

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.6.2 ELECTROMAGNETIC WAVES (PACK 2)

SCORE

/207

PERCENTAGE

%

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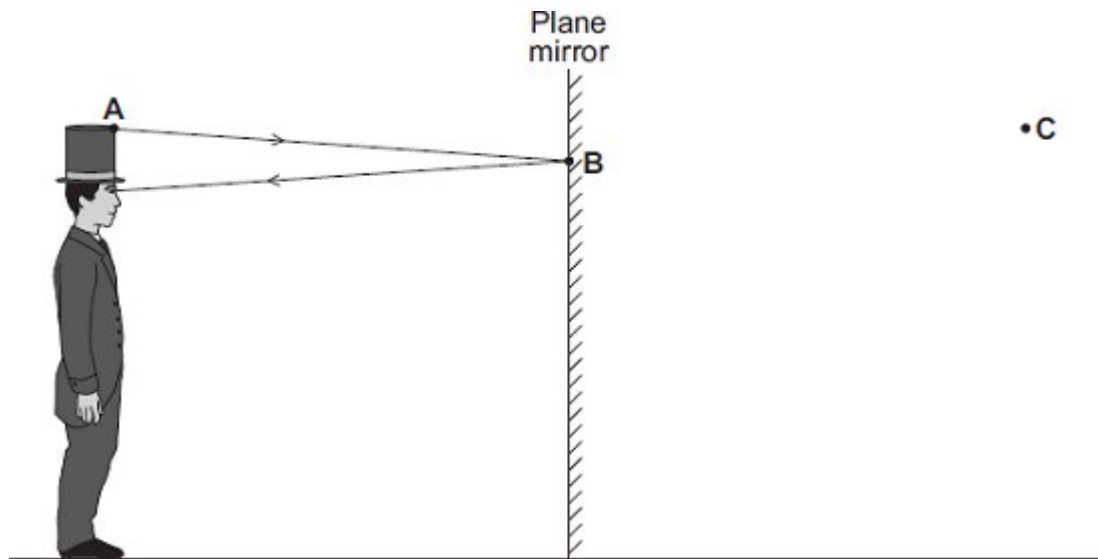
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Q1.

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)

Q2.

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)

Q3.

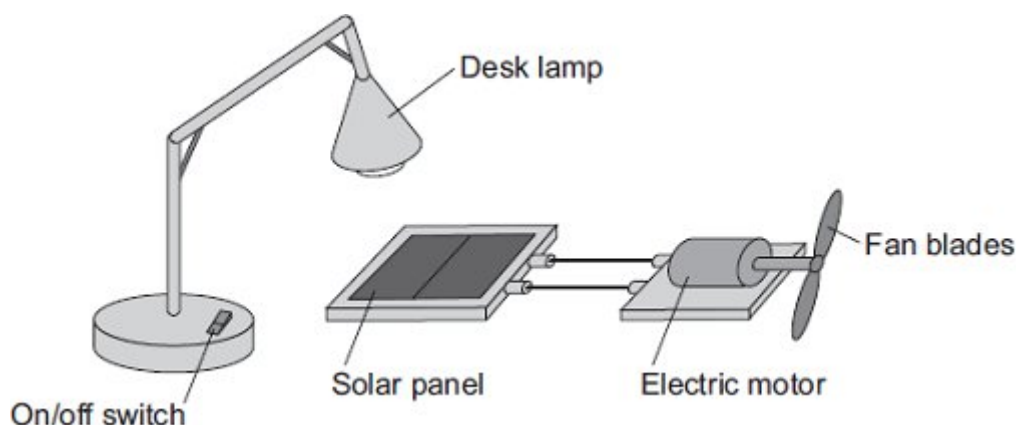
(a) Light waves transfer energy.

(i) Complete the following sentence.

The oscillations producing a light wave are _____
to the direction of the energy transfer by the light wave.

(1)

(ii) The apparatus in the diagram shows that light waves transfer energy.



Describe how switching the desk lamp on and off shows that light waves transfer energy.

You do **not** need to describe the energy transfers.

(2)

(b) A student holds a wrist watch in front of a plane mirror. The student can see an image of the wrist watch in the mirror.

The diagram shows the position of the wrist watch and the mirror.



Draw a ray diagram showing how the image of the wrist watch is formed.

Mark the position of the image.

(4)

- (c) The image of the wrist watch seen by the student is virtual.

What is a virtual image?

(1)

(Total 8 marks)

Q4.

- (a) Electromagnetic waves form a continuous spectrum with a range of wavelengths.

What is the approximate range of wavelengths of electromagnetic waves?

Tick (✓) **one** box.

10^{-15} metres to 10^4 metres ☐

10^{-4} metres to 10^{15} metres ☐

10^{-6} metres to 10^6 metres ☐

(1)

- (b) Infrared waves and microwaves are used for communications.

- (i) Give **one** example of infrared waves being used for communication.

(1)

- (ii) A mobile phone network uses microwaves to transmit signals through the air. The microwaves have a frequency of 1.8×10^9 Hz and travel at a speed of 3.0×10^8 m/s.

Calculate the wavelength of the microwaves.

Give your answer to **two** significant figures.

Wavelength = _____ m

(3)

- (c) Some scientists suggest there is a possible link between using a mobile phone and male fertility.

The results of their study are given in the table.

Mobile phone use in hours per day	Sperm count in millions of sperm cells per cm ³ of semen
0	86
less than 2	69
2 – 4	59
more than 4	50

The results show a negative correlation: the more hours a mobile phone is used each day, the lower the sperm count. However, the results do **not** necessarily mean using a mobile phone causes the reduced sperm count.

Suggest **one** reason why.

(1)

(Total 6 marks)

Q5.

Ultrasound and X-rays are waves used in hospitals to create images of the inside of the human body. To produce the images below, the waves must enter the human body.

Ultrasound scan of an unborn child



© Isabelle Limbach/Thinkstock

X-ray of a broken bone



© itsmejst/iStock

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

Describe the features of ultrasound and X-rays, and what happens to each type of wave after it has entered the human body.

[illegible]

(6)

- (b) It would **not** be safe to use X-rays to produce an image of an unborn child.

Explain why.

(2)

- (c) Ultrasound can be used for medical treatments as well as for imaging.

Give **one** use of ultrasound for medical treatment.

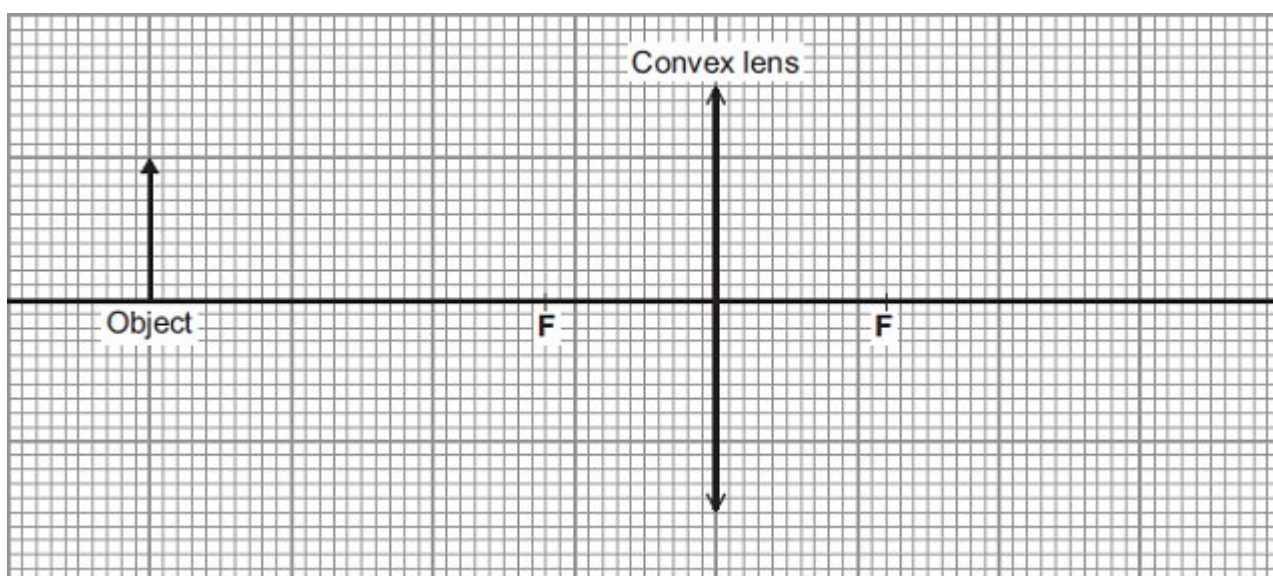
(1)

(Total 9 marks)

Q6.

- (a) A camera was used to take a photograph. The camera contains a convex (converging) lens.

Complete the ray diagram to show how the lens produces an image of the object.



F = Principal focus

(4)

- (b) State **two** words to describe the nature of the image produced by the lens in the camera.

1. _____

2. _____

(2)

(Total 6 marks)

Q7.

Galaxies emit all types of electromagnetic wave.

- (a) (i) Which type of electromagnetic wave has the shortest wavelength?

_____ (1)

- (ii) State **one** difference between an ultraviolet wave and a visible light wave.

_____ (1)

- (b) Electromagnetic waves travel through space at a speed of 3.0×10^8 m/s.

The radio waves emitted from a distant galaxy have a wavelength of 25 metres.

Calculate the frequency of the radio waves emitted from the galaxy and give the unit.

Frequency = _____ (3)

- (c) Scientists use a radio telescope to measure the wavelength of the radio waves emitted from the galaxy in part (b) as the waves reach the Earth. The scientists measure the wavelength as 25.2 metres. The effect causing this observed increase in wavelength is called red-shift.

- (i) The waves emitted from most galaxies show red-shift.

What does red-shift tell scientists about the direction most galaxies are moving?

_____ (1)

- (ii) The size of the red-shift is **not** the same for all galaxies.

What information can scientists find out about a galaxy when they measure the size of the red-shift the galaxy produces?

(2)

- (iii) What does the observation of red-shift suggest is happening to the Universe?

(1)

(Total 9 marks)

Q8.

- (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
------------	--------	------------------	---------------	----------------	------------	-------------

Sunbed


Radio


TV remote control


Filament lamp


(3)

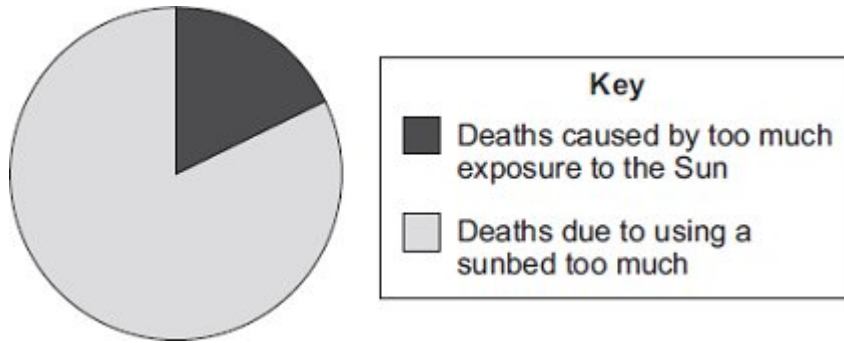
- (b) A headline from a recent newspaper article is shown below.



- (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)

Q9.

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.

Q10.

A doctor uses the radioactive isotope technetium-99 to find out if a patient's kidneys are working correctly.

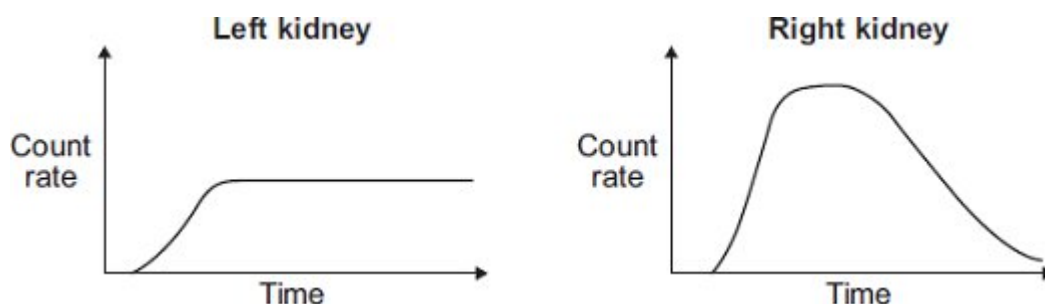


The doctor injects a small amount of technetium-99 into the patient's bloodstream. Technetium-99 emits gamma radiation.

If the patient's kidneys are working correctly, the technetium-99 will pass from the bloodstream into the kidneys and then into the patient's urine.

Detectors are used to measure the radiation emitted from the kidneys.

The level of radiation emitted from each kidney is recorded on a graph.



- (a) How do the graphs show that technetium-99 is passing from the bloodstream into each kidney?

(1)

- (b) By looking at the graphs, the doctor is able to tell if there is a problem with the patient's kidneys.

Which **one** of the following statements is correct?

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

Only the right kidney is working correctly.

☐

Only the left kidney is working correctly.

☐

Both kidneys are working correctly.

☐

Explain the reason for your answer.

(3)
(Total 4 marks)

Q11.

- (a) The wavelengths of four different types of electromagnetic wave, including visible light waves, are given in the table.

Type of wave	Wavelength
Visible light	0.0005 mm
A	1.1 km
B	100 mm
C	0.18 mm

Which of the waves, **A**, **B**, or **C**, is an infra red wave?

(1)

- (b) A TV station broadcasts at 500 000 kHz. The waves travel through the air at 300 000 000 m/s.

Calculate the wavelength of the waves broadcast by this station.

Show clearly how you work out your answer.

Wavelength = _____ m
(2)

- (c) What happens when a metal aerial absorbs radio waves?

(2)

- (d) Stars emit all types of electromagnetic waves. Telescopes that monitor X-rays are mounted on satellites in space.

Why would an X-ray telescope based on Earth **not** be able to detect X-rays emitted from distant stars?

