Q21.

(a) 20,000

accept 20 kilo
or
20 k
or *20 001*

1

an atom

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer in the Marking Guidance and apply a 'best-fit' approach to the marking.

0 marks
no relevant content

Level 1 (1−2 marks)
At least one relevant statement is given for either type of wave

Level 2 (3−4 marks)
either
a use, risk and precaution is given for one type of wave
or
A medical use is given for both types of wave
plus
a risk or precaution for one type of wave

Level 3 (5−6 marks)
At least one medical use is given for both types of wave linked to the risks and any precautions necessary

Examples of the points made in the response

<u>Medical use of X-rays</u>
Any one from:
- Detecting bone fractures
- Detecting dental problems
- Killing cancer cells
- CT scanning.

Ignore details about how X-rays / ultrasound work

accept any specific use of X-rays, eg

- *detecting heart / lung disorders (with chest X-rays)*
- *mammograms / breast cancer detection*
- *detecting stones / bowel disease (with abdominal X-rays)*

<u>Risks with X-rays</u>
X-rays pose a risk / danger / hazard

accept are harmful

X-rays cause ionisation / damage to cells
or
mutate cells / cause mutations / increase chances of mutations
or
turn cells cancerous / produce abnormal growths / produce rapidly growing cells
or
kill cells

accept a description of what ionising is

instead of cell, any of these words can be used: DNA / genes / chromosomes / nucleus

accept (may) cause cancer

Operator precautions with X-rays

The X-ray operator should go behind a (metal / glass) screen / leave the room when making an X-ray / wear a lead lined apron

accept appropriate precautions for the patient e.g. limit the total exposure / dose (in one year)

wear a radiation badge is insufficient

Medical use of ultrasound

Any one from:
- Pre-natal scanning
- Imaging (a named body part).
- removal / destruction of kidney / gall stones
- removing plaque from teeth

  cleaning teeth is insufficient
- accept examples of repair, eg alleviating bruising, repair scar damage, ligament / tendon damage, joint inflammation.

  accept physiotherapy

  *accept curing prostate cancer **or** killing prostate cancer cells*

Risks with ultrasound

Ultrasound poses no risk / danger / hazard (to the user / patient)

accept ultrasound is safer than using X-rays

Ultrasound is not ionising
or
Ultrasound does not damage (human) cells

Precautions with ultrasound

The operator needs to take no precautions when making an ultrasound scan

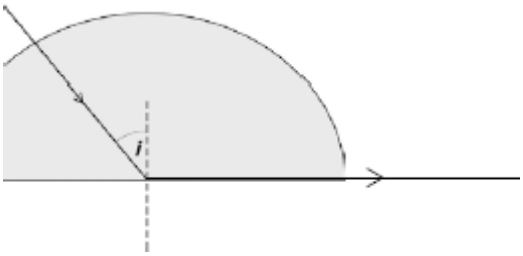
this can be assumed if it is stated that ultrasound is harmless or it is safer than using x-rays or it is non-ionising

6

[8]

Q22.

(a) (i) line drawn at 90 degrees to the normal:



ignore (partial) reflection of the ray

1

(ii) 1.5

award both marks for an answer that rounds to 1.5

*award **1** mark for correct substitution ie 1 / sin 41*
***or** 1 / 0.656(059)*

2

(b) 26

*award **3** marks for an answer that rounds to 26*

*award **2** marks for*

$$1.3 = \frac{0.57(3576)}{\sin r}$$

or

$r = \sin^{-1}(0.57(3576) / 1.3)$

*award **1** mark for correct substitution.ie* $1.3 = \frac{\sin 35}{\sin r}$

or

sin 35° shown correctly, ie 0.57(3576), or used correctly in the calculation

an answer of 0.44 scores 2 marks

an answer of 26.9 scores 0

3

[6]

Q23.

(a) refraction

1

(b) towards the normal

1

(c) (i) convex

1

(ii) principal focus

accept focal point

1

(d) parallel on left

1

refracted towards the normal at first surface

1

refraction away from normal at second surface

1

passes through or heads towards principal focus

1

(e) refractive index

accept material from which it is made

1

(radius of) curvature (of the sides)

accept shape / radius
*do **not** accept power of lens*
ignore thickness / length

1

[10]

Q24.

