

1

The figure below shows an incomplete electromagnetic spectrum.



(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)

2

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.

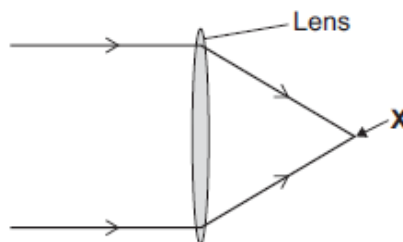
When light passes from air into a glass block, it changes

| | |
|-----------|------------------------------------|
| 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?

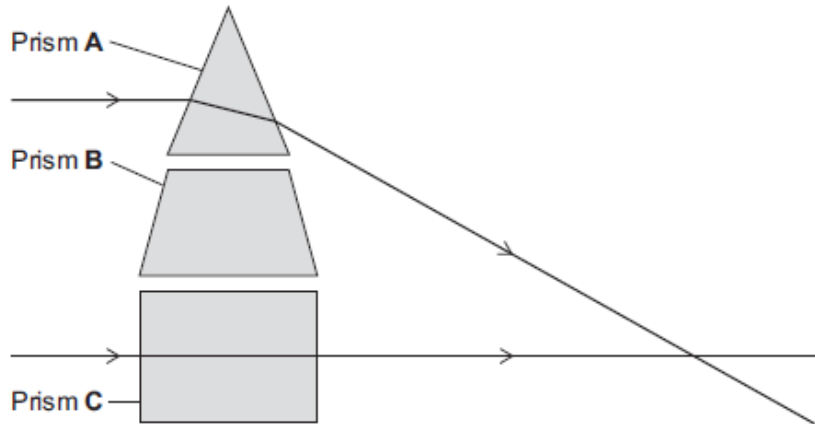
.....

(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)

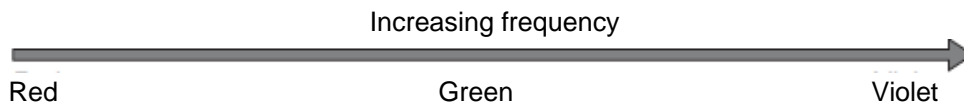
(Total 10 marks)

3

(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

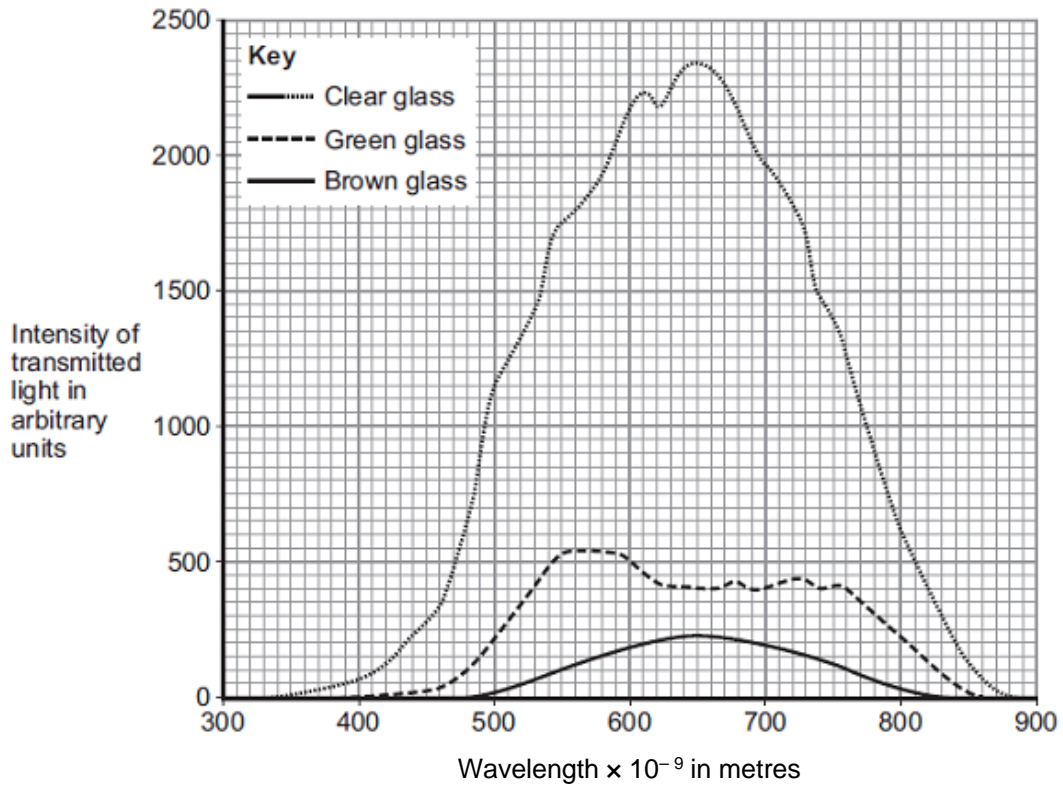
and the energy of the light waves

(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)

4

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)

5

(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 = dioptries

(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.

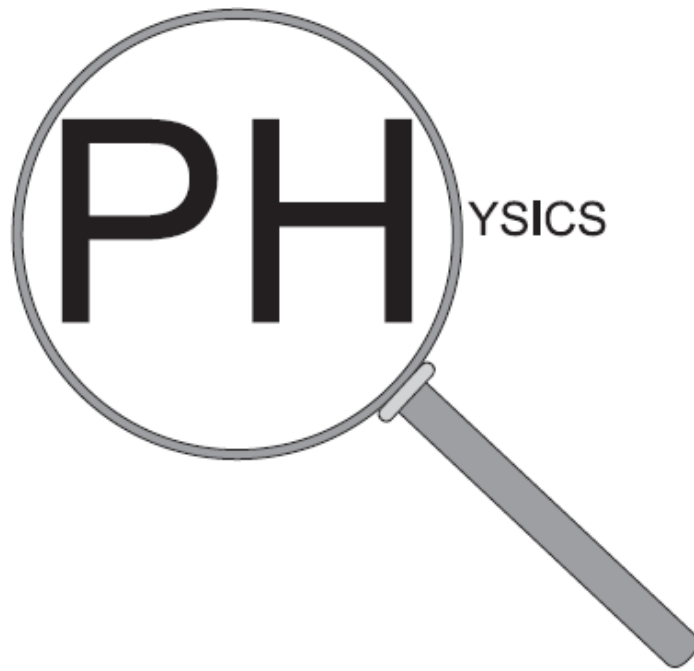
Cauterising open blood vessels

Detecting broken bones

Imaging the lungs

(1)

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



Not to scale

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)

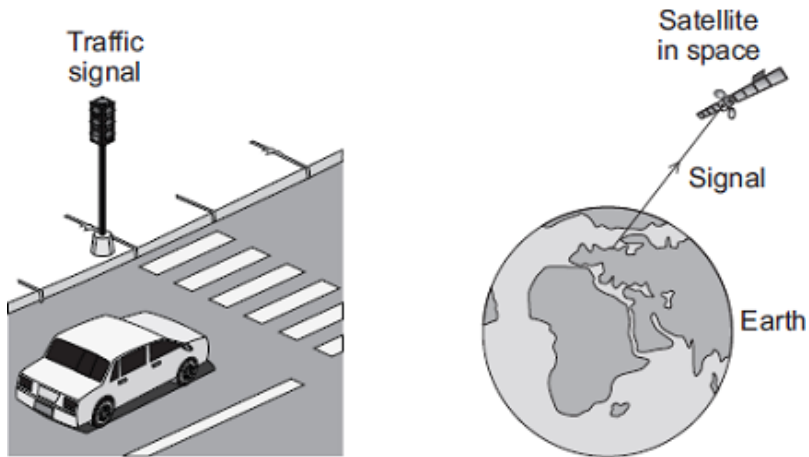
6

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.

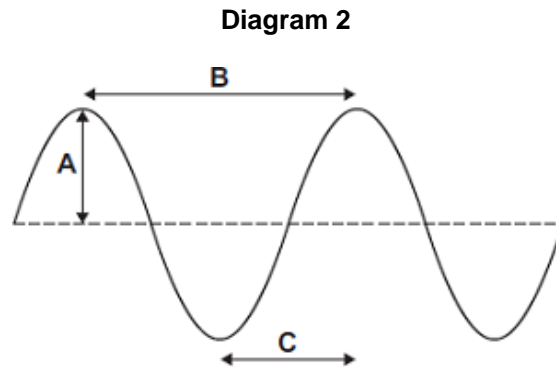
Which letter, **J**, **K** or **L**, shows the position of gamma rays in the electromagnetic spectrum?

Draw a ring around the correct answer.

J K L

(1)

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



- (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.

.....

.....

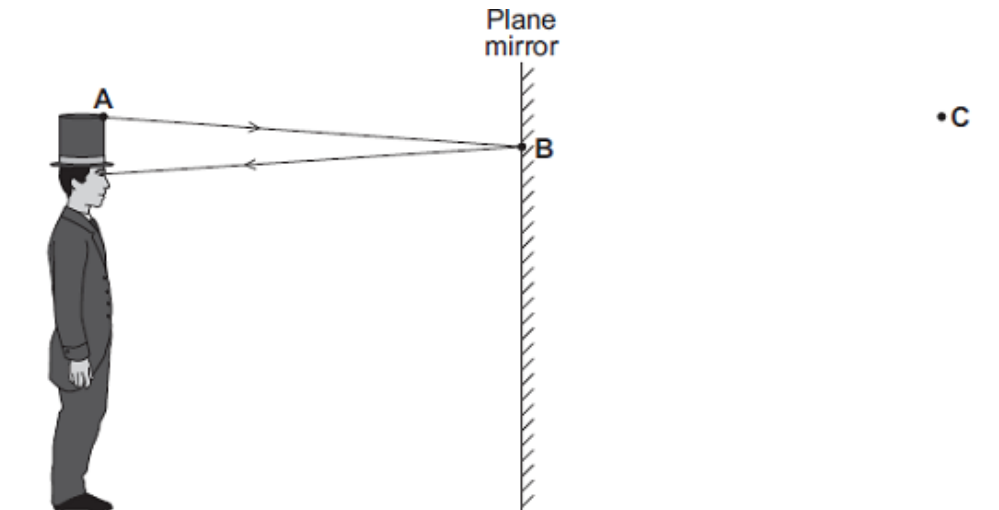
.....

.....

(2)
(Total 8 marks)

7

A person can see an image of himself in a tall plane mirror.



The diagram shows how the person can see his hat.

- (a) Which point, **A**, **B** or **C**, shows the position of the image of his hat?

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

(1)

- (b) On the diagram, use a ruler to draw a light ray to show how the person can see his shoe.

(3)

(c) Which **one** of the words in the box is used to describe the image formed by a plane mirror?

Draw a ring around the correct answer.

| | | |
|-----------|------|---------|
| imaginary | real | virtual |
|-----------|------|---------|

(1)
(Total 5 marks)

8 A lorry has an air horn. The air horn produces sound waves in the air.

(a) Use **one** word to complete the following sentence.

Sound waves cause air particles to

(1)

(b) The air horn produces sound waves at a constant frequency of 420 Hz.

The wavelength of the sound waves is 0.80 m.

Calculate the speed of the sound waves.

.....
.....
.....