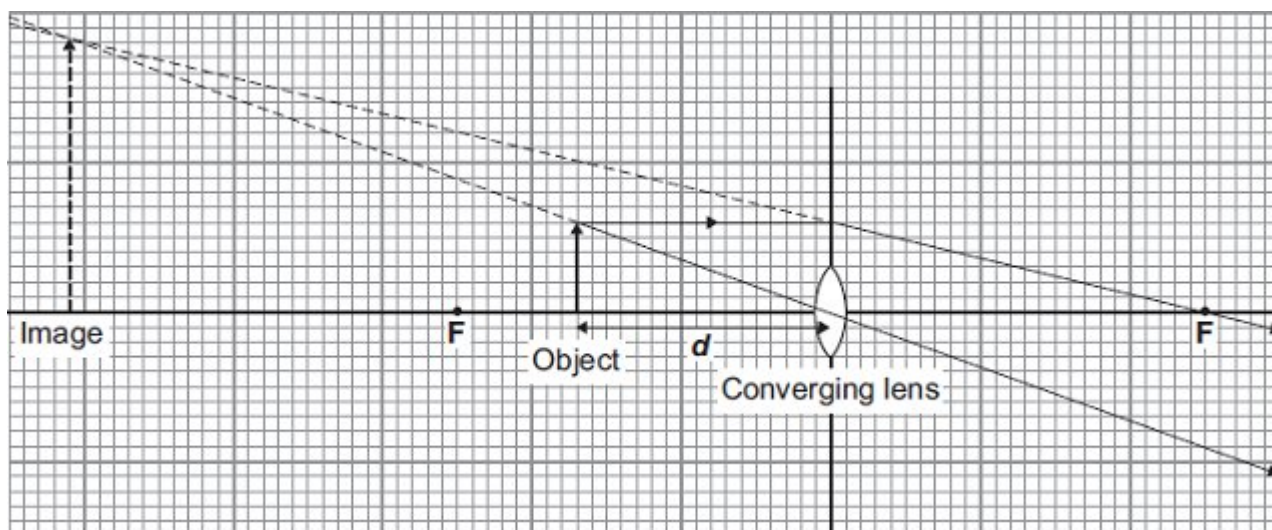
(1)

(Total 6 marks)

Q12.

A student investigates how the magnification of an object changes at different distances from a converging lens.

The diagram shows an object at distance d from a converging lens.



- (a) (i) The height of the object and the height of its image are drawn to scale.

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

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

Show clearly how you work out your answer.

Magnification = _____

(2)

- (ii) The points **F** are at equal distances on either side of the centre of the lens.

State the name of these points.

(1)

- (iii) Explain how you can tell, **from the diagram**, that the image is virtual.

(1)

- (b) The student now uses a different converging lens. He places the object between the lens and the point **F** on the left.

The table shows the set of results that he gets for the distance ***d*** and for the magnification produced.

Distance <i>d</i> measured in cm	Magnification
5	1.2
10	1.5
15	2.0
20	3.0
25	6.0

His friend looks at the table and observes that when the distance doubles from 10 cm to 20 cm, the magnification doubles from 1.5 to 3.0.

His friend's conclusion is that:

The magnification is directly proportional to the distance of the object from the lens.

His friend's observation is correct.

His friend's conclusion is wrong.

- (i) Explain using data from the table why his friend's conclusion is wrong.

(2)

- (ii) Write a correct conclusion.

(1)

- (iii) The maximum range of measurements for **d** is from the centre of the lens to **F** on the left.

The student **cannot** make a correct conclusion outside this range.

Explain why.

(1)

(Total 8 marks)

Q13.

- (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.

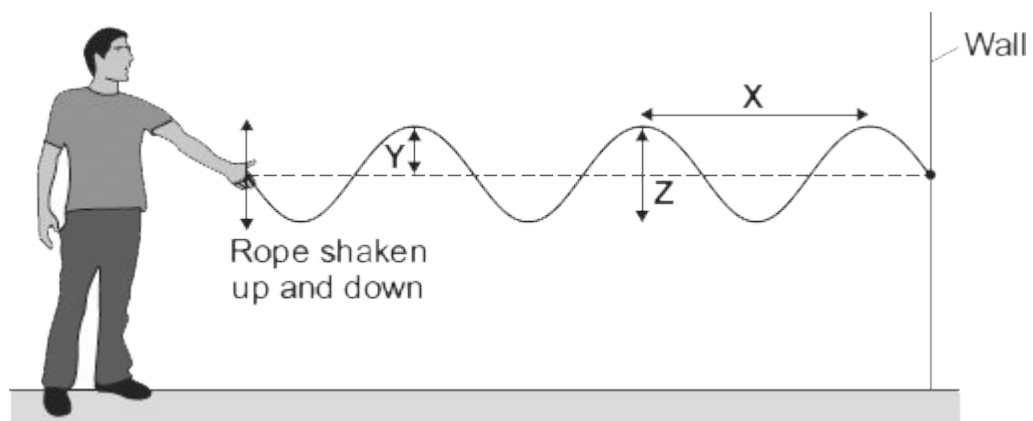
Microwaves travel through a vacuum at

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

(1)

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.

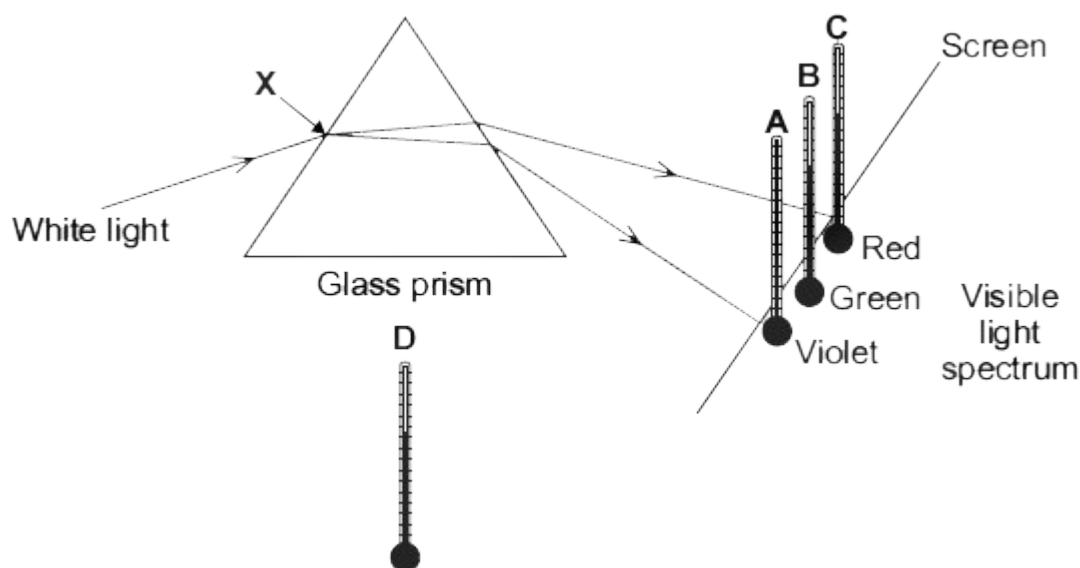
Wave speed = _____ m/s

(2)

(Total 10 marks)

Q14.

The diagram shows the apparatus that a student used to investigate the heating effect of different wavelengths of light.



- (a) (i) The student put thermometer **D** outside of the light spectrum.

Suggest why.

(1)

- (ii) The table gives the position and reading of each thermometer 10 minutes after the investigation started.

Thermometer	Position of thermometer	Temperature in °C
A	in violet light	21
B	in green light	22
C	in red light	24
D	outside the spectrum	20

What should the student conclude from the data in the table?

(2)

- (b) A similar investigation completed in 1800 by the scientist Sir William Herschel led to the discovery of infrared radiation.

Suggest how the student could show that the spectrum produced by the glass prism has an infrared region.

(2)

- (c) A person emits infrared radiation at a frequency of 3.2×10^{13} Hz.

Calculate the wavelength of the infrared radiation that a person emits.

Take the speed of infrared radiation to be 3.0×10^8 m/s.

Show clearly how you work out your answer.

Wavelength = _____ m

(2)

- (d) A thermal imaging camera detects infrared radiation. Electronic circuits inside the camera produce a visible image of the object emitting the infrared radiation.

At night, police officers use thermal imaging cameras to track criminals running away from crime scenes.

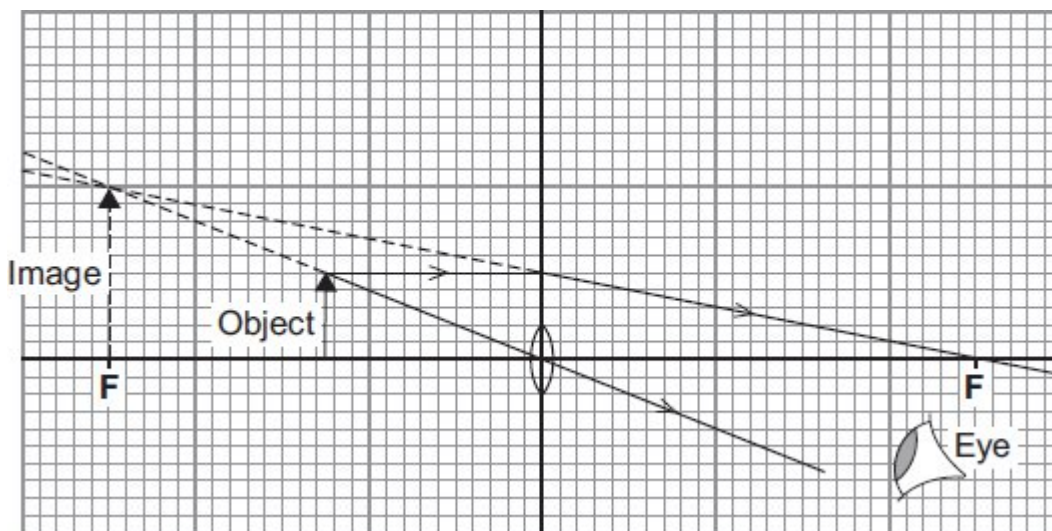
Thermal imaging cameras work better at night than during the day.

Explain why.

(2)
(Total 9 marks)

Q15.

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.

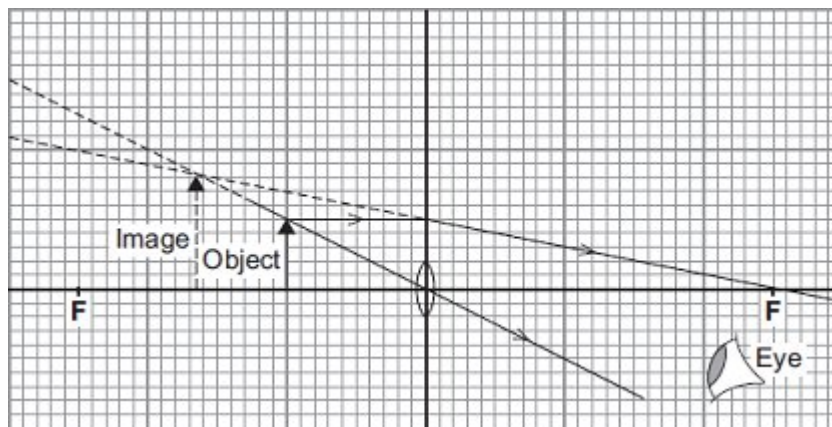
$$\text{magnification} = \frac{\text{image height}}{\text{object height}}$$

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

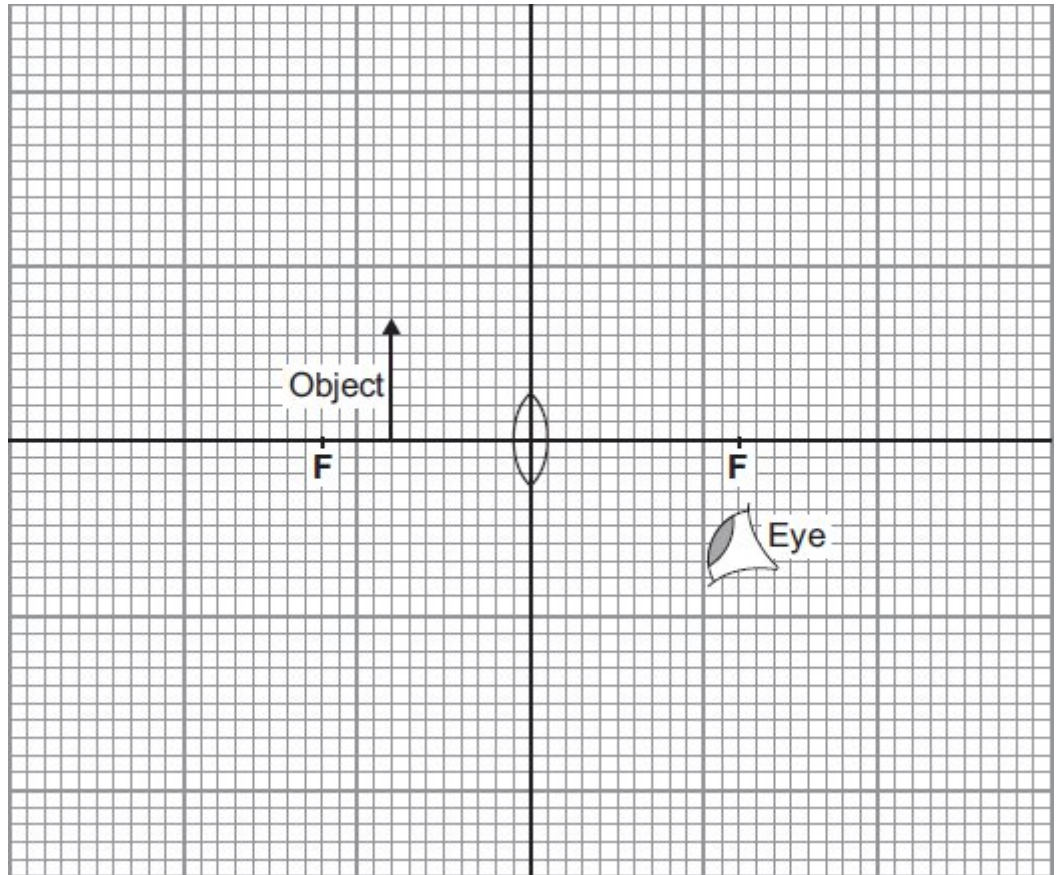
produced by the lens.