(a) (i) frequency

1

wavelength

1

(ii) 10^{-15} to 10^{4}

1

(b) 2.0×10^{5}

correct substitution of
*3.0×10^{8} / 1500 gains **1** mark*

2

Hz

1

(c) (i) (skin) burns

1

(ii) skin cancer / blindness

1

(d) (i) any **one** from:

- (detecting) bone fractures
- (detecting) dental problems
- treating cancer

1

(ii) any **one** from:

- affect photographic film
- absorbed by bone
- transmitted by soft tissue
- kill (cancer) cells

*answer must link to answer given in **(d)(i)***

1

(iii) 9 / 36 = 0.25
0.5 / 2 = 0.25
4 / 16 = 0.25

accept:

36 / 9 = 4

2 / 0.5 = 4

16 / 4 = 4

2

conclusion based on calculation

*two calculations correct with a valid conclusion scores **2** marks*

*one correct calculation of k scores **1** mark*

1

[13]

Q25.

(a) wavelength correctly shown

1

(b) (i) increased

1

decreased

1

(ii) 17-18 inclusive

1

evidence of measurement divided by 3 or mean of 3 separate measurements

1

mm

accept cm if consistent with answer

1

(c) (i) red shift

1

(ii) moving away

1

(iii) the furthest galaxies show the biggest red shift

1

(meaning that) the furthest galaxies are moving fastest

1

(so the) Universe is expanding

1

(extrapolating backwards this suggests that) the Universe started from an initial point

1

(iv) cosmic microwave background radiation

allow CMBR

1

[13]

Q26.

(a) (i) infrared / *IR*

1

(ii) *UV / X-rays / gamma rays*

1

appropriate use corresponding with given wave:

dependent on first marking point

- UV: security marking ***or*** *tanning*
- X-rays: medical imaging ***or*** *checking baggage*
- gamma rays: sterilising surgical instruments ***or*** *killing harmful bacteria in food*

accept any sensible alternative uses

1

(b) D

1

gap must be comparable to wavelength

accept converse

1

can create gap of that size in classroom

dependent on first marking point

1

(c) (i) Q

1

(ii) sound waves reflected

accept 'it' for sound waves

ignore bounce

1

at EF

1

angle of incidence equal to angle of reflection

1

(iii) stop sound going direct from clock to ear

1

(iv) 22 (m)

*allow **1** mark for correct substitution, ie*

*330 = 15 × λ scores **1** mark*

2

(v) outside audible range

1

[14]

Q27.

(a) (i) short sight

accept myopia

1

(ii) diverging

1

(b) light

1

(c) Marks awarded for this answer will be determined by the quality of communication as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1–2 marks)
There is a basic description of one advantage ***or*** disadvantage of using **either** of the methods

Level 2 (3–4 marks)
There is a *description* of some advantages **and / or** disadvantages of using **both** methods
or
a full, detailed description of the advantages and disadvantages of using **either** of the methods.

Level 3 (5–6 marks)
There is a *clear description* of the advantages and disadvantages of using **both** methods.

examples of the points made in the response

extra information

laser surgery

advantages:

- *appearance*
- *permanent effect*
- no glasses which need changing

disadvantages:

- risks associated with surgery
- large cost
- not able to drive etc straightaway
- (still) might need glasses for reading

wearing glasses

advantages:

- able to function straightaway
- any problems easy to sort out

disadvantages:

- *easily broken*
- *easily lost*
- need changing
- overall cost might be greater if several changes in vision
- might eventually need two pairs of glasses

6

(d) move lens

1

closer to film

1

[11]

Q28.

(a) decreases

correct order only

1

increases

1

(b) (i) intensity (of transmitted light) depends on thickness
or
to enable a valid comparison
or
it is a control variable

accept absorption depends on thickness
it would affect the results is insufficient
fair test is insufficient

1

(ii) transmits the least light
or
absorbs the most light

accept very little light is transmitted
*do **not** accept transmits none of the light*
*do **not** accept absorbs all of the light*
any reference to heat negates this mark

1

[4]

Q29.

(a) long

1

(b) lens A

1

it is a concave / diverging lens

this mark is only gained if lens A is stated

any reference to lens material or mass of lens negates this mark

allow it will focus light onto the retina

1

(c) The refractive index of the lens material

1

(d) 4

ignore any signs

*allow **1** mark for correct substitution, ie* $\frac{1}{0.25}$ *provided no subsequent step*

2

(e) Cauterising open blood vessels

1

(f) 5

*allow **1** mark for correct substitution, ie* $\frac{70}{14}$ *provided no subsequent step*

2

[9]

Q30.

(a) transmits

correct order

1

absorbs

1

(b) light

*allow ultra violet **or** UV **or** infrared **or** IR **or** gamma*

1

(c) 20

*allow **1** mark for correct working, ie* $\frac{60}{3}$ *provided no subsequent step*

2

(d) Killing cancer cells

1

[6]

Q31.