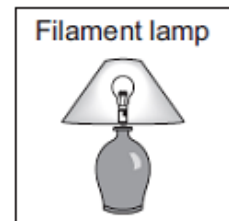
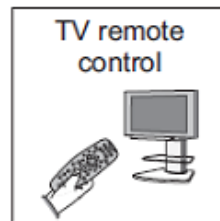
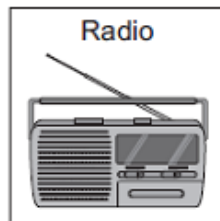
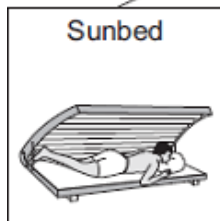
Speed = m/s

(2)
(Total 3 marks)

9 (a) The diagram shows the electromagnetic spectrum.
The pictures show four devices that use electromagnetic waves. Each device uses a different type of electromagnetic wave.

Draw a line from each device to the type of electromagnetic wave that it uses. One has been done for you.

| | | | | | | |
|------------|--------|------------------|---------------|----------------|------------|-------------|
| Gamma rays | X-rays | Ultraviolet rays | Visible light | Infra red rays | Microwaves | Radio waves |
|------------|--------|------------------|---------------|----------------|------------|-------------|



(3)

(b) A headline from a recent newspaper article is shown below.

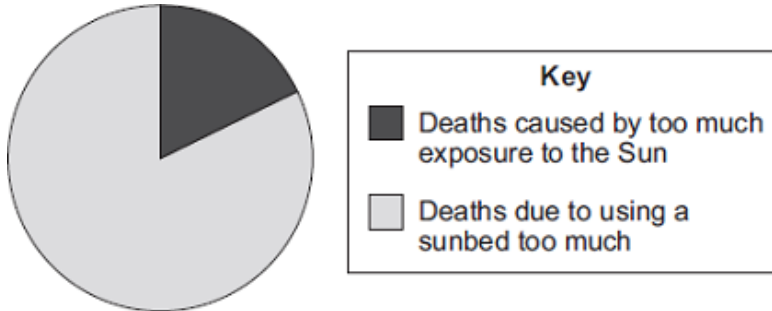


(i) What serious health problem may be caused by using a sunbed too much?

.....

(1)

(ii) The pie chart compares the number of deaths in Britain each year which may have been caused by using sunbeds too much, with those which may have been caused by too much exposure to the Sun.



It is difficult for a doctor to be certain that a person has died because of using a sunbed too much.

Suggest why.

.....
.....

(1)

(iii) A spokesperson for a leading cancer charity said:

'We want people, especially young people, to know the possible dangers of using a sunbed.'

Why is it important that you know the possible dangers of using a sunbed?

.....
.....

(1)
(Total 6 marks)

10

Using an optical telescope to look at stars is not always easy because:

- too many street lights often make it too light to see faint stars
- clouds reduce the light getting to the telescope
- atmospheric pollution often distorts the images.

Large optical telescopes are often positioned high up a mountain.

Describe the advantages of positioning a telescope high up a mountain.

.....

.....

.....

.....

.....

.....

(Total 3 marks)

11

(a) The diagram below shows six of the seven types of wave that make up the electromagnetic spectrum.

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

(i) What type of electromagnetic wave is missing from the diagram?

.....

(1)

(ii) Which of the following electromagnetic waves has the most energy?

Draw a ring around the correct answer.

gamma rays radio waves visible light

(1)

(iii) Which of the following electromagnetic waves is given out by a TV remote control?

Draw a ring around the correct answer.

infrared microwaves ultraviolet

(1)

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

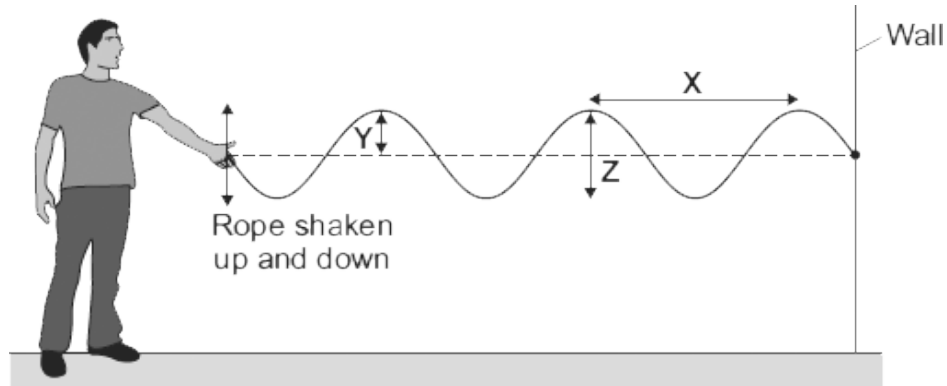
Microwaves travel through a vacuum at

- a slower speed than
- the same speed as
- a faster speed than

radio waves.

(1)

(c) The diagram shows waves being produced on a rope.
The waves are **not** reflected by the wall.



(i) Draw an arrow on the diagram to show the direction in which the waves transfer energy.

(1)

(ii) Which **one** of the arrows, labelled, **X**, **Y** or **Z**, shows the amplitude of a wave?

Write the correct answer in the box.

(1)

(iii) The waves produced on the rope are transverse.

Name **one** other type of transverse wave.

.....

(1)

(d) The rope is shaken up and down, producing 3 waves every second.
The waves have a wavelength of 1.2 metres.

(i) State the frequency of the waves.

..... Hz

(1)

- (ii) Calculate the speed of the waves.

Show clearly how you work out your answer.

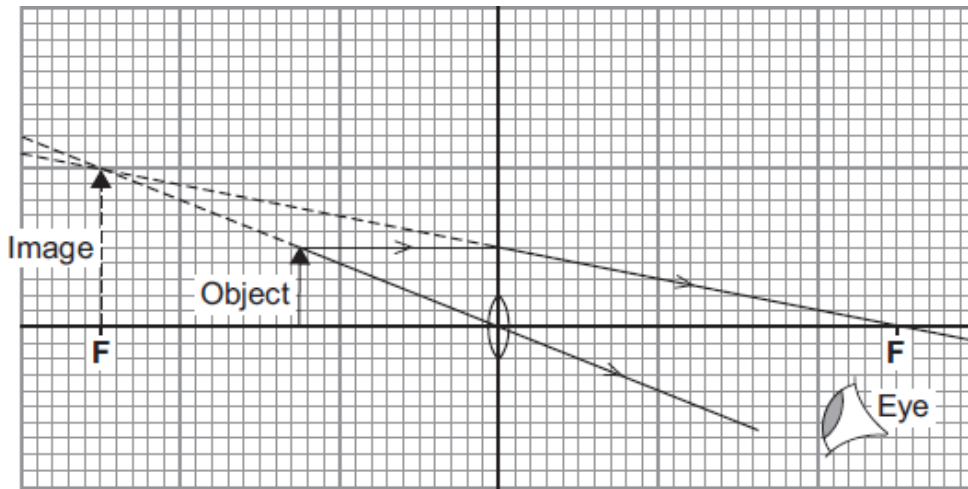
.....

Wave speed = m/s

(2)
 (Total 10 marks)

12

The diagram shows a lens being used as a magnifying glass.



- (a) (i) What type of lens is shown in the diagram?

Draw a circle around your answer.

concave converging diverging

(1)

- (ii) Use the equation in the box to calculate the magnification produced by the lens.

The object and image in the diagram have been drawn to full size.

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

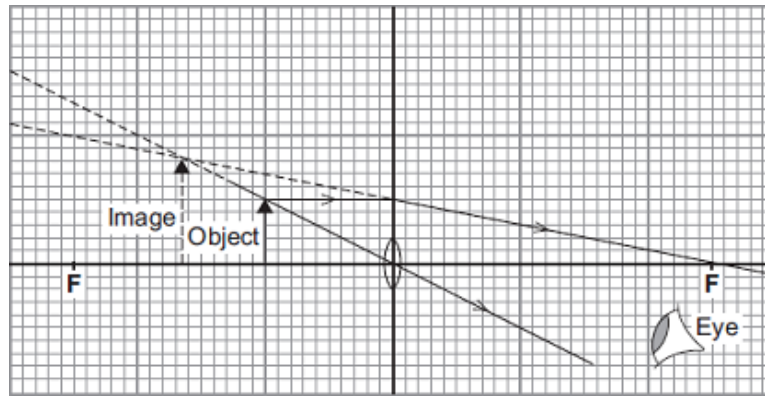
Show clearly how you work out your answer.

.....

Magnification =

(2)

- (b) The diagram shows how the image changes when the object has been moved closer to the lens.



Complete the following sentence by drawing a ring around the correct line in the box.

Moving the object closer to the lens

- | |
|-----------------|
| increases |
| does not change |
| decreases |

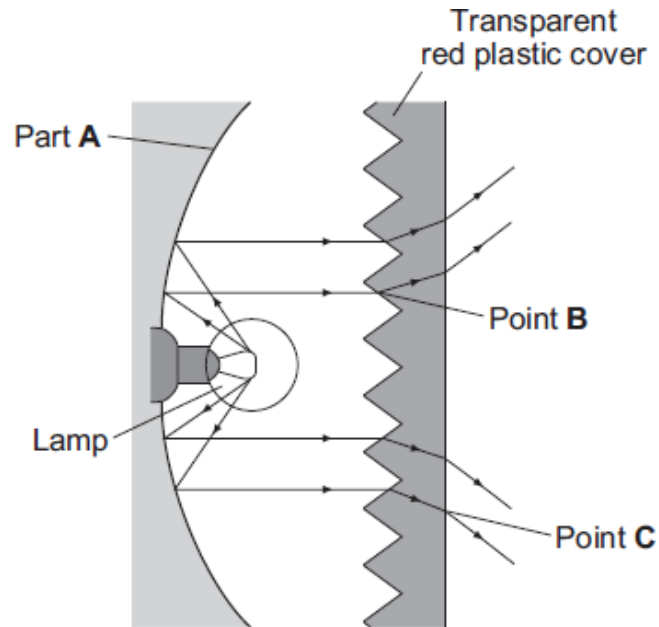
the magnification produced

by the lens.

(1)
(Total 4 marks)

- 13** At night, it is important that the lights of a car can be seen by other drivers but it is dangerous if these lights dazzle them.

The diagram shows a rear light of a car.



- (a) (i) Name part **A**.

.....

(1)

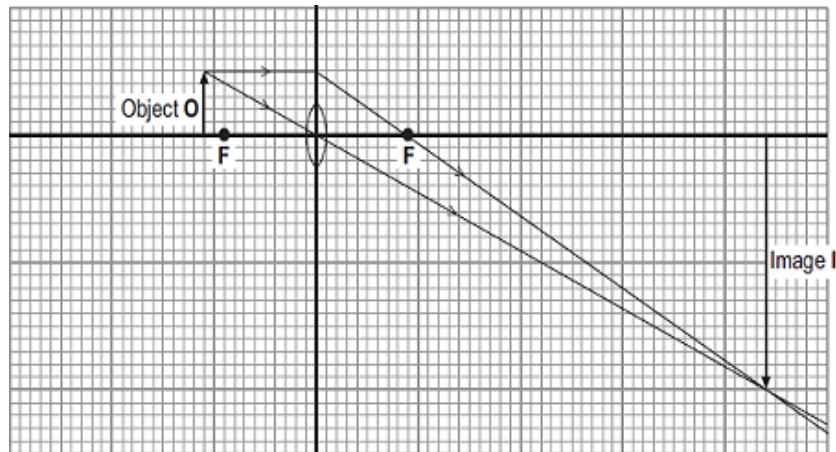
- (ii) Name the process which occurs at point **B** and at point **C**.