(1)

(Total 4 marks)

Q16.

- (a) The diagram shows a converging lens being used as a magnifying glass.
- (i) On the diagram, use a ruler to draw two rays from the top of the object which show how and where the image is formed. Represent the image by an arrow drawn at the correct position.



(3)

- (ii) 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)

- (b) A camera also uses a converging lens to form an image.

Describe how the image formed by the lens in a camera is different from the image formed by a lens used as a magnifying glass.

(2)

Q17.

Radio waves and microwaves are two types of electromagnetic wave.

Both waves:

- can be used for communications
- travel at the same speed through air.

(a) Give **two** more properties that are the same for both radio waves and microwaves.

1. _____

2. _____

(2)

(b) Some satellites are used to transmit television programmes. Signals are sent to, and transmitted from, the satellites using microwaves.

What is the property of microwaves that allows them to be used for satellite communications?

(1)

(c) Electromagnetic waves travel at a speed of 3.0×10^8 m/s.

A radio station transmits waves with a wavelength of 2.5×10^2 m.

Calculate the frequency of the radio waves.

Show clearly how you work out your answer and give the unit.

Frequency = _____

(3)

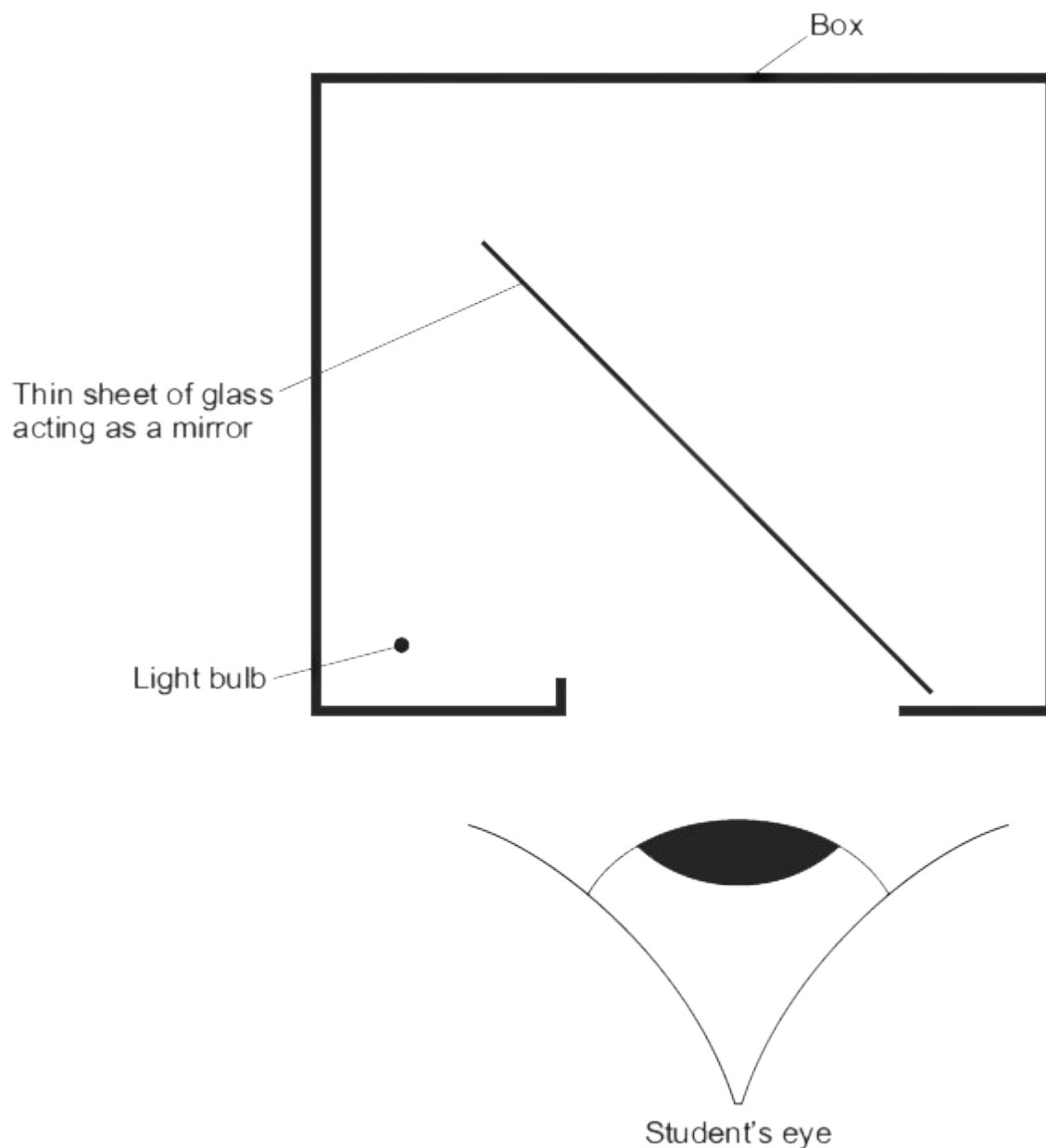
(Total 6 marks)

Q18.

The diagram shows a model used to demonstrate an illusion known as 'Pepper's Ghost'.

A small light bulb and thin sheet of glass are put inside a box. The thin sheet of glass acts as a mirror. Although the light bulb is switched on, a student looking into the box cannot see the bulb. What the student does see is a virtual image of the bulb.

View from above



- (a) Use a ruler to complete a ray diagram to show how the image of the light bulb is formed. Mark and label the position of the image.

(4)

- (b) The image seen by the student is virtual.

Why?

(1)

(Total 5 marks)

Q19.

Small sailing boats can be fitted with a passive radar device. The device increases the chance that the small boat will be seen on the radar screen of a large ship. The radar transmitter on the large ship emits microwaves.

- (a) Microwaves and radio waves are both part of the electromagnetic spectrum.

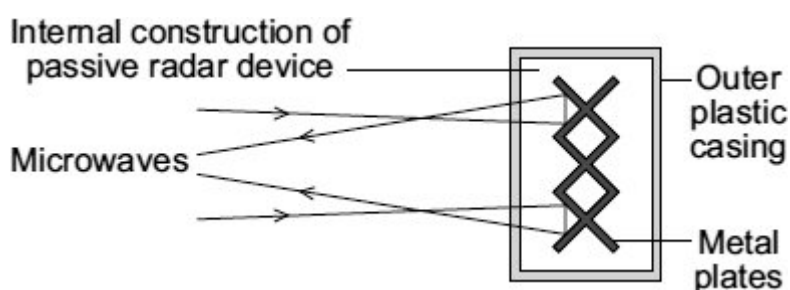
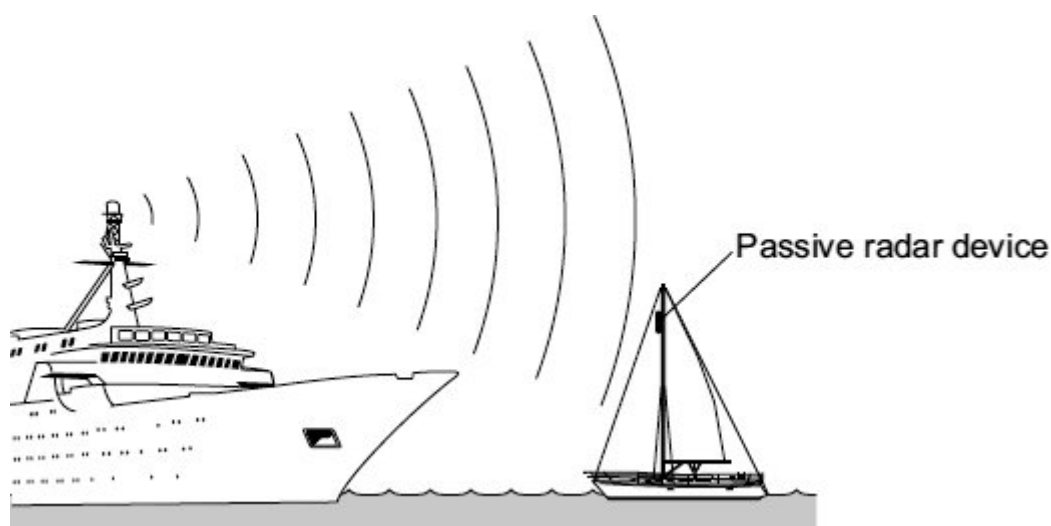
How are microwaves different from radio waves?

(1)

- (b) How fast do microwaves travel through the air or a vacuum compared to radio waves?

(1)

- (c) The diagrams show the position of a passive radar device on a small boat and the internal construction of one type of passive radar device.



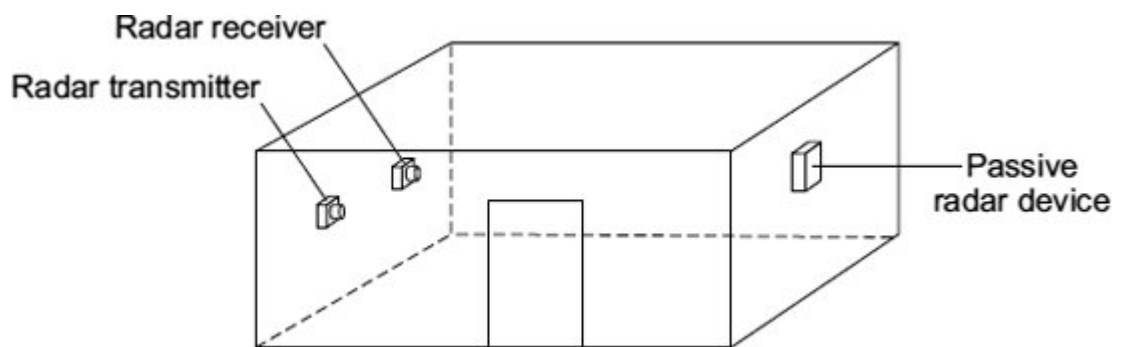
Microwaves can be absorbed, reflected or transmitted by different materials and types of surface.

Explain what happens to the microwaves from the ship's transmitter when they reach the passive radar device.

(2)

- (d) Each type of passive radar device has an RCS value. The larger the RCS value, the easier it is for a small boat fitted with the device to be detected.

An independent group of scientists measured the RCS values of 4 different types of device. The RCS value for each device was measured in the same room using the same equipment.



- (i) Why are the walls of the room covered in a material that absorbs the waves emitted by the radar transmitter?

(1)

- (ii) Why is it important to use the same room and the same equipment?

(1)

- (iii) Why is it important that the measurements are made by an independent group of scientists?

(1)

- (e) The movement of a small boat causes the mast and device to lean over, therefore the RCS values were measured at different angles.

The table gives the RCS values obtained by the scientists.

Device	Angle X
--------	---------



	0 °	5 °	10 °	15 °
A	1.4	1.6	1.7	1.8
B	4.7	2.6	2.3	1.9
C	9.3	3.3	1.9	1.1
D	4.5	4.8	5.0	4.6

- (i) Describe how the RCS values for **device A** are different to the RCS values for **device B**.

(2)

- (ii) The scientists recommended that a passive radar device fitted to a small boat should have:

- the largest possible RCS value
- an RCS value consistently above 2.0

Which **one** of the devices, **A**, **B**, **C** or **D**, would you recommend that someone fits to their boat?

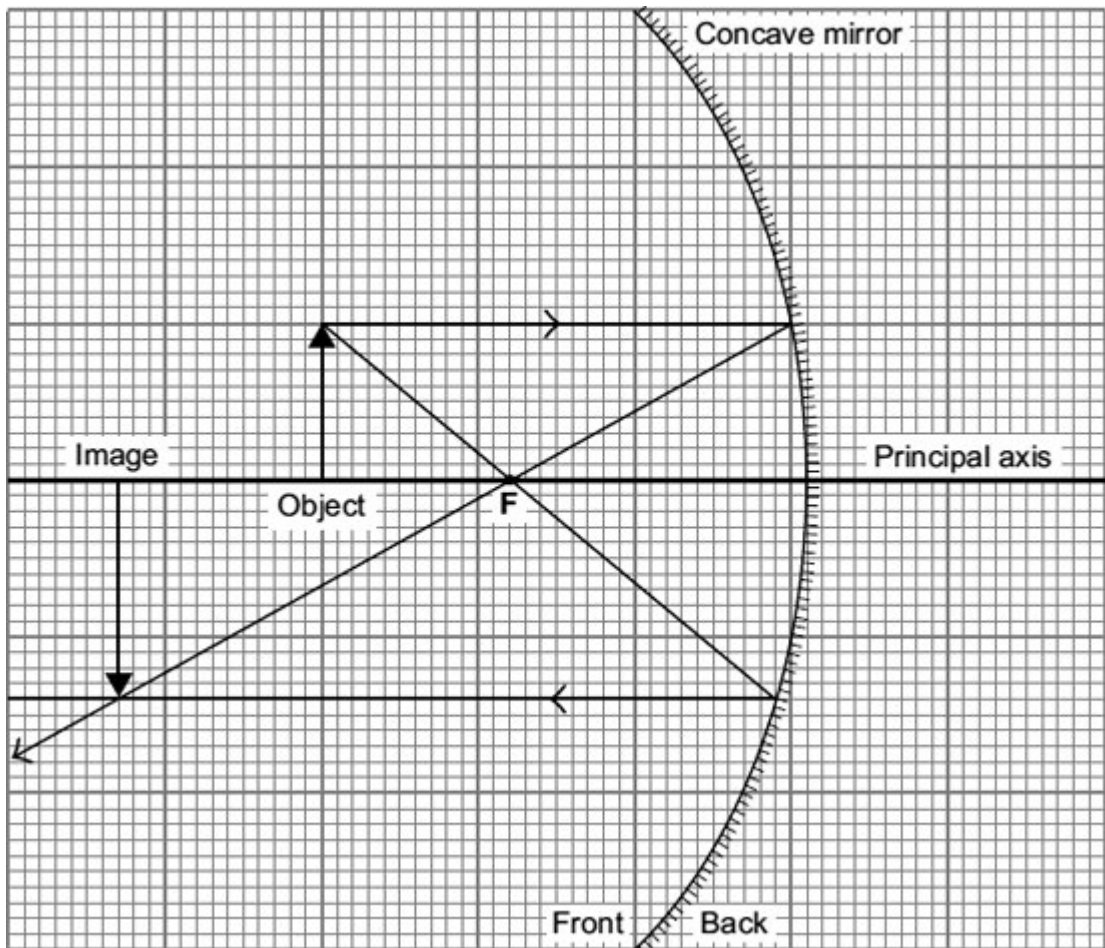
Give a reason for your answer.