(a) (sound waves) which have a frequency higher than the upper limit of hearing for humans

or

a (sound) wave (of frequency) above 20 000 Hz

sound waves that cannot be heard is insufficient

a wave of frequency 20 000 Hz is insufficient

1

(b) 640

*an answer of 1280 gains **2** marks*

*allow **2** marks for the correct substitution*

ie 1600 × 0.40 provided no subsequent step

*allow **2** marks for the substitution* $\frac{1600 \times 0.80}{2}$

provided no subsequent step

*allow **1** mark for the substitution 1600 × 0.80 provided no subsequent step*

*allow **1** mark for the identification that time (boat to bed) is 0.4*

3

(c) any **one** from:

- pre-natal scanning / imaging
- imaging of a named organ (that is not surrounded by bone), eg stomach, bladder, testicles

  accept heart

  *do **not** allow brain **or** lungs (either of these negates a correct answer)*
- Doppler scanning blood flow

1

(d) advantage

any **one** from:

- (images are) high quality or detailed or high resolution

  clearer / better image is sufficient
- (scan) produces a slice through the body
- image can be viewed from any direction

  allow images are (always) 3D / 360°
- an image can be made of <u>any</u> part (inside the body)

  allow whole body can be scanned
- easier to diagnose **or** see a problem (on the image)

1

disadvantage

any **one** from:

- (the X-rays used **or** scans) are <u>ionising</u>

  allow a description of what ionising is
- mutate cells **or** cause mutations **or** increase chances of mutations

  allow for cells:

  DNA / genes / chromosomes / nucleus / tissue
- turn cells cancerous **or** produce abnormal growths **or** produce rapidly growing cells
- kill cells

  damage cells is insufficient
- shielding is needed

  can be dangerous (to human health) unqualified, is insufficient

1

[7]

Q32.

(for both fibres) increasing the <u>wavelength</u> of light decreases and then increases the percentage / amount of light transmitted

*accept for **1** mark:*
(for both fibres) increasing the <u>wavelength</u> (of light) to 5 (x 10^{-7} metres), decreases the (percentage) transmission

1

(for both fibres) the minimum transmission happens at 5 (x 10^{-7} metres)
or
maximum transmission occurs at 6.5 (x 10^{-7} metres)

*accept for a further **1** mark:*
(for both fibres) increasing the <u>wavelength</u> of the light from 5 (x 10^{-7} metres) increases the amount of light transmitted

increasing <u>wavelength</u> (of light), decreases the percentage transmitted is insufficient on its own

1

the shorter fibre transmits a greater percentage of light (at the same wavelength)

*accept for **1** mark:*
Any statement that correctly processes data to compare the fibres

1

[3]

Q33.

(a) the oscillation / vibration (causing the wave)

a movement causes the wave is insufficient

1

for a transverse wave is perpendicular to the direction of <u>energy transfer</u>

accept direction of wave travel

1

and for a longitudinal wave is parallel to the direction of energy transfer

accept direction of wave travel

*if no marks awarded allow **1** mark for correctly linking perpendicular with transverse and parallel with longitudinal*

the marks may be scored by the drawing of two correctly labelled diagrams

1

(b) for radio waves:

accept converse for each mark

are transverse

1

travel at speed of light / higher speed

1

have greater frequencies

1

can travel through vacuum

*accept sound waves are not electromagnetic for **1** mark*

1

[7]

Q34.

(a) (i) magnified

1

upright

1

(ii) v = −6(cm)

*max **2** marks if no minus sign*

*6(cm) gains **2** marks*

1/v = 1/12 − 1/4 = −1/6
*gains **2** marks*

1/12 = 1/4 + 1/v
*gains **1** mark*

−5.99(cm)
*using decimals gains **3** marks*

3

(b) it is virtual

1

[6]

Q35.

(a) (i) (visible) light

accept visible

1

(ii) microwaves

1

(b) J

1

(c) (i) B

1

(ii) shorter than

1

(d) (i) To find out if using a mobile phone is harmful to health

1

(ii) any **two** from:

- (X has a) low(er) SAR value
  "it" refers to mobile phone
  accept has a low(er) rate
- (maximum) energy absorbed (by the head) is less
  accept energy emitted (by phone) is less
  accept radiation for energy
- (if mobiles are harmful) less likely to cause harm
  accept will not cause harm
  accept it is safer

2

[8]