.....

(1)

- (b) A headlamp of a car contains a lens.

The ray diagram shows the position and size of the image, **I**, of an object, **O**, formed by a lens similar to the one inside a car headlamp.



- (i) What type of lens is shown in the ray diagram?

Draw a ring around your answer.

converging **diverging** **plane**

(1)

- (ii) The ray diagram is drawn to scale.

Use the equation in the box to calculate the magnification produced by the lens.

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

Show clearly how you work out your answer.

.....

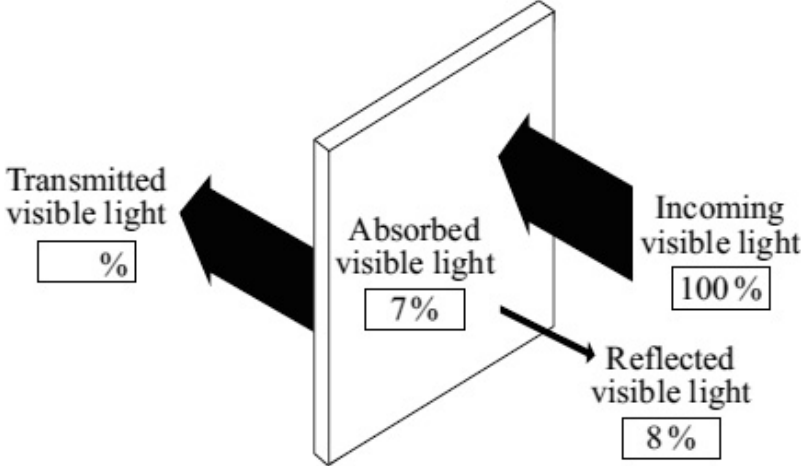
Magnification =

(2)
 (Total 5 marks)

14

Glass reflects, absorbs and transmits both infra red radiation and visible light.

(a) The diagram shows the percentages of visible light that are reflected and absorbed by one type of glass.

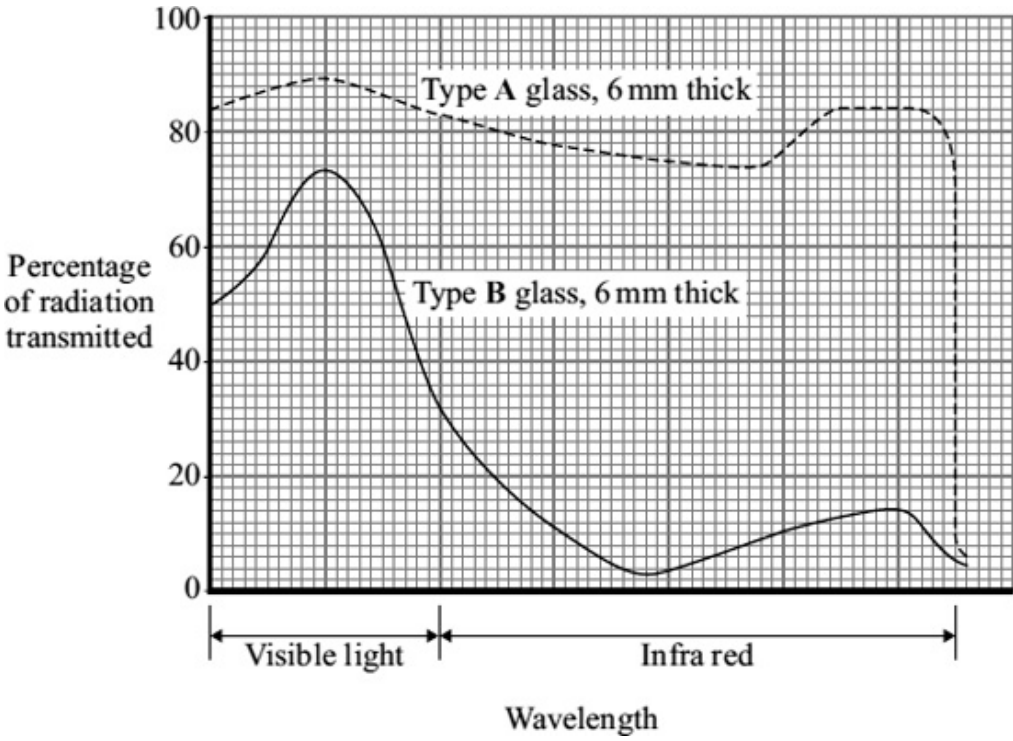


What percentage of visible light is transmitted by this type of glass?

..... %

(1)

(b) The amounts of infra red radiation and visible light transmitted by glass depend on the type and thickness of glass. The data obtained from tests on two different types of glass is displayed in the graph below.



(i) To be able to compare the two types of glass, it was important to control one variable.

What variable was controlled in the tests?

.....

(1)

- (ii) A homeowner has a glass conservatory built on the back of the house. The homeowner tells the builder that the inside of the conservatory should stay as cool as possible throughout the summer.

Explain why the builder uses 'type **B**' glass for the conservatory.

.....

.....

.....

.....

(2)
(Total 4 marks)

15

- (a) The table gives information about the frequencies in the hearing ranges of six different mammals.

| Name of mammal | Frequencies in hearing range |
|----------------|------------------------------|
| Bat | 20 Hz → 160 kHz |
| Dog | 20 Hz → 30 kHz |
| Dolphin | 40 Hz → 110 kHz |
| Elephant | 5 Hz → 10 kHz |
| Human | 20 Hz → 20 kHz |
| Tiger | 30 Hz → 50 kHz |

- (i) Which mammal in the table can hear the highest frequency?

.....

(1)

- (ii) Which mammal in the table, apart from humans, **cannot** hear ultrasound?

.....

(1)

- (iii) Give **one** example of a frequency which an elephant can hear but which a tiger **cannot** hear.

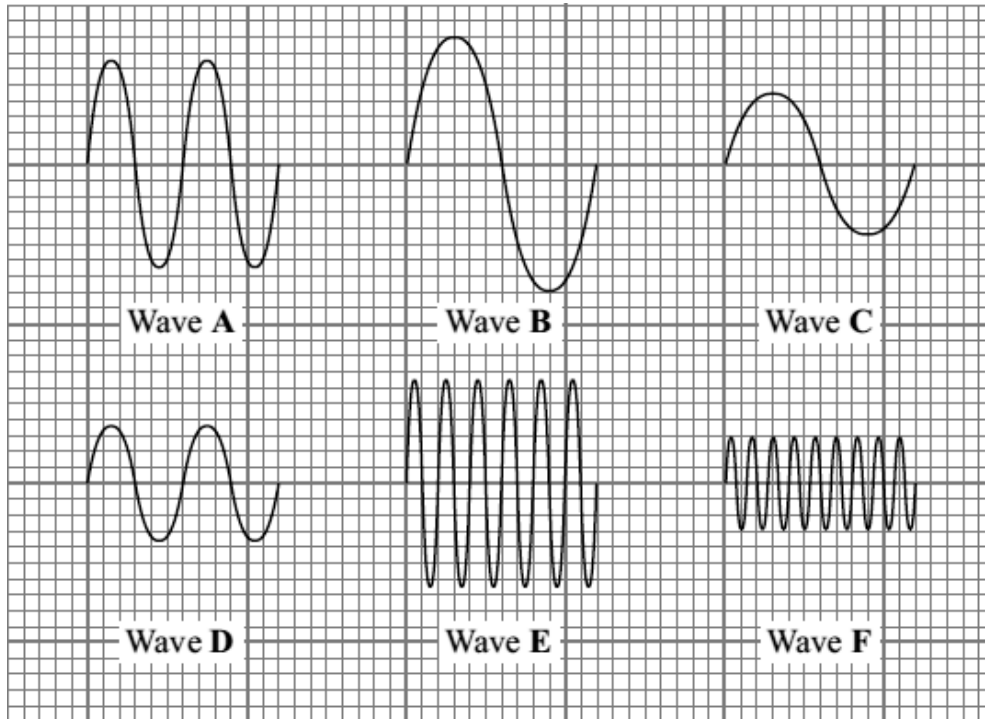
Include the unit in your answer.

Frequency

(1)

- (b) The diagrams show six sound waves, **A**, **B**, **C**, **D**, **E** and **F**, represented on an oscilloscope screen.

They are all drawn to the same scale.



- (i) Which **one** of the waves has the greatest amplitude?

Wave

(1)

- (ii) Which **one** of the waves has the highest frequency?

Wave

(1)

(Total 5 marks)

16

The diagram shows the seven types of wave that make up the electromagnetic spectrum.

| | | | | | | |
|------------|--------|------------------|---------------|----------------|-------------|-------------|
| Gamma rays | X-rays | Ultraviolet rays | Visible light | Infra red rays | Micro-waves | Radio waves |
|------------|--------|------------------|---------------|----------------|-------------|-------------|

- (a) (i) Microwaves and visible light can be used for communications.

Name **one** more type of electromagnetic wave that can be used for communications.

.....

(1)

- (ii) Name **one** type of electromagnetic wave that has a longer wavelength than microwaves.

.....

(1)

- (b) Wi-Fi is a system that joins a laptop computer to the internet without using wires. A 2400 megahertz microwave signal is used to link a computer to a device called a router.

What quantity is measured in hertz?

Draw a ring around your answer.

frequency

wavelength

wave speed

(1)

- (c) A politician commented on the increasing use of Wi-Fi. He said: 'I believe that these systems may be harmful to children.'

- (i) Suggest **one** reason why more scientific research into the safety of Wi-Fi systems is needed.

.....

.....

(1)

- (ii) Complete the following sentence by drawing a ring around the correct line in the box.

What the politician said was

a fact.

an opinion.

a prediction.

(1)

(Total 5 marks)

17

The table shows the electromagnetic spectrum. Three types of wave have been missed out.

| | | | | | | |
|------------|--|------------------|---------------|--|-------------|--|
| Gamma rays | | Ultraviolet rays | Visible light | | Micro-waves | |
|------------|--|------------------|---------------|--|-------------|--|

← Shortest wavelength

Longest wavelength →

- (i) Use words from the box to complete the table.

infra red rays radio waves X-rays

(2)

(ii) Which **one** of the following gives a use of gamma rays?

Put a tick (✓) in the box next to your choice.

to communicate with satellites

to see objects

to kill cancer cells

(1)

(iii) Complete the following sentence by drawing a ring around the correct word in the box.

All electromagnetic waves move

| |
|-----------|
| energy |
| gases |
| particles |

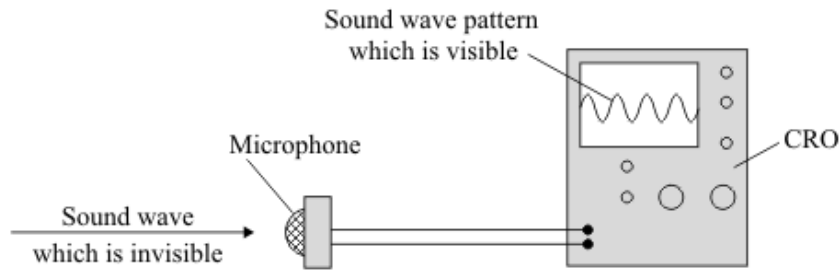
 from one place to another.