(1)

(Total 10 marks)

Q20.

The ray diagram shows the image formed by a concave mirror.



Use the equation in the box to calculate the magnification.

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

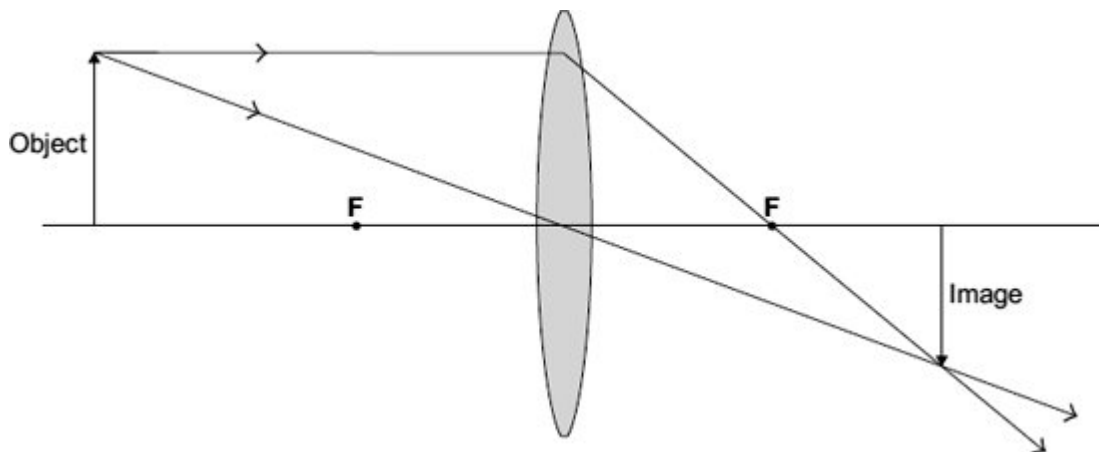
Show clearly how you work out your answer.

Magnification = _____

(Total 2 marks)

Q21.

The diagram shows a lens, the position of an object and the position of the image of the object.



- (a) What type of lens is shown?

_____ (1)

- (b) What is the name of the points, **F**, shown each side of the lens?

_____ (1)

- (c) (i) The image is real and can be put on a screen.

How can you tell **from the diagram** that the image is real?

 _____ (1)

- (ii) Draw a ring around a word in the box which describes the image produced by the lens.

inverted	larger	upright
----------	--------	---------

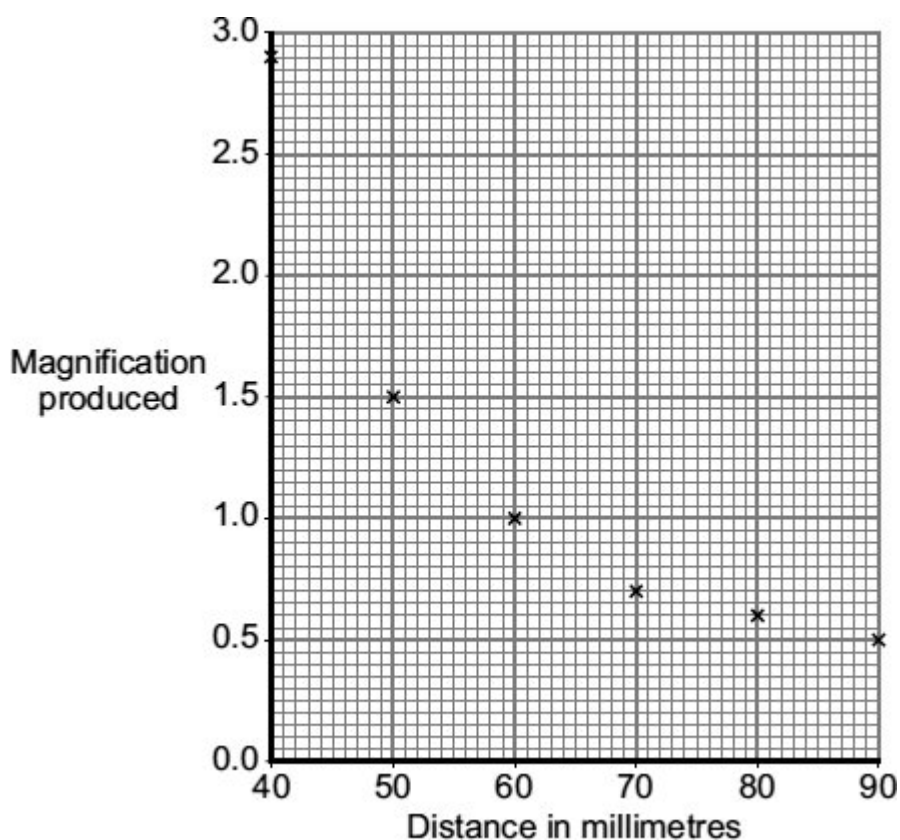
(1)

- (d) A student investigates the relationship between the distance from the object to the lens and the magnification produced by the lens.
 The student's results are given in the table.
 The student did not repeat any measurements.

Distance in millimetres	Height of object in millimetres	Height of image in millimetres	Magnification produced
40	20	58	2.9
50	20	30	1.5
60	20	20	1.0
70	20	14	0.7

80	20	12	0.6
90	20	10	0.5

The student plots the points for a graph of *magnification produced* against *distance*.



- (i) Draw a *line of best fit* for these points.

(1)

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

A line graph has been drawn because both variables are

described as being

categoric.
continuous.
discrete.

(1)

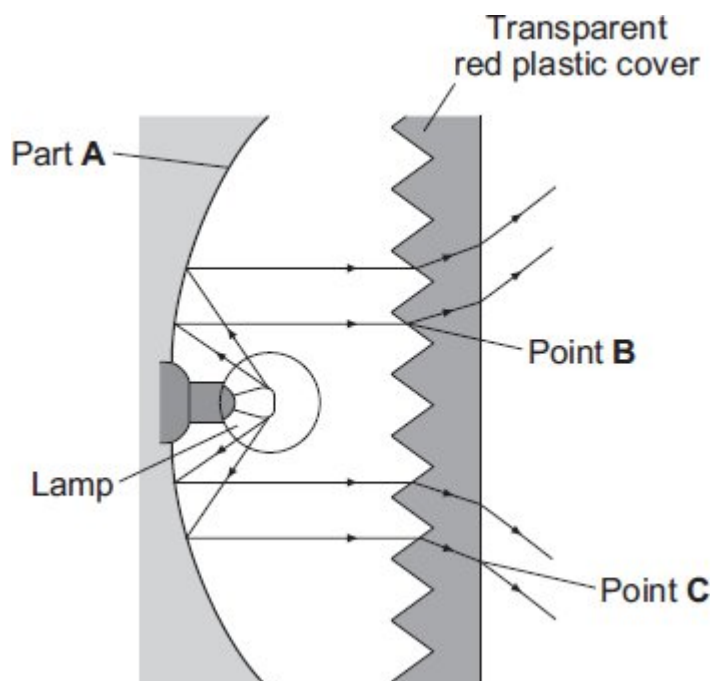
- (iii) Describe the relationship between *magnification produced* and *distance*.

(2)

Q22.

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**.

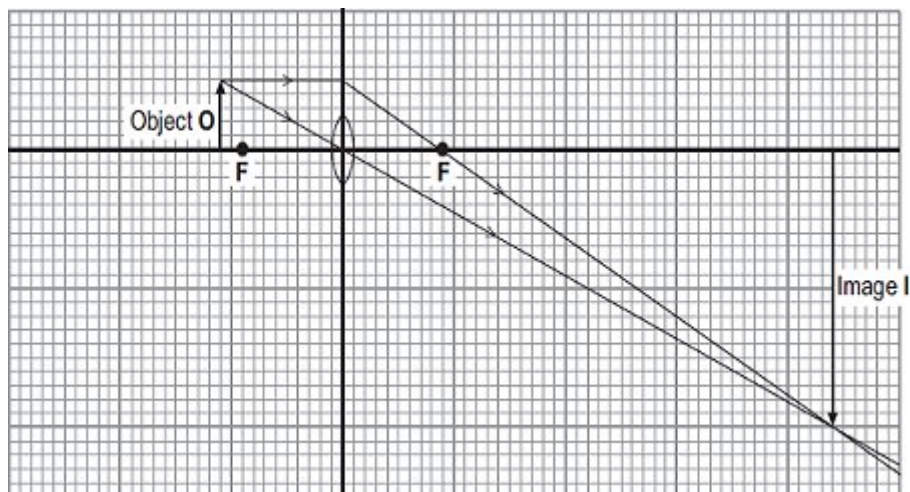
(1)

- (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 = _____

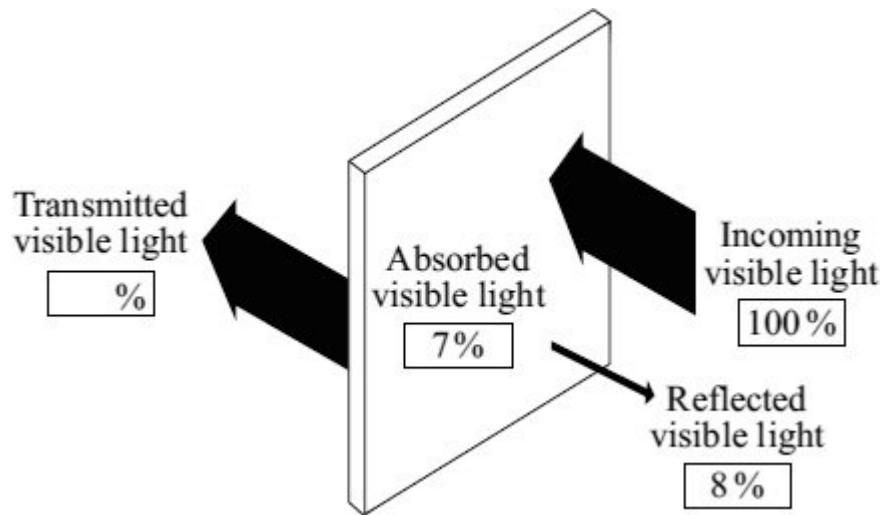
(2)

(Total 5 marks)

Q23.

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.

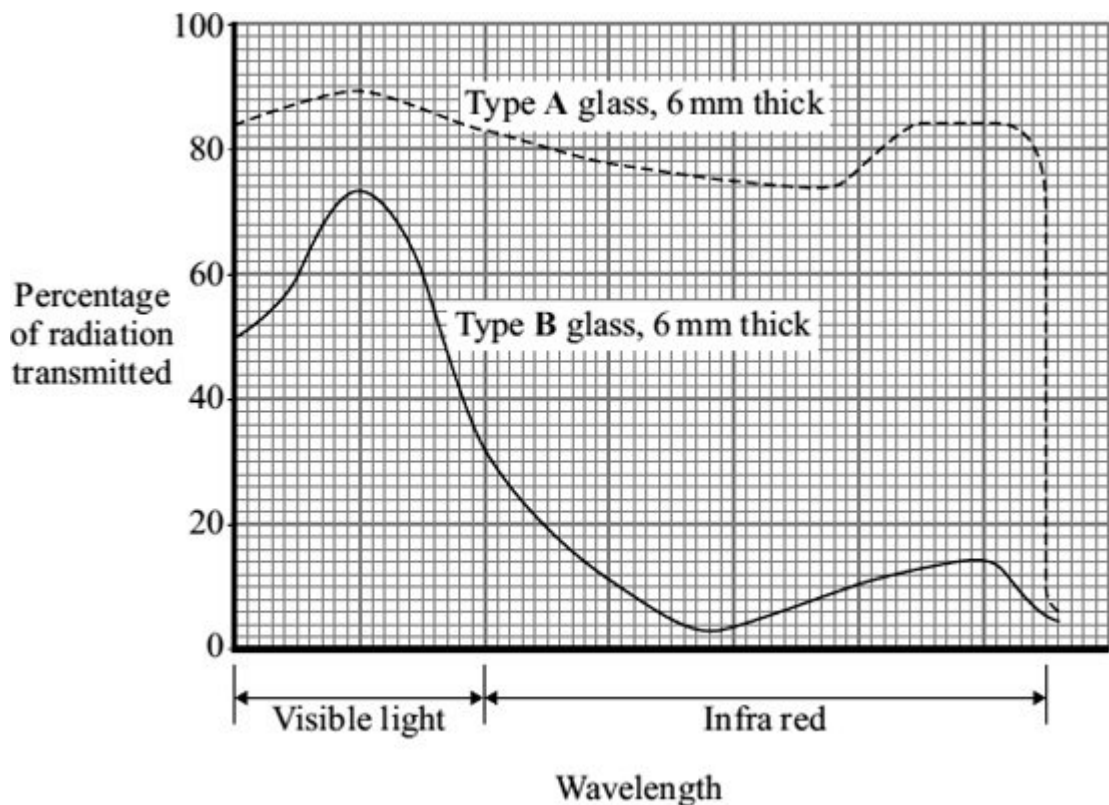


What percentage of visible light is transmitted by this type of glass?