(1)

(Total 4 marks)

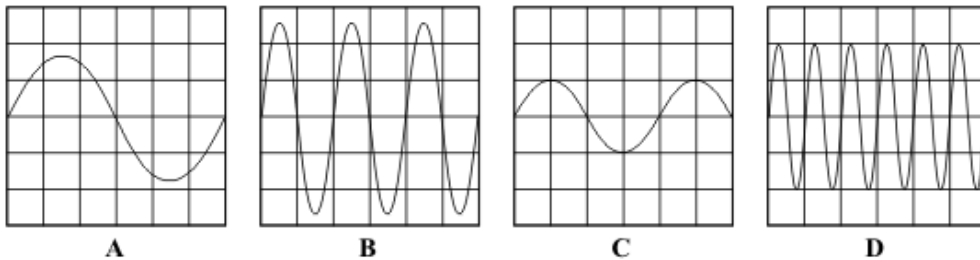
18

A microphone and a cathode ray oscilloscope (CRO) can be used to show the pattern of a sound wave.



Four sound wave patterns, **A**, **B**, **C** and **D**, are shown.

They are all drawn to the same scale.

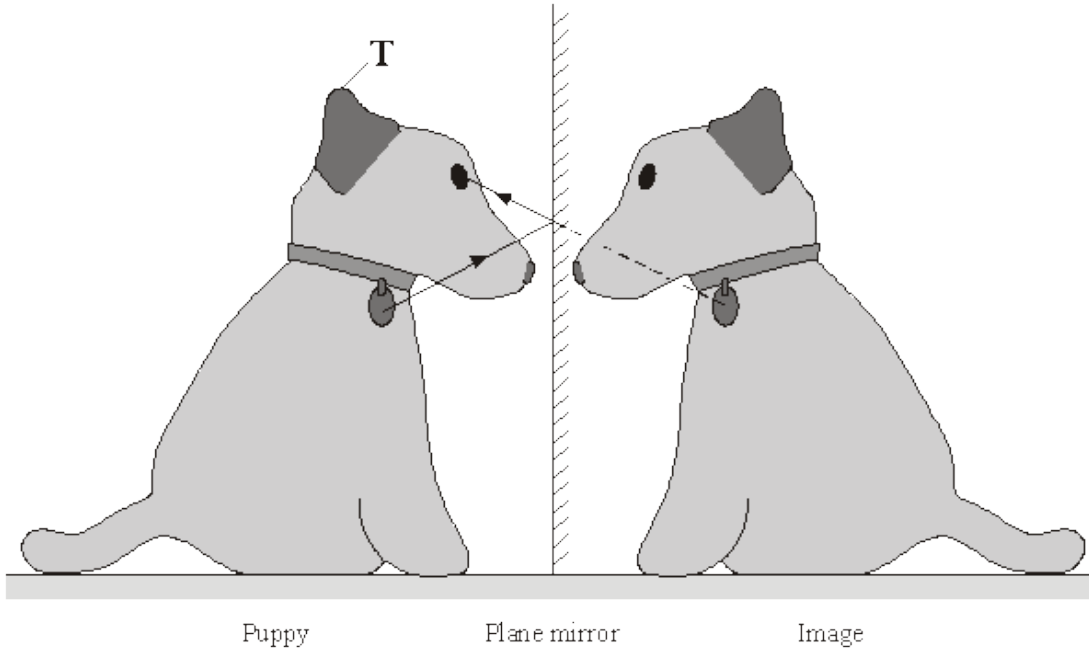


(a) Which **one** of the patterns has the smallest amplitude?

(b) Which **one** of the patterns has the lowest frequency?

(Total 2 marks)

19 A puppy can see an image of himself in a plane mirror.



The diagram shows how the puppy can see his disc.

(a) On the diagram, use a ruler to draw a ray to show how the puppy can see the top of his ear, which is marked as **T**.

(3)

(b) What is a plane mirror?

.....
.....

(1)

(Total 4 marks)

20 In the diagram below, a frog sits on a rock in a pond.

(a) Complete the following sentences by drawing a ring around the correct line in the box.

(i) The frog can see its image in the pond because the surface of the pond acts

like a

| |
|---------|
| concave |
| convex |
| plane |

 mirror.

(1)

- (ii) Draw a ring around each of **two** words from the box below to describe the image in the pond.

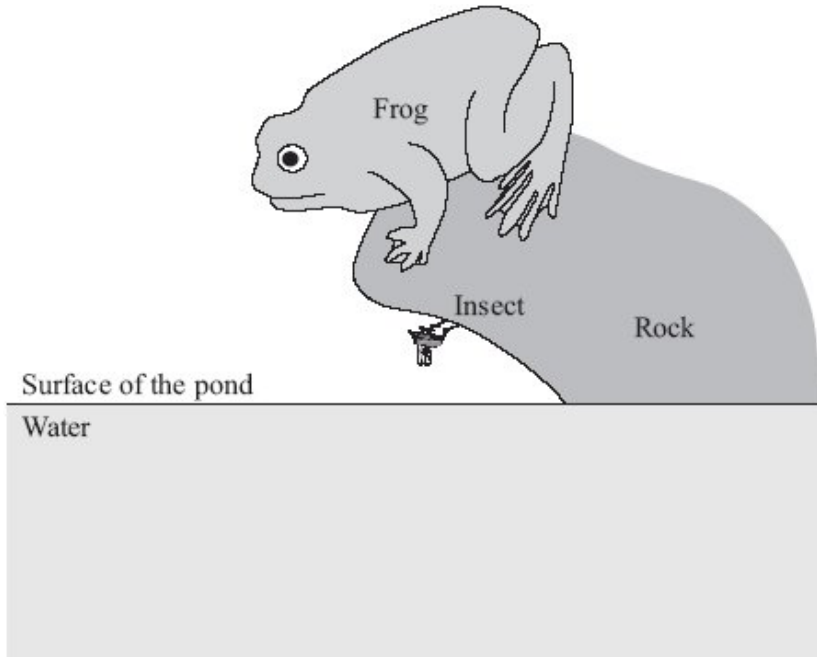
bigger inverted real smaller upright virtual

(2)

- (b) There is an insect underneath the rock.

Use a ruler to draw rays of light on the diagram to show how the frog uses reflection to see the insect.

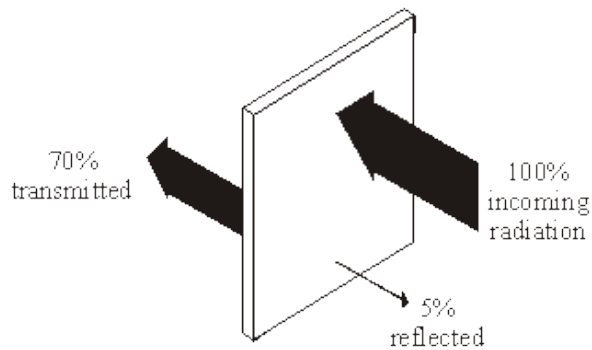
Mark the direction of the rays.



(3)
(Total 6 marks)

21

- (a) Infra red radiation can be reflected, absorbed and transmitted by glass.



- (i) What percentage of infra red is absorbed by the glass?

.....

(1)

- (ii) Complete the following sentence by drawing a ring around the correct word or phrase.

The absorbed infra red

| |
|-----------------|
| increases |
| does not change |
| decreases |

the temperature of the glass.

(1)

- (b) **Two** of the following statements are true. **One** of the statements is false.

Tick (✓) the boxes next to the **two** true statements.

| | |
|--|--|
| All objects absorb infra red radiation. | |
| Black surfaces are poor emitters of infra red radiation. | |
| A hot object emits more infra red than a cooler object. | |

(1)

- (c) The following statement is false.

| |
|--|
| Black surfaces are good reflectors of infra red radiation. |
|--|

Change **one** word in this statement to make it true.

Write down your **new** statement.

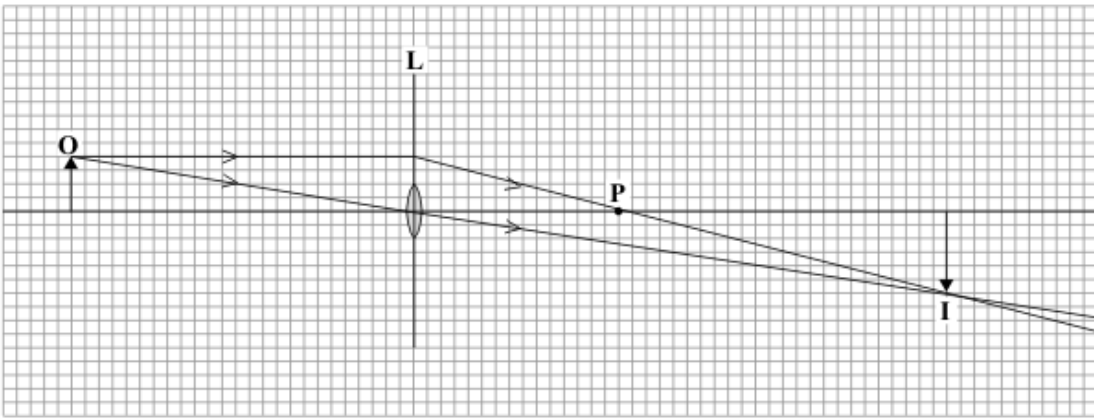
.....

.....

(1)
(Total 4 marks)

22

The ray diagram shows the position and size of the image, **I**, of an object, **O**, formed by a lens, **L**.



(a) What type of lens is shown in the ray diagram?
 (1)

(b) Name the point labelled **P**.
 (1)

(c) The ray diagram has been drawn to scale.
 Use the equation to calculate the magnification.

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

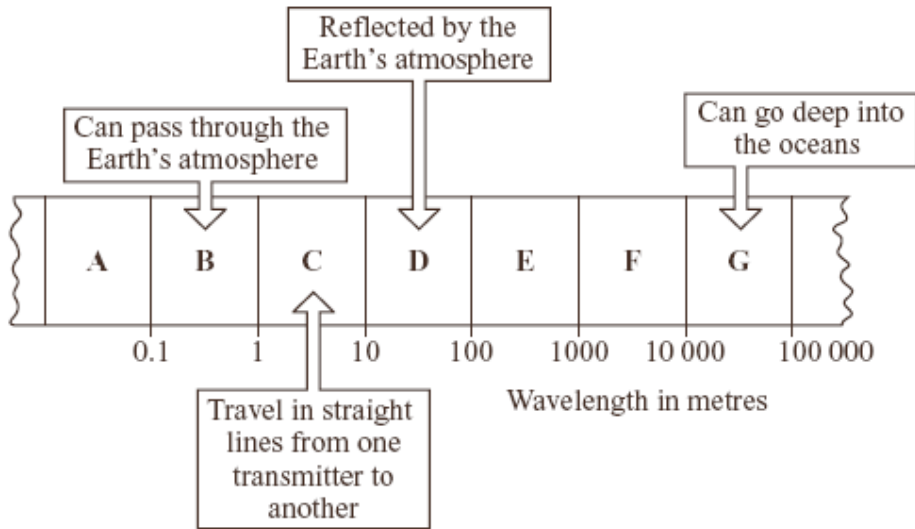
Show clearly how you work out your answer.

Magnification = (2)

(d) How can you tell from this ray diagram that the image is a real image?

(1)
(Total 5 marks)

- 23** The diagram shows a small part of the electromagnetic spectrum divided into seven sections. The different properties of the waves in each section make them useful in different ways.



The waves in which section, **A**, **B**, **C**, **D**, **E**, **F** or **G**, are:

- (a) used to send a signal to a satellite in space

.....

(1)

- (b) used to communicate with a submarine under the water

.....

(1)

- (c) used by a radio station to broadcast programmes around the world

.....

(1)

- (d) the waves with the shortest wavelength?

.....

(1)

(Total 4 marks)

- 24** (a) Mobile phones send *digital* signals using electromagnetic waves.

- (i) Which **one** of the following types of electromagnetic wave is used to carry information between masts in a mobile phone network?

Draw a ring around your answer.

| | | |
|-------|-----------|-------|
| light | microwave | radio |
|-------|-----------|-------|

(1)

- (b) Some people worry that using a mobile phone may be bad for their health.

Look at this information taken from a recent newspaper article.

- Scientists in Sweden found that the regular use of a mobile phone increases the risk of a cancerous growth between the ear and the brain.
- Some people who use mobile phones for a long time complain of headaches and tiredness. The same effect has not been noticed in laboratory tests.
- There is no reliable evidence to link using mobile phones with ill health.
- The waves from a mobile phone are not strong enough to cause long-term heat damage to cells in the body.

- (i) Complete the following sentence by drawing a ring around the word in the box that is correct.

The evidence from different scientists doing the same investigation is reliable if

all the scientists get

different
identical
random

results.

(1)

- (ii) What information in the article supports the idea that mobile phones are bad for your health?

.....
.....
.....
.....

(2)

- (iii) Some scientists say that using a mobile phone is totally safe.

What information in the article supports this view?

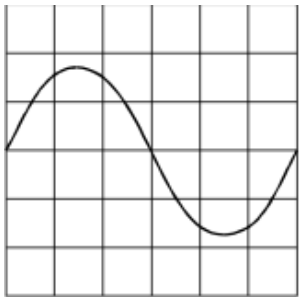
.....
.....
.....
.....

(2)

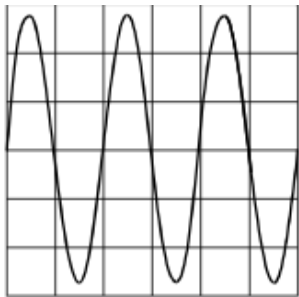
(Total 6 marks)

25

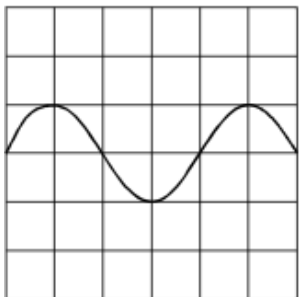
The diagram shows four oscilloscope wave traces. The controls of the oscilloscope were the same for each wave trace.



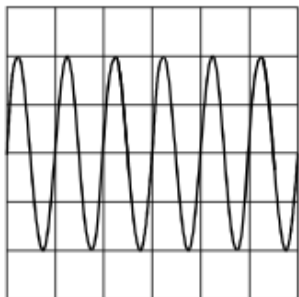
A



B



C



D

Which **one** of the waves traces, **A**, **B**, **C** or **D**, has:

(i) the largest amplitude,

(1)

(ii) the lowest frequency?

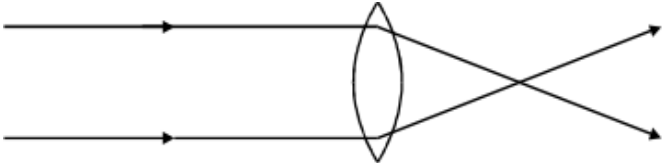
(1)

(Total 2 marks)

26

(a) The diagram shows how parallel rays of light pass through a convex lens.

(i) Mark the position of the focus.



(1)

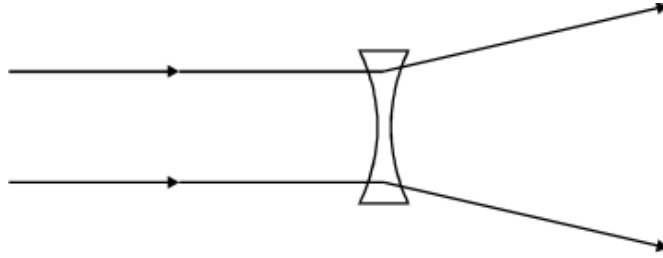
(ii) Is this a **converging** lens, a **diverging** lens, **both** or **neither**?

.....

(1)

(b) The diagram shows how parallel rays of light pass through a concave lens.

(i) Mark the position of the focus.



(1)

(ii) Is this a **converging** lens, a **diverging** lens, **both** or **neither**?

.....

(1)

(c) Complete these sentences by crossing out the **two** lines in each box that are wrong.

In a camera, a

| |
|------------|
| converging |
| diverging |
| parallel |

 lens is used to produce an image of an object on a

| |
|--------|
| film |
| lens |
| screen |

.

The image is

| |
|------------------|
| larger than |
| smaller than |
| the same size as |

 the object.

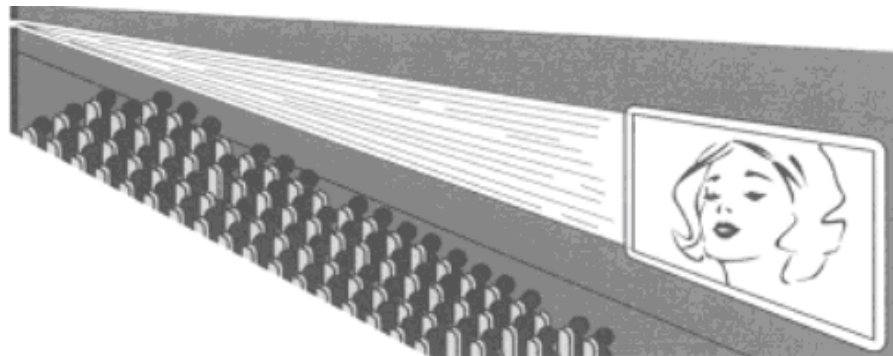
The image is

| |
|------------------------|
| further from |
| nearer to |
| the same distance from |

 the lens, compared to the distance of the object from the lens.

(4)

(d) In a cinema projector, a convex lens is used to produce a *magnified, real* image.



(i) What does *magnified* mean?

.....
.....

(1)

(ii) What is a *real* image?

.....
.....

(1)

(e) You are in a dark room. You have a box containing some lenses. Only **one** of them is a converging lens.

Describe how, by just feeling the lenses, you can pick out the converging lens.

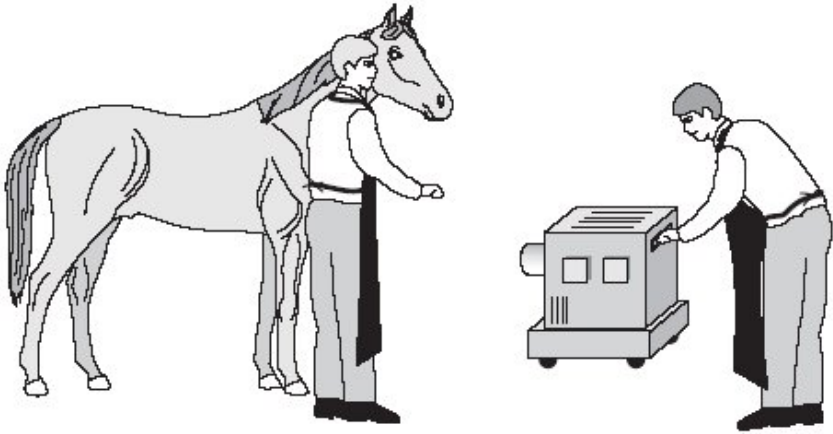
.....
.....
.....
.....

(2)

(Total 12 marks)

27

The picture shows a horse being prepared for an X-ray.



The person who will take the X-ray and the person holding the horse are wearing special aprons. These aprons have a lead lining.

Explain why the lead lining is important.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

.....

.....

.....

.....

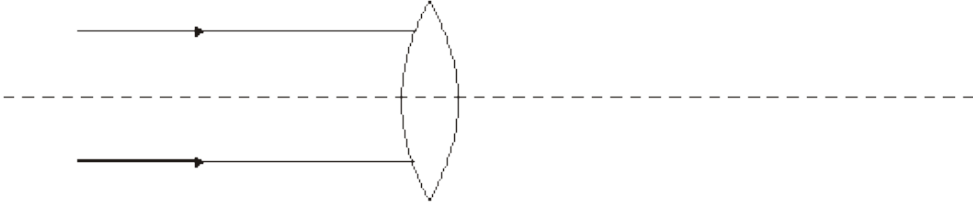
.....

(Total 3 marks)

28

(a) The diagram shows two parallel rays of light, a lens and its axis.

(i) Complete the diagram to show what happens to the rays.



(2)

(ii) Name the point where the rays come together.

.....

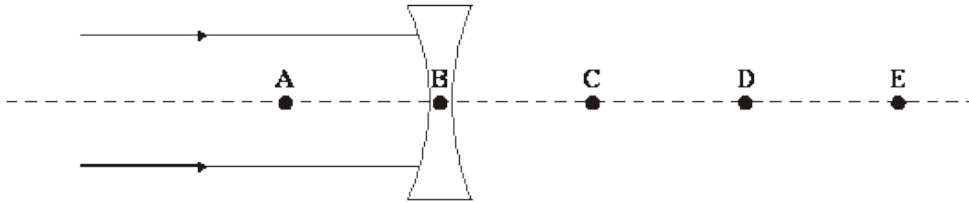
(1)

(iii) What word can be used to describe this type of lens?

.....

(1)

(b) The diagram shows two parallel rays of light, a lens and its axis.



(i) Which point **A**, **B**, **C**, **D** or **E** shows the focal point for this diagram?

Point

(1)

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

.....
.....

(1)

(iii) What word can be used to describe this type of lens?

.....

(1)

(c) Complete the following **three** sentences by crossing out the **two** lines in each box which are wrong

In a camera a converging lens is used to produce an image on a

| |
|--------|
| film |
| lens |
| screen |

The image is

| |
|------------------|
| larger than |
| smaller than |
| the same size as |

the object.

Compared to the distance of the image from the lens, the object is

| |
|------------------------|
| further away from |
| nearer to |
| the same distance from |

the lens.

(3)

(d) Explain the difference between a *real* image and a *virtual* image.

.....

.....

.....

.....

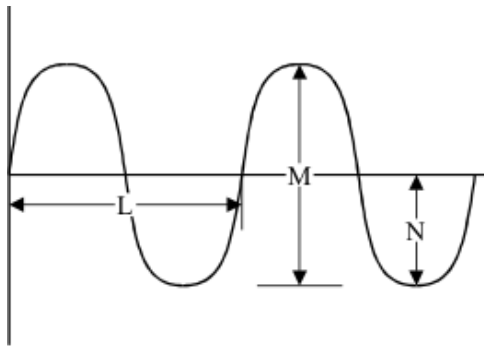
.....