_____ %

(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)

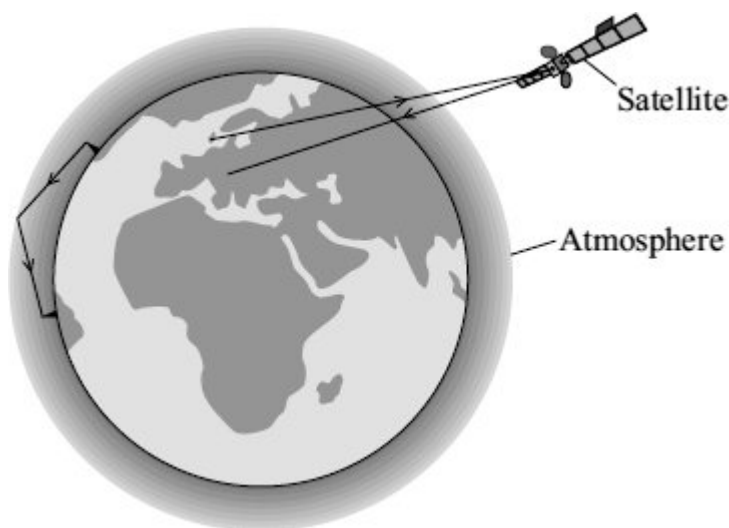
- (ii) A homeowner has a glass conservatory built on the back of the house. The homeowner tells the builder that the inside of the conservatory should stay as cool as possible throughout the summer.

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

(2)
(Total 4 marks)

Q24.

- (a) Electromagnetic waves have many uses. The diagram shows two ways of sending information using electromagnetic waves.



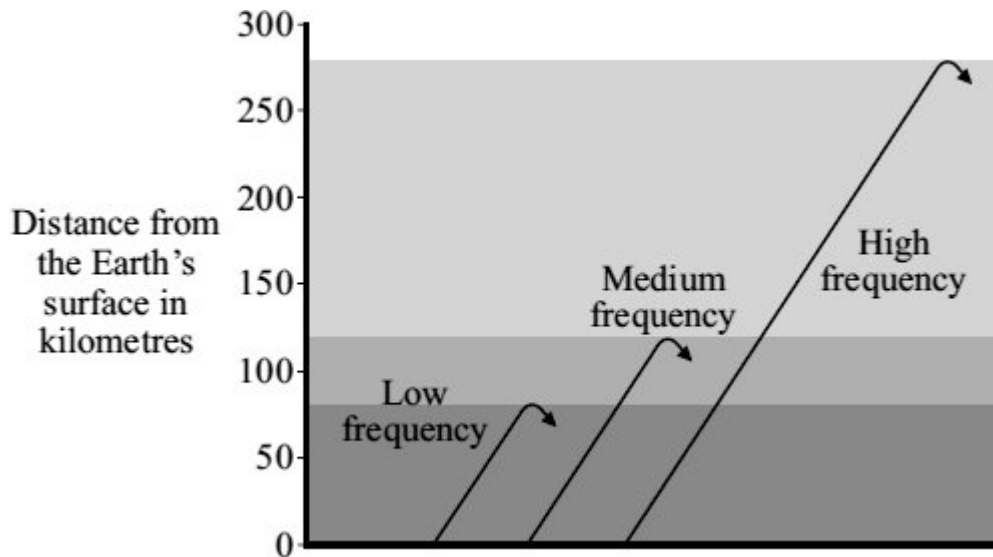
- (i) What type of wave is used to send information to and from satellites?

(1)

- (ii) What property of this type of wave makes it suitable for satellite communications?

(1)

- (b) Different frequency radio waves travel different distances through the atmosphere before being reflected.



Use the information in the diagram to describe the connection between the frequency of a radio wave and the distance the radio wave travels through the atmosphere before it is reflected.

(1)

- (c) Electromagnetic waves travel at a speed of 300 000 000 m/s.

A radio station transmits waves with a wavelength of 20 metres.

Calculate the frequency, in kilohertz (kHz), of these waves.

Show clearly how you work out your answer.

Frequency = _____ kHz

(2)

(Total 5 marks)

Q25.

- (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)

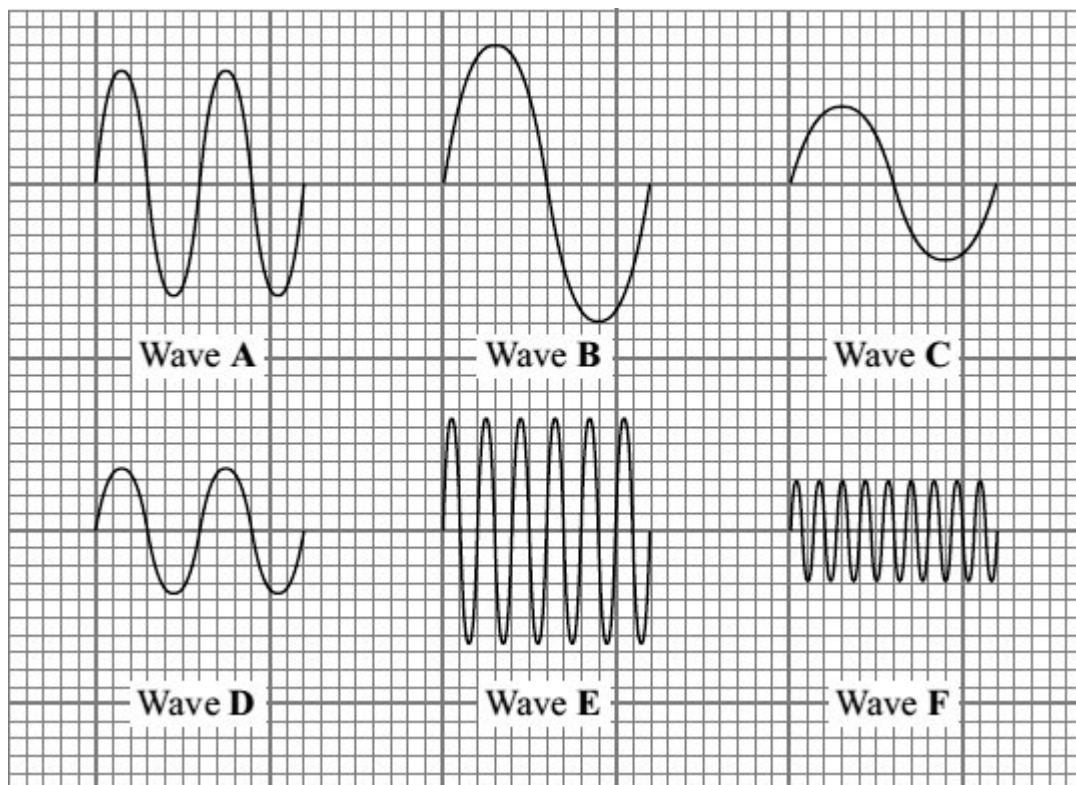
- (iii) Give **one** example of a frequency which an elephant can hear but which a tiger **cannot** hear.

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 _____

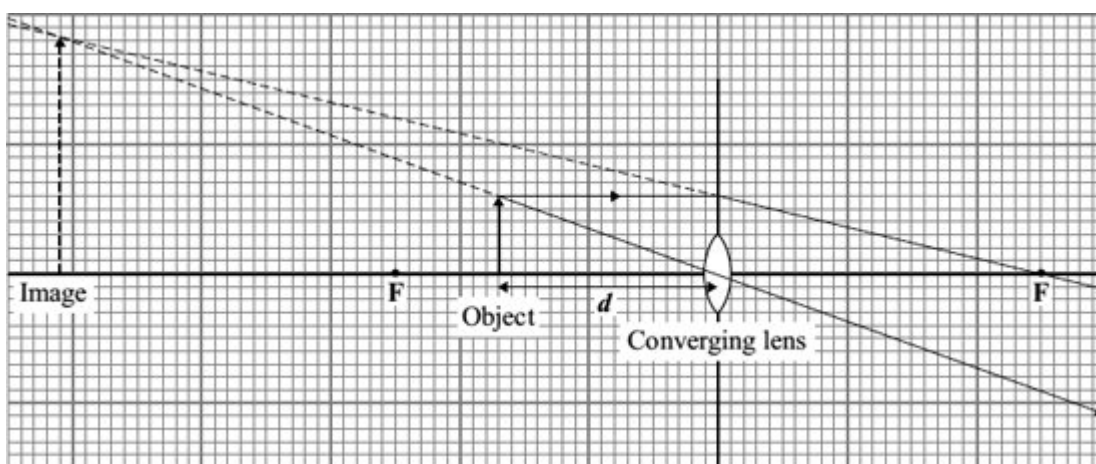
(1)

(Total 5 marks)

Q26.

A student investigates how the magnification of an object changes at different distances from a converging lens.

The diagram shows an object at distance d from a converging lens.



- (a) (i) The height of the object and the height of its image are drawn to scale.

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

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

Show clearly how you work out your answer.

Magnification = _____

(2)

- (ii) The points **F** are at equal distances on either side of the centre of the lens.

State the name of these points.

(1)

- (iii) Explain how you can tell, **from the diagram**, that the image is virtual.

(1)

- (b) The student now uses a different converging lens. He places the object between the lens and point **F** on the left.

The table shows the set of results that he gets for the distance ***d*** and for the magnification produced.

Distance <i>d</i> measured in cm	Magnification
5	1.2
10	1.5
15	2.0
20	3.0
25	6.0

His friend looks at the table and observes that when the distance doubles from 10 cm to 20 cm, the magnification doubles from 1.5 to 3.0.

His friend's conclusion is that:

The magnification is directly proportional to the distance of the object from the lens.

His friend's observation is correct but his friend's conclusion is **not** correct.

- (i) Explain, with an example, why his friend's conclusion is **not** correct.

(2)

- (ii) Write a correct conclusion.

(1)

- (iii) The maximum range of measurements for d is from the centre of the lens to **F** on the left.

The student **cannot** make a correct conclusion outside this range.

Explain why.

(1)

(Total 8 marks)

Q27.

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)

Q28.

- (a) Microwaves and visible light are two types of electromagnetic wave. Both can be used for communications.

- (i) Give **two** properties that are common to both visible light and microwaves.

1. _____

2. _____

(2)

- (ii) Name **two** more types of electromagnetic wave that can be used for communications.

_____ and _____

(1)

- (b) Wi-Fi is a system that joins computers to the internet without using wires. Microwaves, with a wavelength of 12.5 cm, are used to link a computer to a device called a router. Microwaves travel through the air at 300 000 000 m/s.

Calculate the frequency of the microwaves used to link the computer to the router.

Show clearly how you work out your answer and give the unit.

Frequency = _____

(3)

- (c) Wi-Fi is used widely in schools. However, not everyone thinks that this is a good idea.

A politician commented on the increasing use of WiFi. He said: 'I believe that these systems may be harmful to children.'

However, one group of scientists said that there is no reason why Wi-Fi should not be used in schools. These scientists also suggested that there is a need for further research.

- (i) Suggest what the politician could have done to persuade people that what he said was not just an opinion.

(1)

- (ii) Why did the group of scientists suggest that there is a need for further research?

(1)

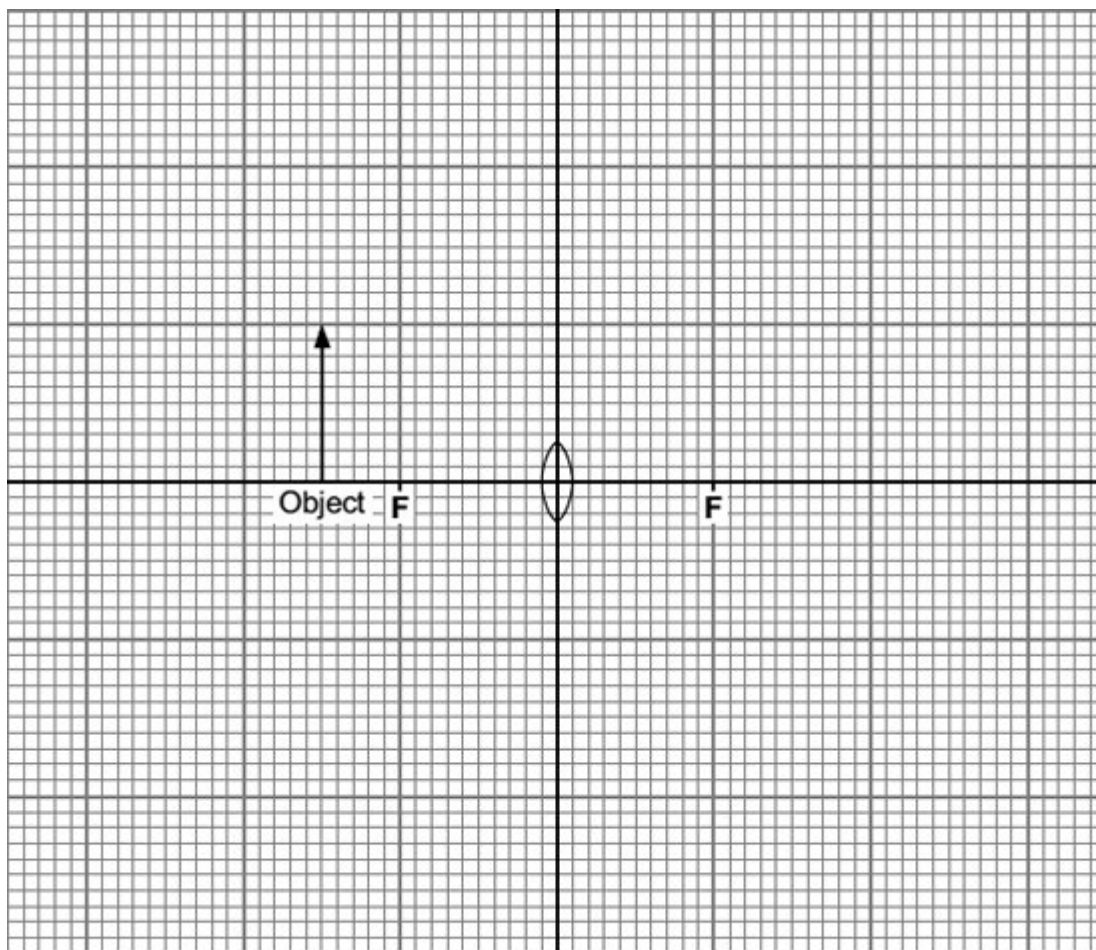
(Total 8 marks)

Q29.

A student investigated how the nature of the image depends on the position of the object in front of a large converging lens.

The diagram shows one position for the object.

- (a) Use a ruler to complete a ray diagram to show how the image of the object is formed.