.....

(3)
(Total 13 marks)

29

(a) The diagram shows a wave pattern.



Which letter, **L**, **M** or **N** shows:

- (i) the wavelength?
- (ii) the amplitude?

(2)

- (c) Describe how you could show that visible light travels in straight lines. You may wish to draw a diagram to help explain your answer.

.....

.....

.....

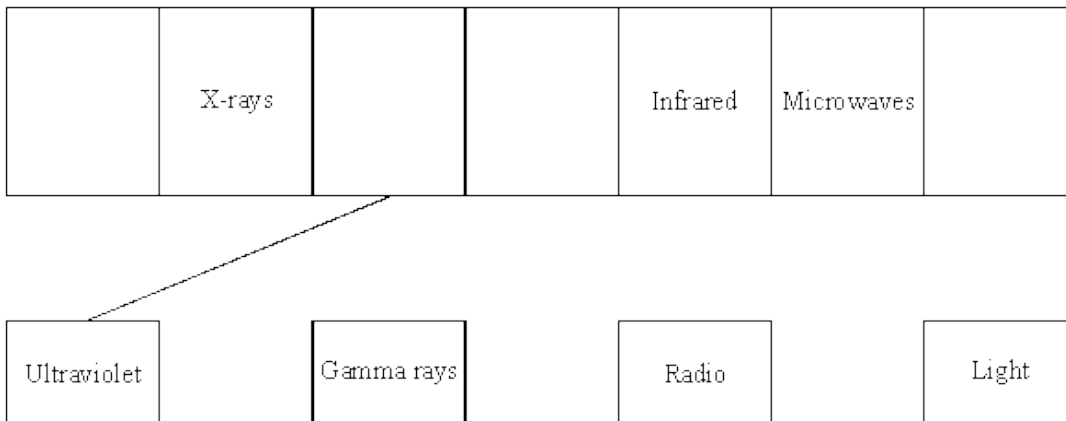
.....

.....

(2)
(Total 4 marks)

30

- (a) The diagram represents the electromagnetic spectrum. Four of the waves have not been named. Draw lines to join each of the waves to its correct position in the electromagnetic spectrum. One has been done for you.



(2)

- (b) Complete the following sentence by choosing the correct answer and crossing out in the box the two lines which are wrong.

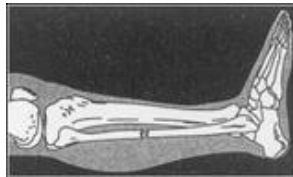
The speed of radio waves through a vacuum is
light through a vacuum.

| |
|---|
| faster than the same as slower than |
|---|

the speed of

(1)

- (d) The diagram shows an X-ray photograph of a broken leg.



Bones show up white on the photographic film. Explain why.

.....

.....

.....

(2)

(Total 5 marks)

31

- (a) A swimming pool has a wave making machine. The diagram shows the water wave pattern for 3 seconds.



- (i) How many water waves are shown in the diagram?

.....

(1)

- (ii) What is the frequency of the water waves?

.....

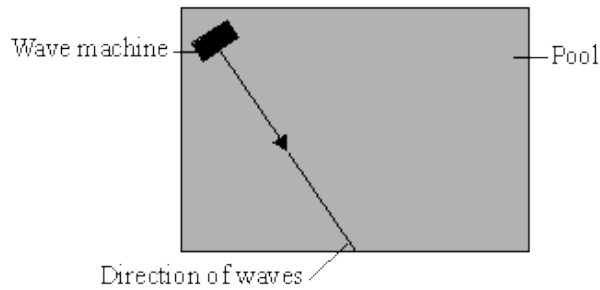
(1)

- (iii) Which **one** of the units below is used to measure frequency? Underline your answer.

hertz joule watt

(1)

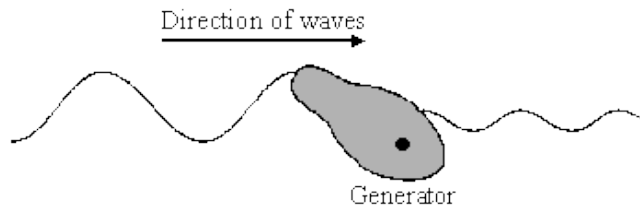
- (b) The diagram shows the direction of the waves across the pool. The waves reflect off the side of the pool.



Draw a line on the diagram to show the direction of the waves after they hit the side of the pool.

(1)

- (c) The swimming pool is used to test a model of an electricity generator. The waves make the floating generator move up and down. This energy is transferred to electricity.



- (i) In the following sentence, cross out the **two** lines that are wrong in the box.

The diagram shows that the amplitude of the waves

| |
|----------------|
| gets larger |
| stays the same |
| gets smaller |

 as the waves pass the generator.

(1)

- (ii) What type of energy does the generator transfer to electricity?

.....

(1)

- (iii) Energy from ocean waves could be used to generate electricity. Would this be a renewable or non-renewable energy resource?

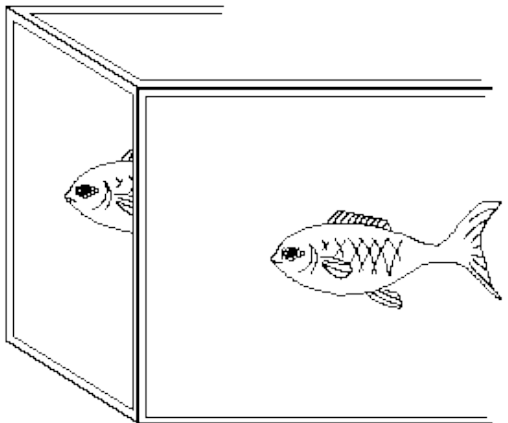
.....

(1)

(Total 7 marks)

32

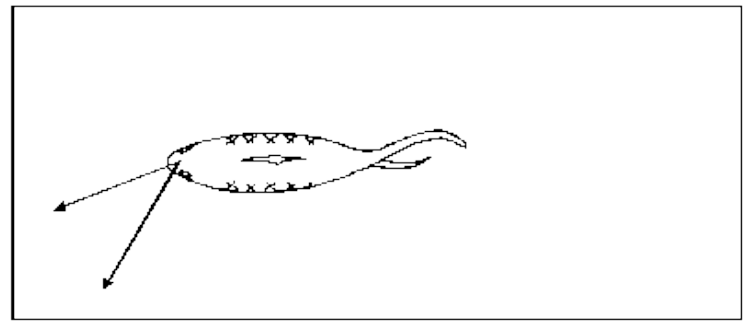
An aquarium contains only one fish. But if you look at the corner of the aquarium, there seem to be two fish.



The diagram below shows the top of the aquarium.

Two light waves have been drawn from the fish.

(a) Complete the diagram to show how the light waves reach the eye.



(2)

(b) Complete each sentence by using the correct words from the box.

| | | | |
|------------|-------------|--------------|------------|
| colour | diffraction | longitudinal | reflection |
| refraction | speed | transverse | |

When the light waves pass from glass into the air they change

This causes a change in direction called

Light waves are waves.

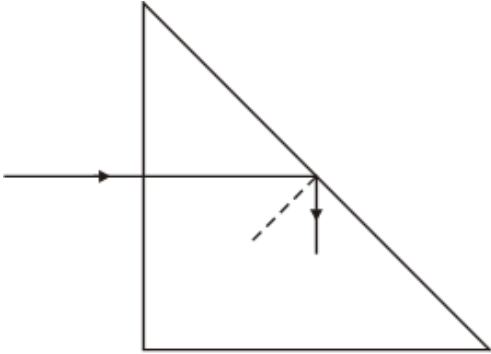
(3)

(Total 5 marks)

33

Glass prisms are used in many optical devices.

(a) The diagram shows what happens to a ray of light as it travels through a glass prism.



To gain full marks for this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

Use the words in the box to help you to explain why the ray behaves in this way.

angle critical normal

.....

.....

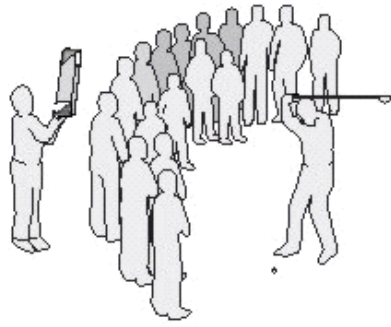
.....

.....

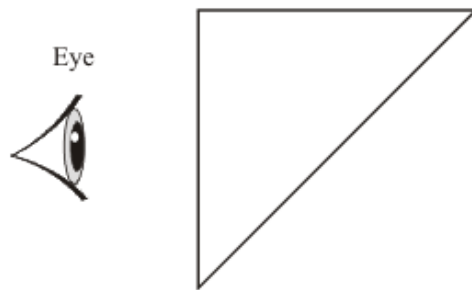
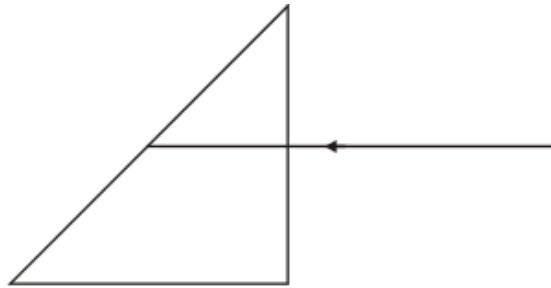
.....

(3)

(b) Periscopes can be used to look over the heads of other people.



A periscope contains two glass prisms.
Complete the diagram to show the ray of light reaching the person's eye.



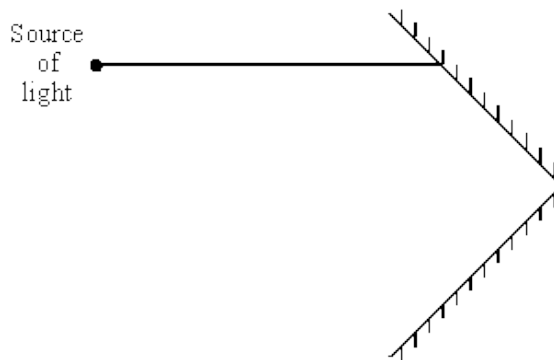
(3)
(Total 6 marks)

34

- (a) The diagram shows two mirrors at right angles to each other. A ray of light shines onto one mirror as shown.

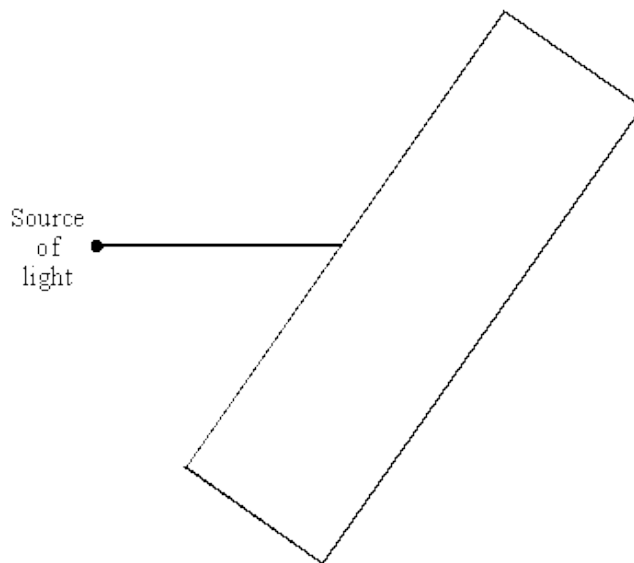
Carefully draw the path of the ray which is reflected from both mirrors.