Key: F = principal focus

(4)

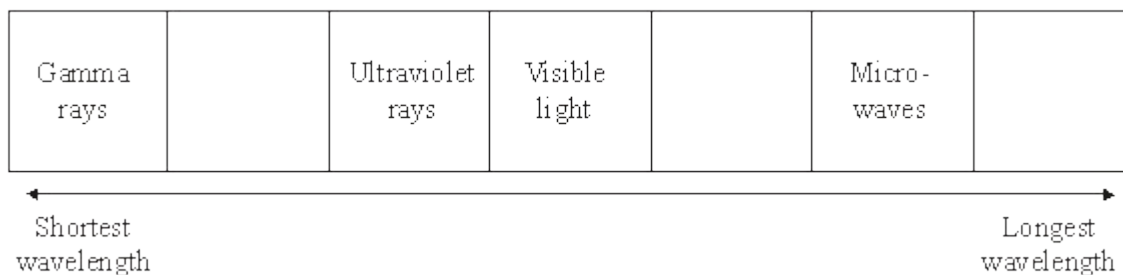
- (b) Describe the nature of this image relative to the object.

(2)

(Total 6 marks)

Q30.

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



- (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

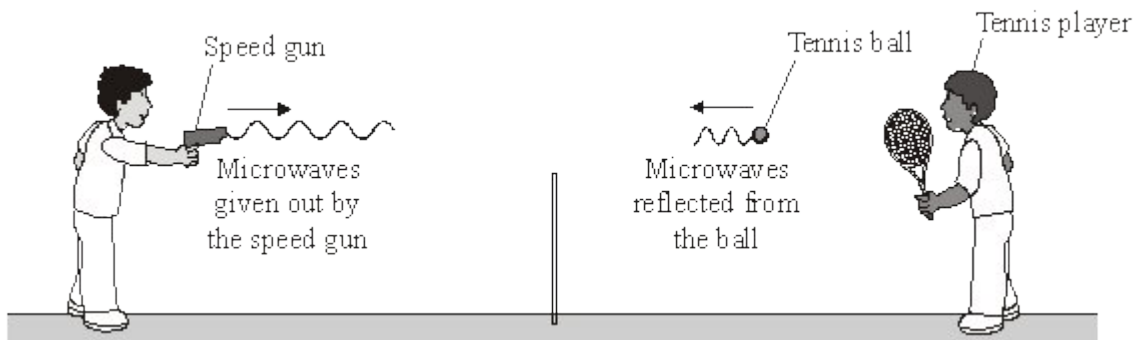
from one place to another.

(1)

(Total 4 marks)

Q31.

- (a) The picture shows a speed gun being used to measure how fast a tennis player hits the ball.



Some of the microwaves from the speed gun are absorbed by the ball and some are reflected by the ball.

- (i) Complete the following sentence by choosing **one** of the phrases from the box.

longer than	the same as	shorter than
--------------------	--------------------	---------------------

The wavelength of the microwaves reflected from the ball are

_____ the wavelength of the microwaves from the speed gun.

(1)

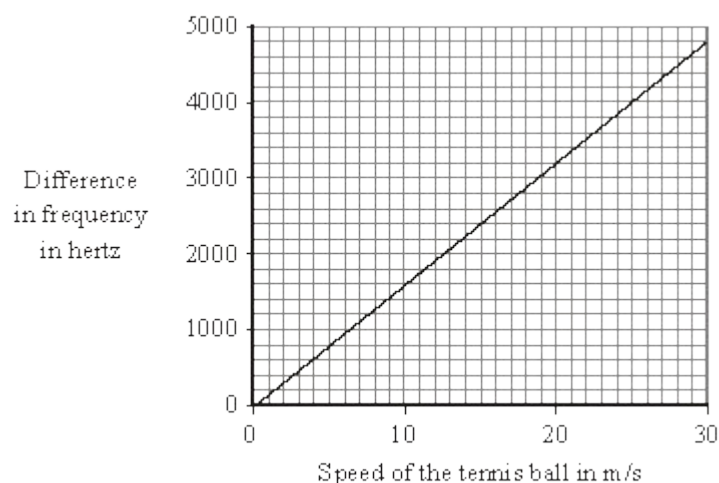
- (ii) Complete the following sentence by drawing a ring around the correct line in the box.

When the ball absorbs microwaves, its temperature will

decrease slightly
not change
increase slightly

(1)

- (b) The microwaves reflected from the ball have a higher frequency than the microwaves from the speed gun.
The graph shows how the difference between the two frequencies depends on the speed of the ball.



- (i) Describe the pattern that links the difference between the two frequencies and the speed of the ball.

(1)

- (ii) The speed gun measures the difference between the two frequencies as 3200 Hz.

Use the graph to find the speed of the tennis ball.

Show clearly on the graph how you obtain your answer.

Speed of the tennis ball = _____ m/s

(2)

- (iii) Which **one** of the following gives the reason why the data has been shown as a line graph and **not** as a bar chart?

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

Frequency and speed are both categoric variables.

☐

Frequency and speed are both continuous variables.

☐

Speed is a continuous variable and frequency is a categoric variable.

☐

(1)

(Total 6 marks)

Q32.

- (a) Microwaves are one type of electromagnetic wave.

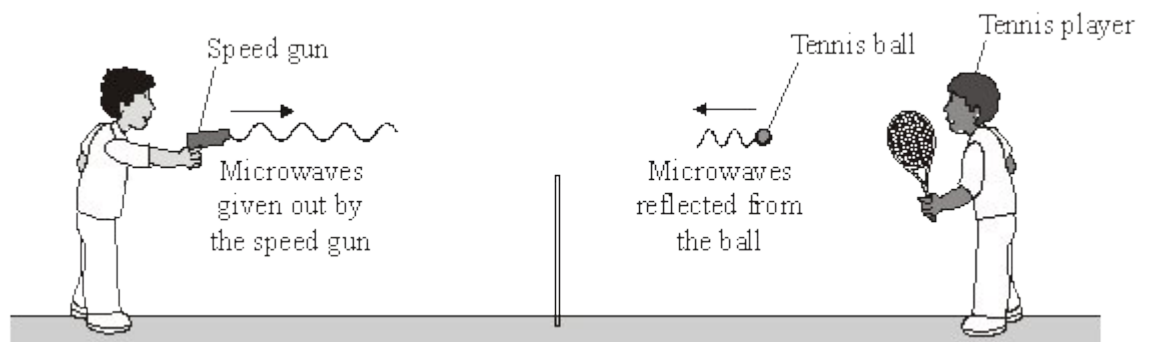
- (i) Which type of electromagnetic wave has a lower frequency than microwaves?

(1)

- (ii) What do all types of electromagnetic wave transfer from one place to another?

(1)

- (b) The picture shows a tennis coach using a speed gun to measure how fast the player serves the ball.



- (i) The microwaves transmitted by the speed gun have a frequency of 24 000 000 000 Hz and travel through the air at 300 000 000 m/s.

Calculate the wavelength of the microwaves emitted from the speed gun.

Show clearly how you work out your answer.

Wavelength = _____ m

(2)

- (ii) Some of the microwaves transmitted by the speed gun are absorbed by the ball.

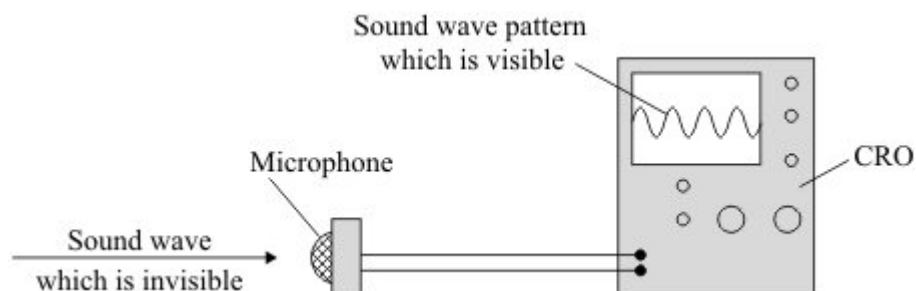
What effect will the absorbed microwaves have on the ball?

(1)

(Total 5 marks)

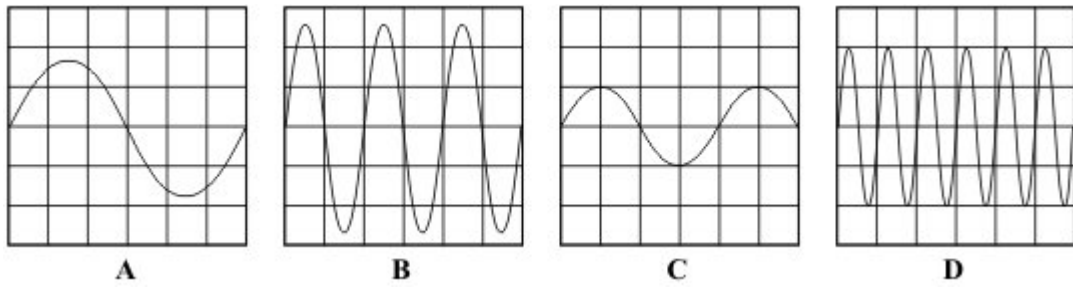
Q33.

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.

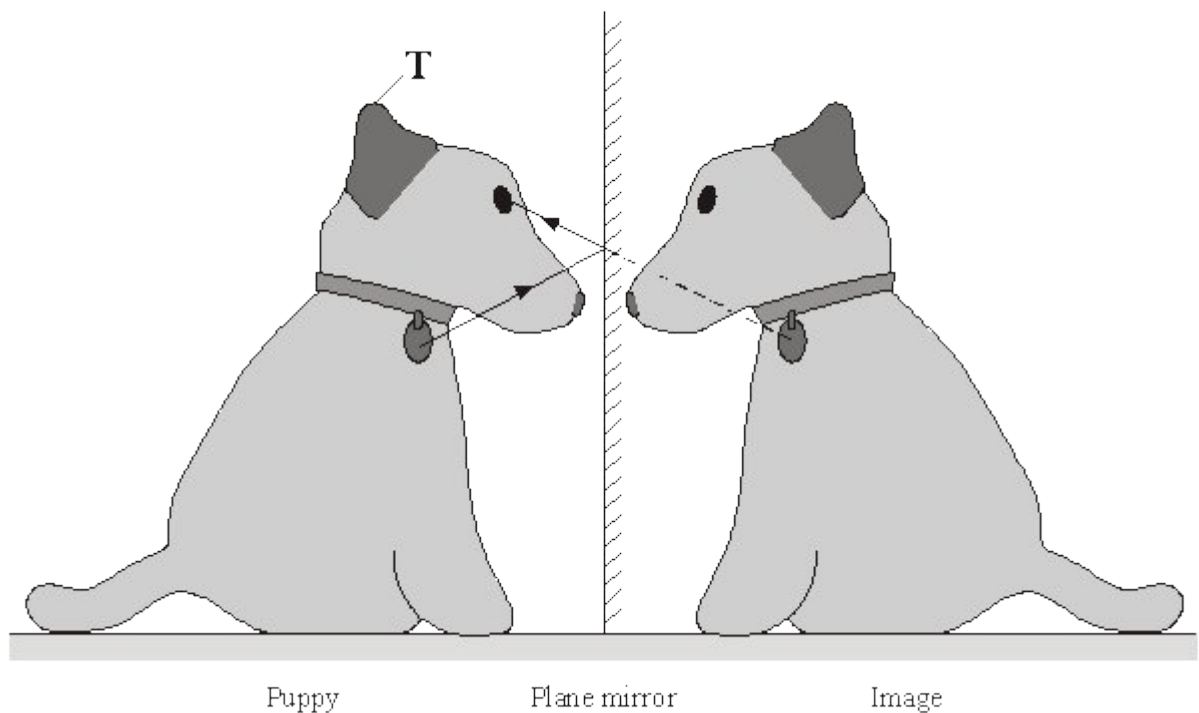


- (a) Which **one** of the patterns has the smallest amplitude? _____
- (b) Which **one** of the patterns has the lowest frequency? _____

(Total 2 marks)

Q34.

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)

Q35.

- (a) Some scientists think that there is a link between using a mobile phone and some types of illness. Other scientists disagree. They say that the evidence is limited and unreliable.

- (i) Suggest what scientists could do to show a link between using a mobile phone and illness.

(1)

- (ii) How could scientists improve the reliability of the evidence?

(1)

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

There has been little or no experimental research into the health of children who use mobile phones.

This is partly because of the

economic
environmental
ethical

issues involved in using

children in scientific research.

(1)

- (b) Before being sold, new mobile phones must be tested and given a SAR value. The SAR value is a measure of the energy absorbed by the head while a mobile phone is being used.

The table gives the SAR value for three mobile phones made by different companies.

To be sold in the UK, a mobile phone must have a SAR value lower than 2.0 W/kg.

Mobile phone	SAR value in W/kg
J	0.18
K	0.86
L	1.40

- (i) All companies use the same test to measure a SAR value.

Why is using the same test important?

(1)

- (ii) Would the companies that make the mobile phones, **J**, **K** and **L**, be correct to claim that these three phones are totally safe to use?

Answer yes or no. _____

Give a reason for your answer.

(1)

- (c) Devices designed to protect a mobile phone user from microwave radiation are now available.

Why is it important that these devices are tested by scientists who are **not** working for the company that makes the devices?

(1)

(Total 6 marks)

Mark schemes

Q1.

(a) C

1

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

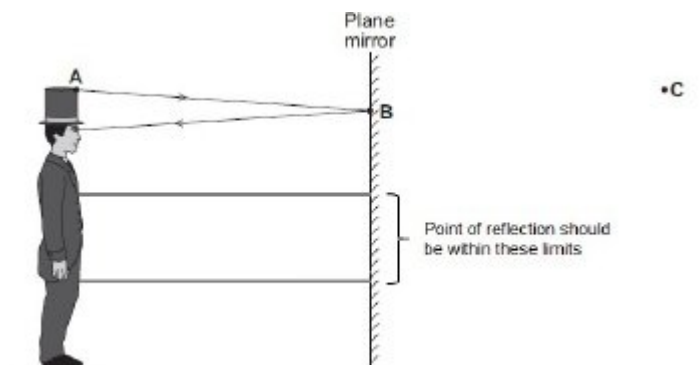
1

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]

Q2.