Draw an arrow on the ray to show the direction of the light.



(3)

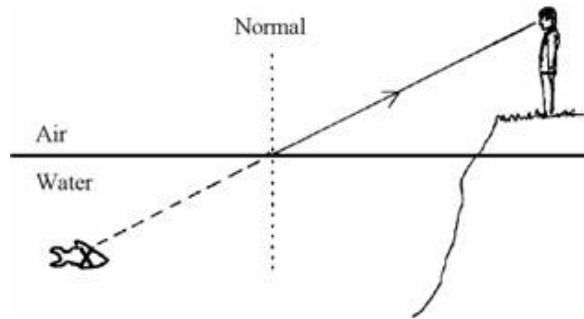
- (b) Light can also be made to change direction as it passes into and out from a block of glass. Complete the ray diagram below.



(2)
(Total 5 marks)

35 A man is walking along the bank of a river.

He sees a fish which seems to be at X.



(a) Show, on the diagram, where the fish **really** is.

Complete the ray of light which goes from the fish into the man's eye.

(2)

(b) Complete the sentence.

The ray of light is as it passes from the water into the air.

(1)

(Total 3 marks)

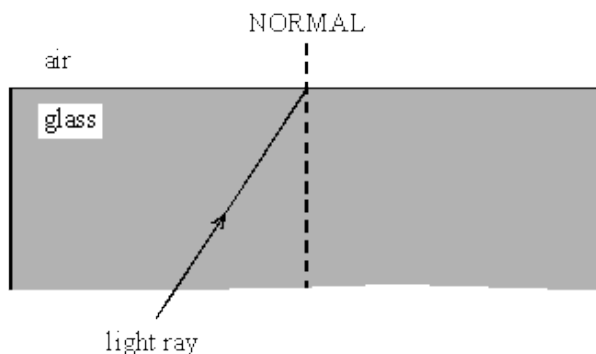
36 The diagram shows some of the kinds of waves in the electromagnetic spectrum. Choose words from this list to complete the empty boxes on the diagram.

alpha radiation infrared radiation radio waves X-rays

| Shortest wavelength | | | | | | | Longest wavelength |
|---------------------|--|-----------------------|-------|--|------------|--|--------------------|
| gamma radiation | | ultraviolet radiation | light | | microwaves | | |

(Total 3 marks)

37 The diagram shows a ray of light travelling through a glass block.



(a) Complete the diagram to show what happens to the ray of light when it comes out of the glass.

(2)

(b) Explain why this happens to the ray of light.

.....

(2)

(Total 4 marks)

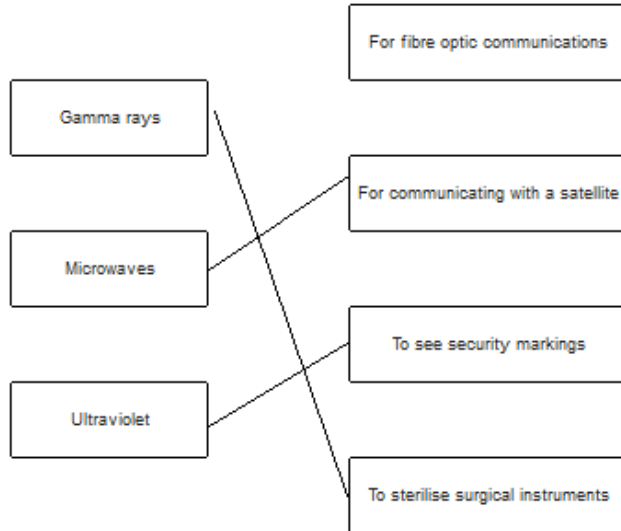
Mark schemes

1

(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]

2

(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]

3

(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]

4

(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]

| | | |
|----------|--|------------|
| 5 | (a) long | 1 |
| | (b) lens A | 1 |
| | it is a concave / diverging lens <i>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</i> | 1 |
| | (c) The refractive index of the lens material | 1 |
| | (d) 4 <i>ignore any signs</i> <i>allow 1 mark for correct substitution, ie $\frac{1}{0.25}$ provided no subsequent step</i> | 2 |
| | (e) Cauterising open blood vessels | 1 |
| | (f) 5 <i>allow 1 mark for correct substitution, ie $\frac{70}{14}$ provided no subsequent step</i> | 2 |
| | | [9] |
| 6 | (a) (i) (visible) light <i>accept visible</i> | 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]

7

(a) C

1

(b) reflection at the mirror of ray from shoe to person's eye
may be drawn freehand

1

angle of incidence = angle of reflection

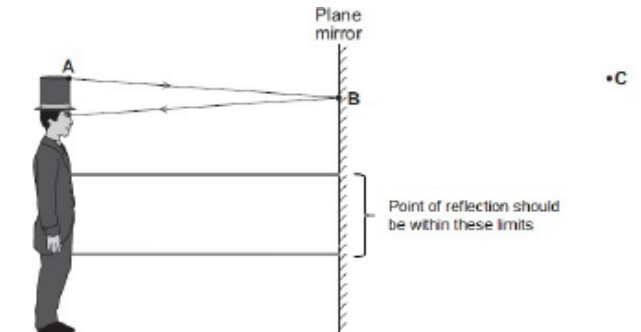
judged by eye
a ruler must have been used

1

arrow to show correct direction on either incident or reflected ray

only one arrow needed but if more drawn must be no contradiction
both incident and reflected ray must be shown

1



(c) virtual

1

[5]

8

(a) vibrate / oscillate

accept a correct description
move is insufficient

1

(b) 336

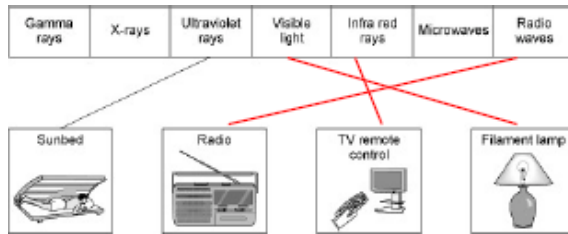
allow 1 mark for correct substitution, ie $420 \times 0.8(0)$ provided no subsequent step shown

2

[3]

9

(a) all three lines correct



allow 1 mark for each correct line

if more than one line goes from a device then all lines from that device are wrong

3

(b) (i) skin cancer

do **not** accept cancer

do **not** accept sunburn

correct answer only

1

(ii) other factors may be involved

accept may have been in the Sun too long

accept (over)-use of sunbeds and (over)- exposure to the Sun (both) give the same symptoms

accept any other sensible factor that could lead to doubt

do **not** accept irrelevant answers eg may be run over by a car

do **not** accept killed by exposure to the Sun

1

(iii) can assess risk

answers should be in terms of assessing our own health risk

or

make your own decision

accept so you limit its use / don't use one

do **not** accept so you don't get skin cancer

do **not** accept so you don't get sunburn

1

[6]

10

less / no light pollution

accept no / fewer streetlights

1

less cloud cover / above clouds

1

less atmospheric pollution

accept air for atmosphere
accept idea of thinner atmosphere
do **not** accept closer to stars

1

[3]

11

(a) (i) X-ray(s)

1

(ii) gamma rays

1

(iii) infrared

1

(b) the same speed as

1

(c) (i) horizontal arrow drawn pointing to the right

judge by eye

accept drawn anywhere on diagram

1

(ii) Y

1

(iii) any **one** from:

- any type of electromagnetic wave
accept electromagnetic wave(s)
- water (wave)
do not accept seismic waves
- (earthquake / seismic) S waves
do not accept P waves
do not accept earthquakes

1

(d) (i) 3

1

(ii) 3.6

or

their (d)(i) $\times 1.2$ correctly calculated

$$v = f \times \lambda$$

allow 1 mark for correct substitution

ie 3 or their (d)(i) $\times 1.2$ provided that no subsequent step is shown

2

[10]

12

(a) (i) converging

1

(ii) (x) 2

allow 1 mark for correct substitution

ie 10/5 or 20/10 or 2/1

ignore any units

2

(b) decreases

1

[4]

13

(a) (i) (concave) mirror / reflector

do not allow convex mirror / reflector

1

(ii) refraction

1

(b) (i) converging

1

(ii) 4

allow 1 mark for correct substitution

ie 20 / 5 or 4 / 1

ignore any units

2

[5]

14

(a) 85

1

(b) (i) thickness (of glass)

accept how thick the glass is

do not accept light intensity

1

(ii) transmits less infra red

accept radiation / or heat for infra red

accept transmits less energy (at all wavelengths)

*accept (glass **B**) absorbs more infra red*

accept infra red is the same as heat

ignore reference to visible light

1

infra red has a heating effect

or

infra red warms the room

ignore references to conservatory

keeping cool

1

- 15** (a) (i) bat(s) 1
- (ii) elephant(s) 1
- (iii) any example in the inclusive range 5 ↔ 29 Hz / hertz
appropriate number and unit both required 1
- (b) (i) **B** 1
- (ii) **F** 1

[5]

- 16** (a) (i) infra red (rays)
accept IR
or
radio (waves)
do not accept heat waves
do not accept TV waves 1
- (ii) radio (waves)
this answer only 1
- (b) frequency 1
- (c) (i) *answer should be in terms of establishing if harmful or not harmful ie trying to clear up any uncertainty*
do not accept answers that assume it is harmful
eg Wi-Fi systems will make you ill

need to know if it is harmful / makes you ill
accept idea that safety issue may worry people
accept idea that (more) research may reassure people
accept idea of finding out (the truth) 1
- (ii) an opinion 1

[5]

17

- (i) X-rays
- infra red (rays)
- radio (waves)
- all three in correct order*
- allow 1 mark for 1 correct*

2

- (ii) to kill cancer cells

1

- (iii) energy

1

[4]

18

- (a) C (only)
- (b) A (only)

1

1

[2]

19

- (a) reflection at the mirror of ray from tip of real puppy's ear to real puppy's eye (1)
- may be drawn freehand*

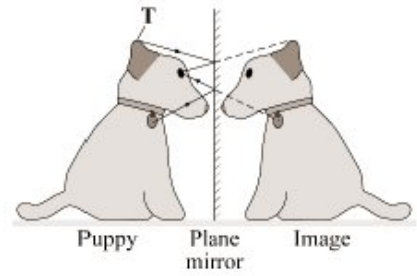
accurate (1)

ruler must have been used and the reflected ray is an extension of the straight line from point virtual ear however the virtual part of the line need not be shown

arrow to show correct direction (1)

only one arrow needs to be shown but there must be no contradiction

example of (3) mark response



3

(b) flat

accept 'it's not curved/bent'

accept 'it's straight'

1

[4]

20

(a) (i) plane

accept any unambiguous indication

1

(ii) inverted

1

virtual

accept any unambiguous indication

1

(b) reflection takes place at the surface of the pond and angle of incidence = angle of reflection

as judged by eye

1

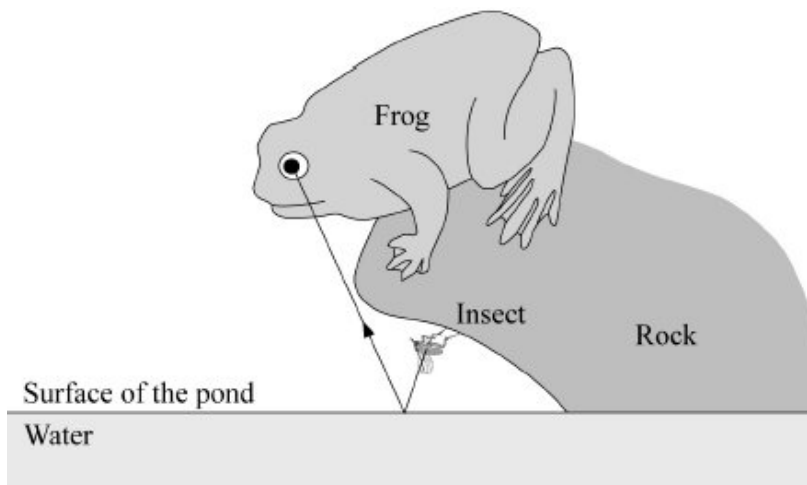
reflected ray is a straight line to frog's eye through the air

1

correct direction arrow **either** from insect **or** to frog's eye

only one arrow essential but

*do **not** accept if either arrow contradicted example of a fully correct response*



1

[6]

- 21** (a) (i) 25 (%)
do not accept ¼ 1
- (ii) increases 1
- (b) tick (✓) in top and bottom box
both required 1
- (c) SHINY surfaces are good reflectors of infra-red radiation
accept white for shiny
- or** black surfaces are POOR reflectors of infra-red radiation
accept bad for poor
accept insertion of 'not' before 'good' in statement
- or** black surfaces are good EMITTERS of infra-red radiation
- or** black surfaces are good ABSORBERS of infra red radiation 1

[4]

- 22** (a) converging
or convex 1
- (b) (principal) focus
or focal point 1
- (c) **either** (x)1.5 **or** (x)1½ **or** 150%
unambiguous evidence of appropriate measurements for 1 mark
only eg 4 and 6 or 8 and 12 or 0.8 and 1.2 2
- (d) real rays cross to form it / formed at the intersection of real rays
accept 'image on the opposite side of the lens to the object'
accept 'can be put onto a screen' 1

[5]

| | | | |
|----|---|---|------------|
| 24 | (a) (i) microwave | 1 | |
| | (b) (i) identical | 1 | |
| | (ii) • increased risk of cancerous growth (between ear and brain) | 1 | |
| | • complaints of headaches and tiredness | 1 | |
| | (iii) any two from: | | |
| | • tests in a laboratory did not give effects of tiredness or headaches | | |
| | • waves not strong enough to cause long term heat damage to cells | | |
| | • evidence to link mobile phones and ill health is not reliable | 2 | |
| | | | [6] |
| | | | |
| 25 | (i) B | 1 | |
| | (ii) A | 1 | |
| | | | [2] |
| | | | |
| 26 | (a) (i) point where the rays cross <i>do not credit if ambiguous</i> | 1 | |
| | (ii) converging (lens) <i>do not accept convex</i> | 1 | |
| | (b) (i) point where the rays appear to diverge from <i>this should appear to be within 10mm in front of the back of the arrows on the approximate centre line</i> <i>need not be accurately constructed using a ruler</i> | 1 | |
| | (ii) diverging (lens) <i>do not accept concave</i> | 1 | |

- (c) converging 1
- film 1
- smaller than
- nearer to
- accept any clear indication of the response e.g. ticking, ringing,
writing in after a mistake* 1
- (d) (i) (image) bigger than object enlarge
accept just 'made bigger' 1
- (ii) it / real image can be put on a screen **or** real image on the opposite side
of the lens to the object
*accept 'not an imaginary or virtual image'
assume 'it' refers to a real image
do **not** credit 'it can be seen'* 1
- (e) **either** (the converging lens is) thick in the middle thin(ner) at the edge
thickest in the middle gains 2 marks 1
- or** (both) sides bend outwards (1) in the middle (1)
*convex gains 2 marks
suitable diagrams gains 2 marks* 1
- or** one side bends in the middle (1) more than the other side bends inwards
(in the middle) (1) 1

[12]

27

Quality of written communication

*award for a sensible sequence of **two** points*

1

X-rays do not go through lead

*accept lead protects them from the X-rays
accept not exposed to X-rays*

1

lead stops / reduces risk of X-rays harming / damaging / killing (persons) cells

*accept X-rays (may) cause cancer
accept organs for cell
do **not** accept references to electric shock
do **not** accept stops bones of people showing on X-ray
answers involving the horse wearing an apron are incorrect
references to gamma rays are incorrect*

1

[3]

28

(a) (i) rays continued to meet on the right hand side of the lens and beyond

*must be straight lines from the right hand side of the lens
ignore details through the lens
allow if no arrows*

1

meet exactly on the axis

*negate mark if contradictory arrow(s) added
do not need to go beyond the focus for this mark*

1

(ii) (principal) focus

***or** focal (point)*

1

(iii) converging

***or** convex*

1

(b) (i) **A**

1

(ii) rays seem to come from this point

***or** words to this effect
or shows this on the diagram*

1

(iii) diverging

***or** concave*

1

- (c) film
accept any unambiguous method of showing the correct response 1
 smaller than 1
 further away from 1
- (d) any **three** from:
- real image can be put on a screen
allow film
 - virtual image cannot be put on a screen / film
 - virtual image is imaginary
 - real image is formed where (real) rays cross / converge
allow real image has light travelling through it
 - virtual image is where virtual / imaginary rays (seem to) come from
or virtual image is where rays seem to come from
 - virtual image formed where virtual rays intersect / cross

3 [13]

29

- (a) (i) L 1
 (ii) N 1

- (c) the answer should be in the form:
not inside the eye
- either** for **both** marks an arrangement which could demonstrate visibly light travels in straight lines
full credit should be given for answer presented as a diagram

and
 an explanation of how it shows the straightness

or for one mark

named device which uses principle of light travelling in straight lines to work

examples

light (from a street lamp) strikes an object producing a shadow

laser light travelling through (fine) dust shows a straight beam

three pieces of card with central holes need to be lined up to be able to see through the third hole from the first

ray box type experiment using mirrors/prisms, etc

beams on paper or in smoke

torch beams through smoke

example devices:-

-pinhole camera (qualification may get second mark)

-periscope

-optical fibre

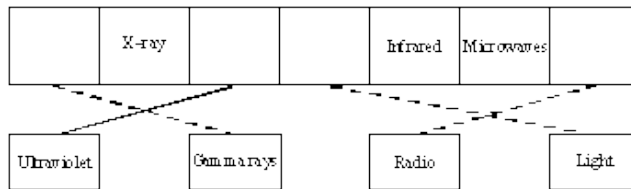
*-reflection in a **mirror***

2

[4]

30

(a) all **three** correct



one only correct, **1** mark only

allow names in boxes

there should be only **one** line from **or** to each box

2

(b) the same as

1

(d) any **two** from:

- bones absorb X-rays
- so film not exposed
- X-rays pass through flesh or skin or
- body or tissue (to expose film)

allow X-rays cannot pass through bones

2

[5]

| | | | |
|-----------|---|---|------------|
| 31 | (a) (i) 3 | 1 | |
| | (ii) 1 | | |
| | <i>accept a definition of frequency ignore units</i> | 1 | |
| | (iii) hertz | 1 | |
| | (b) straight line in correct direction | | |
| | <i>judge by eye (from 'a' of waves to 's' of across) ignore arrow</i> | | |
| | <i>accept equal angles shown on waves</i> | 1 | |
| | (c) (i) gets smaller | 1 | |
| | (ii) kinetic | | |
| | <i>accept movement</i> | 1 | |
| | (iii) renewable | 1 | |
| | | | [7] |

| | | | |
|-----------|---|---|------------|
| 32 | (a) one mark for each ray correctly drawn straight to glass then bent towards pupil | | |
| | <i>accept both rays hitting any part of eye</i> | | |
| | <i>judge straightness by eye</i> | | |
| | <i>accept dotted or dashed lines</i> | | |
| | <i>ignore any arrows</i> | | |
| | <i>N.B. the rays must reach the eye</i> | 2 | |
| | (b) speed | 1 | |
| | refraction | 1 | |
| | transverse | 1 | |
| | | | [5] |

33

(a) Quality of written communication:
Correct use of 2 of the words, angle, critical, normal and reflection

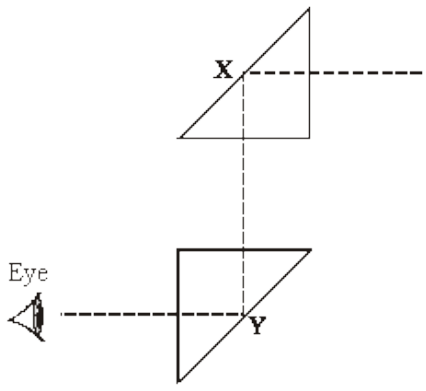
1

any **two** from

- light is reflected / bounces off
- if angle between ray and normal angle of incidence
- is greater than critical angle
- idea that no refraction bending if ray at 90°

2

(b)



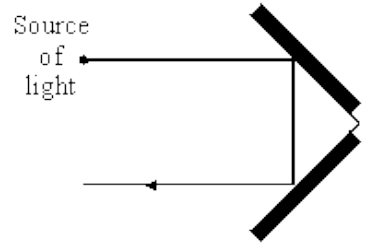
1 mark for reflection at X if ray would reach the lower prism
 1 mark for subsequent reflection at Y
 1 mark for subsequent ray emerging from prism in direction of front of eye
 accept dotted or dashed lines
 ignore any arrows

3

[6]

34

(a) first reflection vertically down to the fourth hatch line or just to the left of it reaching mirror (must come from incident ray given)



1

second reflection back parallel to incident ray must be linked to first part of ray

1

appropriate arrow on a part of the ray (may be given if lines wrong)

(must come from source of light)

maximum of one mark to be lost for poor diagrams not using a ruler for straight lines

first time you come across wavy line, it is penalised

1

(b) ray in block bent downwards, not beyond the normal

do not credit if exactly on normal

1

emergent ray parallel to incident ray

do not credit a continuation of the line straight through the block these are independent

1

[5]

35

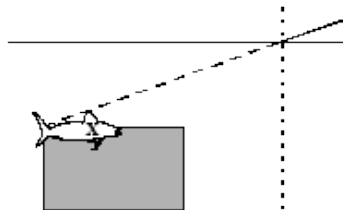
(a) line (from fish) to complete ray to eye

[mark awarded even if begins outside the box]

[credit only if fish shown to left of normal]

• fish within the region shown or X or start of ray

(i. e. not necessarily directly below x) each for 1 mark



2

(b) bent/refracted/deviated/speeded up

for 1 mark

1

[3]

36

X-rays {infrared } {radio }
 {radiation } {waves }

for 1 mark each

[3]

37

(a) ray shown refracted (to rhs or along normal)
gains 1 mark

but

ray shown refracted away from normal
gains 2 marks

2

(b) *idea that*
travels at a different speed
gains 1 mark

(allow refracted / travels slower in air / air is less dense) (do not allow bent)

but

travels more quickly in air
gains 2 marks

2

[4]