(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]

Q3.

(a) (i) perpendicular
accept correct description 1

1

- (ii) light off – no / slow rotation 1
- light on – fast(er) rotation
accept starts rotating
ignore references to energy transfers 1
- (b) one ray drawn from wrist watch and reflected by mirror
accept solid or dashed lines 1
- two rays drawn from wrist watch and reflected by mirror with $i = r$ for both rays
judge angles by eye 1
- one ray traced back behind mirror
accept solid or dashed lines 1
- image in correct position
judged by eye
accept image marked where two reflected rays traced back cross behind the mirror 1
- (c) cannot be formed on a screen
accept image formed behind the mirror
- or**
- rays of light seem to come from it but do not pass through it 1
- [8]**

Q4.

- (a) 10^{-15} metres to 10^4 metres 1
- (b) (i) any **one** from:
- (TV / video / DVD) remote controls
mobile phones is insufficient
 - (short range) data transmission
accept specific example, eg linking computer peripherals
 - optical fibre (signals)
*do **not** accept Bluetooth*
- 1
- (ii) 0.17
an answer 17 cm gains 3 marks
an answer given to more than 2 significant figures that rounds to

0.17 gains 2 marks

allow 1 mark for correct substitution, ie $3 \times 10^8 = 1.8 \times 10^9 \times \lambda$

3

- (c) (maybe) other factors involved

*accept a named 'sensible' factor, eg higher stress /
sedentary lifestyle / overweight / smoking more / diet / hot
office / age*

not testing enough people is insufficient

unreliable data is insufficient

1

[6]

Q5.

- (a) 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 to the information in the [Marking guidance](#), and apply a 'best-fit' approach to the marking.

0 marks

No relevant / correct content.

Level 1 (1-2 marks)

There is a basic description of either wave

OR

What happens to either wave when they enter the body. However there is little other detail.

Level 2 (3-4 marks)

There is either:

A clear description of BOTH waves

OR

A clear description as to what happens to BOTH waves inside the body

OR

A clear description of ONE of the waves with clear detail as to what happens to either wave inside the body.

Level 3 (5-6 marks)

There is a detailed description of BOTH of the waves

AND

A detailed description as to what happens to EITHER wave inside the body.

Examples of the points made in the response:

Description of an X-ray

- X-rays are electromagnetic waves / part of the electromagnetic spectrum
*do **not** allow a description of a property – eg X-rays travel*
- X-rays are (very) high frequency (waves)
through a vacuum / at the speed of light
- X-rays are (very) high energy (waves)

- X-rays have a (very) short wavelength
- Wavelength (of X-rays) is of a similar size to (the diameter of) an atom
- X-rays are a transverse wave
correct description acceptable – oscillations / vibrations are perpendicular (at 90°) to direction of energy transfer
- X-rays are ionising radiation

Description of ultrasound

- ultrasound has a frequency above 20 000 (hertz)
or
ultra sound is above 20 000 hertz
- ultrasound is above / beyond the human (upper) limit (of hearing)
accept ultrasound cannot be heard by humans
- ultrasound is a longitudinal wave
correct description acceptable – oscillations / vibrations (of particles) are parallel (in same direction) to direction of energy transfer

Statement(s) as to what happens to X-rays inside the human body:

- X-rays are absorbed by bone
- X-rays travel through / are transmitted by tissue / skin

Statement as to what happens to ultrasound inside body:

- ultrasound is (partially) reflected at / when it meets a boundary between two different media
- travel at different speeds through different media

6

- (b) (because the X-rays) are ionising
accept a description of what ionising is

1

(they will) damage cells

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

or

mutate cells / cause mutations / increase chances of mutations

or

turn cells cancerous / produce abnormal growths / produce rapidly growing cells

*do **not** accept they can be dangerous (to human health)*

do **not** accept damage to soft tissue

or

kill cells

1

(c) any **one** from:

- removal / destruction of kidney / gall stones
- repair of damaged tissue / muscle
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
- removing plaque from teeth
cleaning teeth is insufficient

1

[9]

Q6.

(a) any **two** correct construction lines:

if more than 2 construction lines treat as a list

2

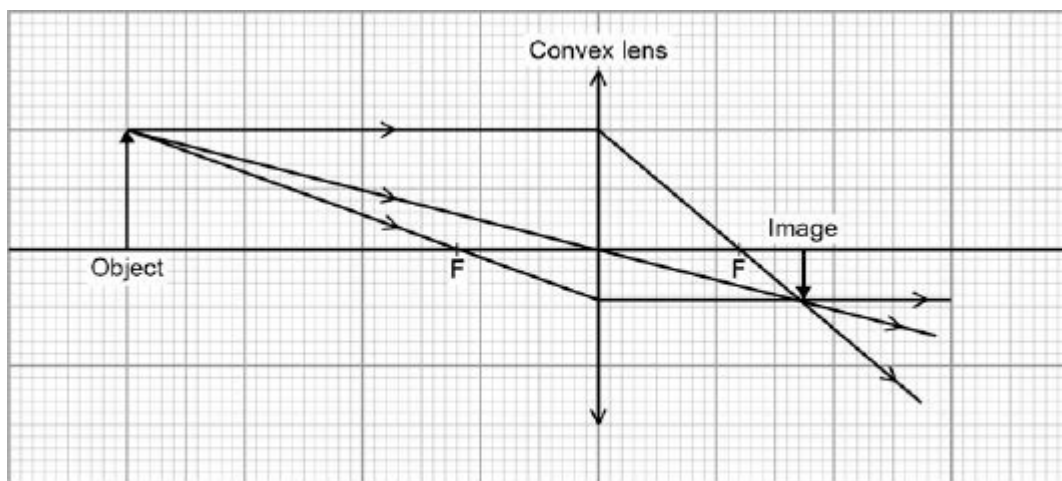
- line passing straight through centre of lens (& out other side)
- line travelling parallel to principal axis & then being refracted through principal focus (on RHS)
- line travelling through principal focus (on LHS) & then being refracted to be parallel to principal axis (on RHS)

inverted image drawn (with arrow) in correct location

1

one arrowhead from object to image on any construction ray

conflicting arrowheads negate this mark



F = Principal focus

1

(b) any **two** from:

- inverted
accept upside down
- real
- diminished / smaller
*allow ecf if ray diagram wrongly drawn but descriptions must relate to **their image***
a converse negates mark, eg real and virtual scores zero

2

[6]

Q7.

(a) (i) gamma

accept correct symbol

1

(ii) any **one** from:

- (ultraviolet has a) higher frequency
ultraviolet cannot be seen is insufficient
- (ultraviolet has a) greater energy
- (ultraviolet has a) shorter wavelength
ignore ultraviolet causes cancer etc

1

(b) $1.2 \times 10^7 / 12\,000\,000$

allow 1 mark for correct substitution, ie $3 \times 10^8 = f \times 25$

2

hertz / Hz / kHz / MHz

*do **not** accept hz or HZ*

answers 12 000 kHz or 12 MHz gain 3 marks

for full credit the numerical answer and unit must be consistent

1

- (c) (i) away (from each other)
accept away (from the Earth)
accept receding

1

- (ii) distance (from the Earth)
accept how far away (it is)

1

speed galaxy is moving

1

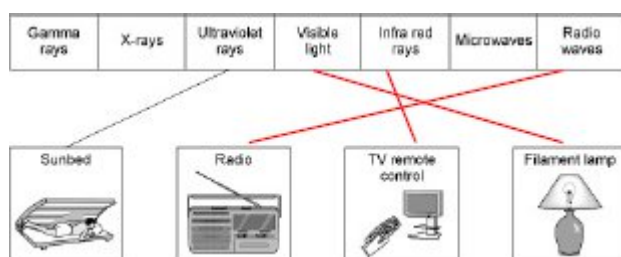
- (iii) (Universe is) expanding

1

[9]

Q8.

- (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]

Q9.

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]

Q10.

(a) (both graphs show an initial) increase in count rate

accept both show an increase

1

(b) only the right kidney is working correctly

1

any **two** from:

if incorrect box chosen maximum of 1 mark can be awarded

reference to named kidney can be inferred from the tick box

- count-rate / level / line for right kidney decreases (rapidly)
it decreases is insufficient
- count-rate / level / line for left kidney does not change
it does not change is insufficient
- radiation is being passed out into urine – if referring to right kidney
- radiation is not being passed out – if referring to the left kidney
- left kidney does not initially absorb as much technetium-99

2

[4]

Q11.

(a) C or 0.18 mm

1

(b) 0.6 (m)

*allow 1 mark for correct substitution and/or transformation or
1 mark for changing frequency to Hz
answer 600 gains 1 mark*

2

- (c) creates an alternating current
*accept 'ac' for alternating current
accept alternating voltage*

1

with the same frequency as the radio wave
*accept signal for radio wave
accept it gets hotter for 1 mark provided no other marks
scored*

1

- (d) X-rays cannot penetrate the atmosphere
*accept atmosphere stops X-rays
do **not** accept atmosphere in the way*

or

X-rays are absorbed (by the atmosphere) before reaching Earth
ignore explanations

1

[6]

Q12.

- (a) (i) answer in the range $3.0 \leftrightarrow 3.1$ inclusive
*accept for 1 mark
 $3.6 \div 1.2$ or $3.7 \div 1.2$
or $36 \div 12$ or $37 \div 12$
or $18 \div 6$ or $18.5 \div 6$
or $10.2 \div 3.4$ or $102 \div 34$
or answer in the range but with a unit eg 3 cm*

2

- (ii) (principal) focus / focal (point(s)) / foci / focus
*accept 'focusses'
accept focals
do **not** accept focal length*

1

- (iii) at the intersection of virtual / imaginary rays
***or** 'where virtual / imaginary rays cross'
or the rays of (real) light do not cross
or the image on the same side (of the lens) as the object
or the image is drawn as a dotted line
or the image is upright
do **not** accept 'cannot be put on a screen'
do **not** accept any response which refers to reflected rays*

1

- (b) (i) another correct observation about relationship between values of **d**
example
15 is three times bigger than 5 but 1
- (but) not the relationship between corresponding values for magnification
2.0 is not three times bigger than 1.2 1
- (ii) when the distance / **d** increases the magnification increases
or the converse
accept 'there is a positive correlation'
*do **not** accept any response in terms of proportion / inverse proportion* 1
- (iii) (student has) no evidence (outside this range)
accept data / results / facts for 'evidence' 1
- [8]**

Q13.

- (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]

Q14.

- (a) (i) to check rise in temperature (of other thermometers) was due to the (different wavelengths of) light
- accept as a control / comparison*
- to measure room temperature is insufficient*
- 1
- (ii) any **two** from three:
- different colours produce different heating effects / (rises in) temperatures
 - red light produces the greatest heating effect / (rise in) temperature
- or**
- violet produces the least heating effect / (rise in) temperature
 - all colours produce a greater heating effect than outside the spectrum
- an answer*
- the longer the wavelength the greater the (rise in) temperature*
- or**
- the lower the frequency the greater the (rise in) temperature*
- gains both marks*
- 2
- (b) move a thermometer into the infrared region / just beyond the red light
- allow use an infrared camera / infrared sensor*
- 1
- the temperature increases beyond 24(°C)
- accept temperature higher than for the red light*
- 1
- (c) $v = f \times \lambda$
- 9.4×10^{-6}
- accept 9.375×10^{-6} or 9.38×10^{-6}*

or

0.0000094

accept 0.000009375

or 0.00000938

allow 1 mark for correct substitution

ie $3 \times 10^8 = 3.2 \times 10^{13 \times \lambda}$

2

- (d) at night the surroundings are cooler

accept at night the air is colder

there is no heat from the Sun is insufficient

or

at night there is a greater temperature difference between people and surroundings

1

(so surroundings) emit less infrared (than in daytime)

accept camera detects a greater contrast

or

gives larger difference in infrared emitted (between people and surroundings)

1

[9]

Q15.

- (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

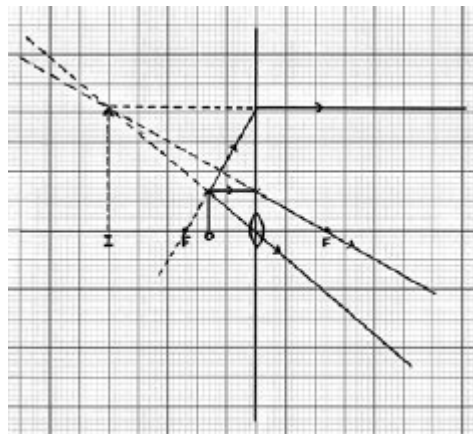
[4]

Q16.

- (a) (i) **two** correct rays drawn

1 mark for each correct ray

- ray parallel to axis from top of object **and** refracted through focus **and** traced back beyond object
- ray through centre of lens **and** traced back beyond object
- ray joining top of object to focus on left of lens taken to the lens refracted parallel to axis **and** traced back parallel to axis beyond object



2

an arrow showing the position **and** correct orientation of the image for their rays

*to gain this mark, the arrow must go from the intersection of the traced-back rays to the axis **and** the image must be on the same side of the lens as the object and above the axis*

1

(ii) (x) 3.0

accept 3.0 to 3.5 inclusive

or

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

correctly calculated

allow 1 mark for correct substitution into equation using their figures

ignore any units

2

(b) any **two** from:

in a camera the image is:

- real not virtual
- inverted and not upright
accept upside down for inverted

- diminished and not magnified
accept smaller and bigger
accept converse answers but it must be clear the direction of the comparison
both parts of each marking point are required

2

[7]

Q17.

(a) any **two** from:

- travel (at same speed) through a vacuum / space
*do **not** accept air for vacuum*
- transverse
- transfer energy
- can be reflected
- can be refracted
- can be diffracted
- can be absorbed
- travel in straight lines

2

- (b) can pass through the ionosphere
accept atmosphere for ionosphere
*do **not** accept air for ionosphere*
accept travel in straight lines
accept not refracted / reflected / absorbed by the ionosphere

1

- (c) $v = f \lambda$

$$1.2 \times 10^6 / 1200\ 000$$

*allow **1** mark for correct substitution*
ie $3.0 \times 10^8 = f \times 2.5 \times 10^2$

2

hertz / Hz

*do **not** accept hz **or** HZ*
*accept kHz **or** MHz*
*answers 1.2 MHz **or** 1200 kHz gain all **3** marks*
for full credit the unit and numerical value must be consistent

1

[6]

Q18.

- (a) two rays drawn from the bulb and reflected by the glass
*angle **I** = angle **R** judged by eye*
*allow **1** mark for one incident and reflected ray even if angle **I** doesn't equal angle **R***

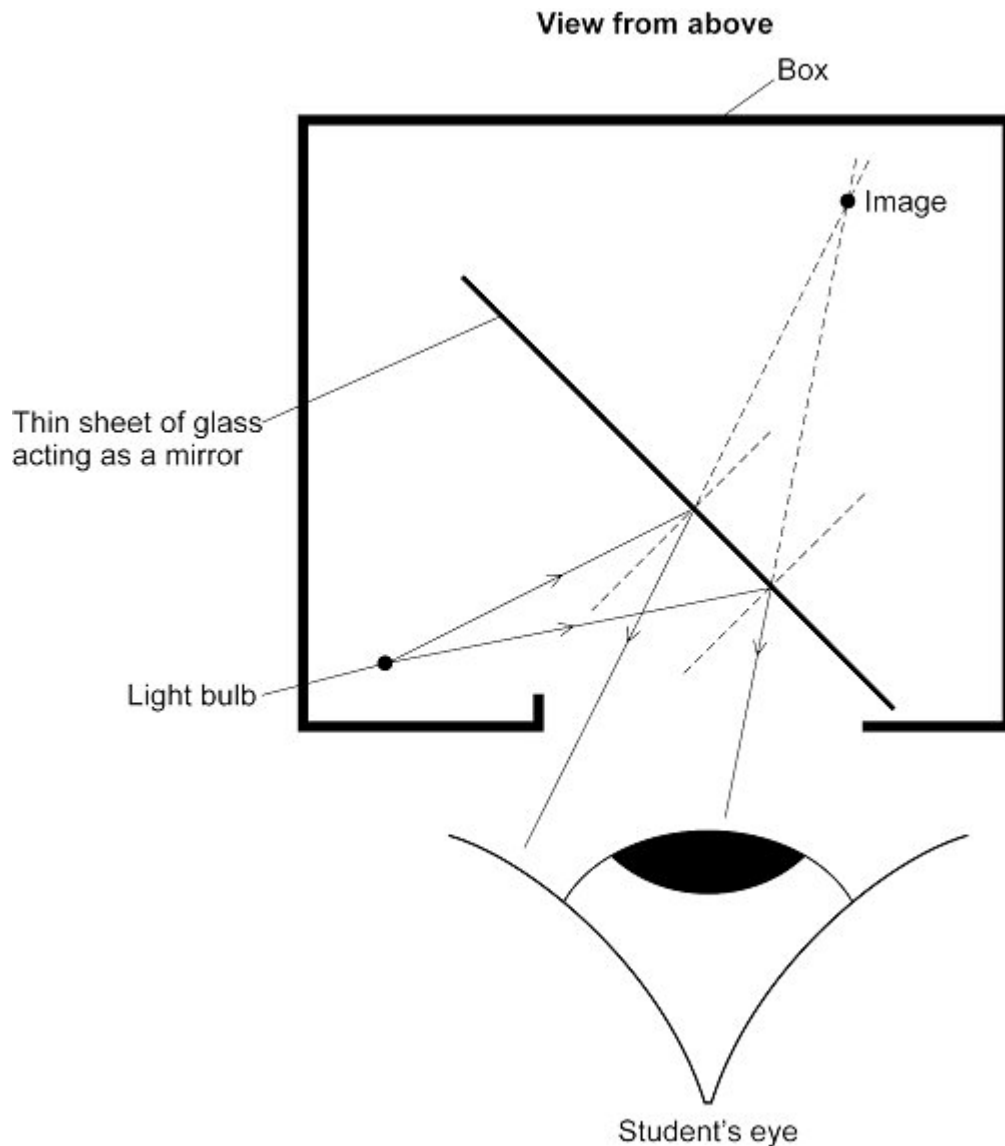
2

at least one arrow drawn in correct direction

any conflicting arrows negate this mark
ignore any arrows drawn on construction lines behind the glass

1

position of image correct



judged by eye

1

- (b) image is formed by virtual / imaginary rays crossing
accept construction lines only show where the light seems to come from
accept the image is behind the glass / mirror
accept image is seen through the glass / mirror
accept (real) rays of light do not pass through the image
accept (real) rays do not cross
accept the image is a reflection (of the object)
accept the image is formed by reflection
do not accept a virtual image can't be formed on a screen
do not accept the object / image is reflected

1

[5]

Q19.

- (a) higher frequency
general properties / uses are neutral

- or**
shorter wavelength
*do **not** accept different frequency / wavelength / energy*
- or**
greater energy
1
- (b) the same (speed)
accept they travel at the speed of light
1
- (c) pass through / transmitted by the plastic / casing
1
- reflected by the metal / plates
*do **not** accept bounce / deflected etc for reflected*
*if neither marking point scores an answer reflected (back to boat / from the device) scores **1** mark*
1
- (d) (i) waves are not reflected from the walls
accept microwaves / radar for waves
*do **not** accept bounce / deflected etc for reflected*
or
only waves (reflected) from the device are detected
accept to stop reflected waves affecting results
1
- (ii) different types (of device) can be compared
fair test is insufficient
accept idea that only one variable is then changed
1
- (iii) so (measurements / results / scientists) are not biased towards one type / manufacturer of device/s
accept to avoid bias
accept so they are not biased
1
- (e) (i) any **two** from:
*if temperature is mentioned rather than angle a maximum of **1** mark can be scored*
- (for any angle) **A** values < **B** values
*or converse eg **B** values are higher / better / stronger*
 - **A** values increase with (increasing) angle
accept weakest at 0° strongest at 15°
values go up is insufficient
 - **B** values decrease with (increasing) angle
accept strongest at 0° weakest at 15°
values go down is insufficient
 - **A** values do not vary as much (as **B** values)

(ii) **D***mark is for the reason**reason cannot score if **D** is not chosen**values are always over 2(.0)*

1

[10]**Q20.**

1.4

*allow **1** mark for correct substitution**ie $14 \div 10$* **or** *$28 \div 20$* **[2]****Q21.**

(a) converging (lens)

*accept 'convex (lens)'**accept biconvex*

1

(b) (principal) foci

*accept 'focus' / 'focuses' / 'focis'**focal point(s)*

1

(c) (i) formed where (real) rays (of light) intersect / meet / cross

*accept rays (of light) pass through the image**accept 'image is on the opposite side (of the lens to the object)'**accept (construction) lines cross over**a response relating to a screen or similar is neutral**lines are solid and not dotted is neutral*

1

(ii) inverted

accept any unambiguous correct indication

1

(d) (i) smooth curve which matches the points

*judge by eye but do **not** accept point to point by ruler or otherwise*

1

(ii) continuous

1

(iii) as distance increases, magnification decreases

accept negative correlation

a statement 'inversely proportional' is incorrect and limits maximum mark for this part question to 1

1

further detail eg magnification falls steeply between 40 and 50 cm
or
 magnification begins to level out after / at 70 cm

1

[8]

Q22.

- (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]

Q23.

- (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

[4]

Q24.

- (a) (i) microwaves

1

- (ii) can pass through the ionosphere
accept travels in a straight line
accept atmosphere for ionosphere
*do **not** accept air for ionosphere*

1

- (b) higher the frequency, further the wave travels
 (into the atmosphere before reflection)

1

- (c) 15 000

allow 1 mark for correct transformation and substitution

$$\frac{300\,000\,000}{20}$$

ie

an answer of 15 000 000 only gains 1 mark

allow both marks for an answer of 15 MHz (unit must be changed)

an answer of 15 gains no credit

2

[5]**Q25.**

- (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]**Q26.**

- (a) (i) answer in the range 3.0 ↔ 3.1 inclusive

accept for 1

3.6 ÷ 1.2 or 3.7 ÷ 1.2

or 36 ÷ 12 or 37 ÷ 12

or 18 ÷ 6 or 18.5 ÷ 6

or 10.2 ÷ 3.4 or 102 ÷ 34

or answer in the range but with a unit eg 3 cm

2

- (ii) (principal) focus / focal (point(s)) / foci / focus
 accept 'focusses'
 accept focals
 do **not** accept focal length
 1
- (iii) at the intersection of virtual / imaginary rays
 or 'where virtual / imaginary rays cross'
 or the rays of (real) light do not cross
 or the image on the same side (of the lens) as the object
 or the image is drawn as a dotted line
 or the image is upright
 do **not** accept 'cannot be put on a screen'
 do **not** accept any response which refers to reflected rays
 1
- (b) (i) another correct observation about relationship between values of **d** (1)
 (but) not the same relationship between corresponding
 values for magnification (1)
example
 15 is three times bigger than 5 but
 2.0 is not three times bigger than 1.2
 2
- (ii) when the distance / **d** increases the magnification increases
 or the converse
 accept 'there is a (strong) positive correlation'
 do **not** accept any response in terms of proportion / inverse
 proportion
 1
- (iii) (student has) no evidence (outside this range)
 accept data / results / facts for 'evidence'
 1

[8]

Q27.

- (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]

Q28.

- (a) (i) any **two** from:

- travel at the same speed (through a vacuum)
*accept travel at the speed of light
accept air for vacuum*
- can travel through a vacuum / space
*do **not** accept air for vacuum*
- transfer energy
- can be reflected
- can be refracted
- can be diffracted
- can be absorbed
- can be transmitted
- transverse
*accept any other property common to electromagnetic waves
accept travel at the same speed through a vacuum for both
marks
do **not** accept both radiated from the Sun*

2

- (ii) infra red
both required for the mark

radio(waves)
accept IR for infra red

1

- (b) 2 400 000 000
*correct transformation and substitution gains **1** mark*

$$\text{ie } \frac{300000000}{0.125} \quad \text{or} \quad \frac{300000000}{0.125}$$

an answer of 24 000 000 gains **1** mark

either 2 400 000 kHz

or 2 400 MHz scores **3** marks but the symbol only scores the 3rd mark if it is correct in every detail

2

hertz

accept Hz

do **not** accept hz

1

- (c) (i) presented (scientific) evidence / data
do an experiment / investigation is insufficient

1

- (ii) to find out if there is a hazard (or not)
accept to find out if it is safe
accept not enough evidence to make a decision
not enough evidence is insufficient

1

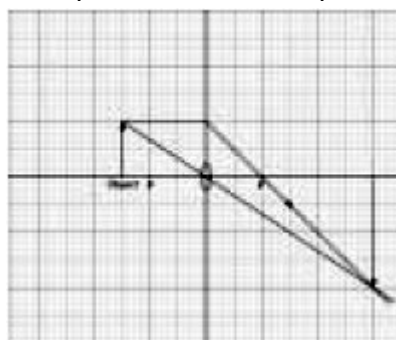
[8]

Q29.

- (a) any **two** for **1** mark each
deduct (1) from the first two marks if a ruler has not been used but the intention is clear

ray from the object's arrowhead

- through centre of lens
 - parallel to the axis then, when it reaches the lens, through F on the right
 - through F on the left then, when it reaches the lens parallel to the axis
- example of a **4** mark response



if more than two construction lines have been drawn all must be correct to gain **2** marks

construction lines drawn as dashed lines do not score credit

2

image shown as vertical line from axis to where their rays intersect

image need not be marked with an arrowhead but, if it is, it must be correct

1

ray direction shown

only one correct direction

arrow needed but there must not be any contradiction

1

(b) any **two** from:

- inverted

accept 'upside down'

- magnified

accept 'bigger'

- real

accept 'not virtual / not imaginary'

one correct feature gains 1 mark

ignore any reference to position

an incorrect feature negates a correct response

2

[6]

Q30.

(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]

Q31.

(a) (i) shorter than

1

(ii) increase slightly

1

(b) (i) go up in the same ratio

or (directly) proportional **or** as speed (of the tennis ball) increases so does the (difference in) frequency

accept as one goes up, so does the other

accept positive correlation

1

(ii) 20 (m/s)

*allow 1 mark for showing correct method on graph
(ie horizontal or vertical line anywhere on graph)
if indicated by a cross, must be $\pm$ half square of correct value)*

2

(iii) frequency and speed are both continuous variables

1

[6]

Q32.

(a) (i) radio(waves)

1

(ii) energy

correct answer only

1

(b) (i) 0.0125 (m)

allow 1 mark for correct transformation and substitution

2

(ii) make it hot(ter)

*do **not** accept cook it
accept (air) particles inside ball will move faster
accept water in the ball gets hotter*

1

[5]

Q33.

(a) C (only)

1

(b) A (only)

1

[2]

Q34.

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

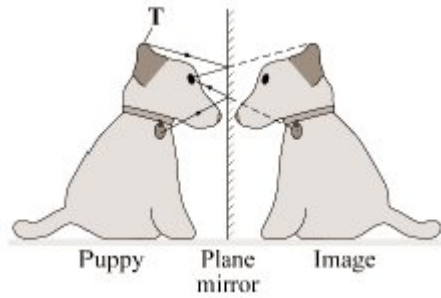
accurate (1)

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]

Q35.

(a) (i) compare (the health of) mobile phone users with non-mobile phone users

must be an implied comparison between users and non-users

any idea of doing an experiment negates the mark

1

(ii) increase the sample size

accept use more people

accept have a large sample size

repeat the research / test is neutral

1

(iii) ethical

1

(b) (i) so the phones can be compared (fairly)

a fair test is insufficient

accept different tests (may) give different results

*do **not** accept to make the results reliable, unless qualified
eg all variables are controlled*

*do **not** accept bias unless qualified*

1

(ii) yes all are below the legal limit / 2 (W/kg)

or no and any **one** from:

- even absorbing a small amount of energy may be harmful
accept microwaves for energy
accept emits energy absorbed by head / other parts of body
- no proof that small amounts of energy are not harmful
accept because the SAR value is not 0 (W/kg)

1

(c) any **one** from:

- to get an independent opinion
- company scientists may be biased
accept company scientists may manipulate results

1

[6]