Waves Questions 3

31 Questions

Name: _____

Class: _____

Date: _____

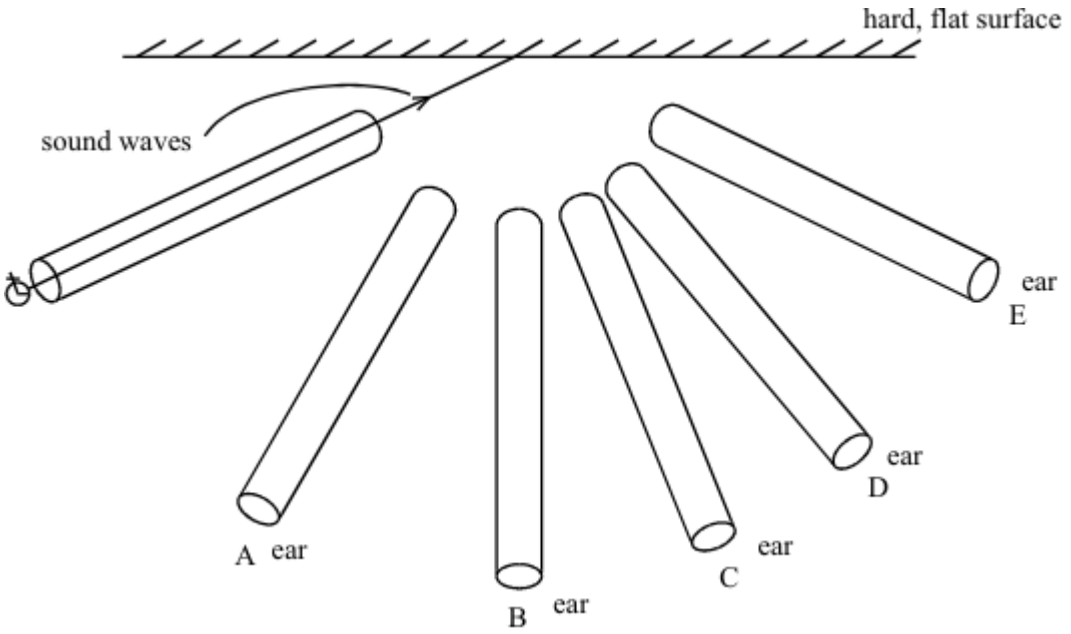
Time:

Marks:

Comments:

Q1.

A hard, flat surface reflects sound just like a plane (flat) mirror reflects light.



You want to hear the reflection (echo) of the ticking watch through a tube.

Which is the best position to put the tube?

Choose from positions A-E on the diagram _____

(You may draw on the diagram if you want to.)

(Total 2 marks)

Q2.

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**

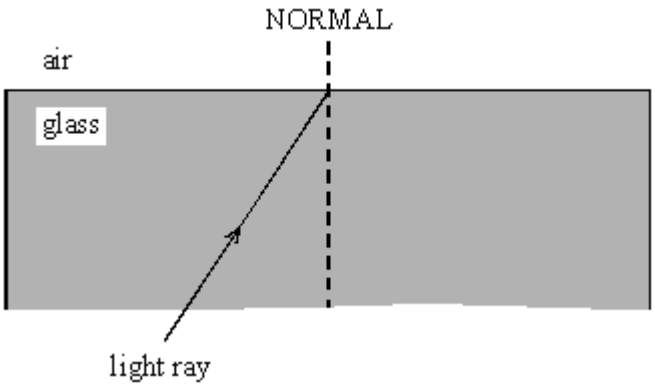
Shortest wavelength → Longest wavelength

gamma radiation		ultraviolet radiation	light		microwaves	

(Total 3 marks)

Q3.

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)

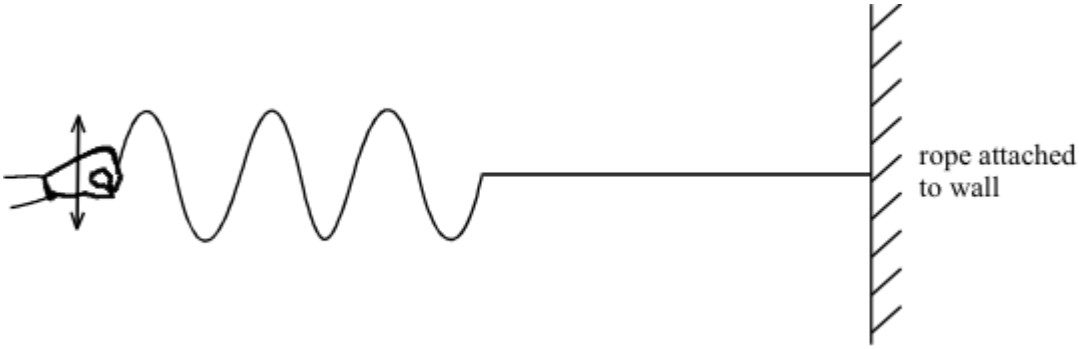
(b) Explain why this happens to the ray of light.

_____

(2)
(Total 4 marks)

Q4.

The diagram shows some waves travelling along a rope.



(a) Show on the diagram

(i) the wavelength of one of the waves

(2)

(ii) the amplitude of one of the waves

(2)

(b) The waves shown on the diagram were produced in two seconds.

What is the frequency of the waves?

_____

(2)
(Total 6 marks)

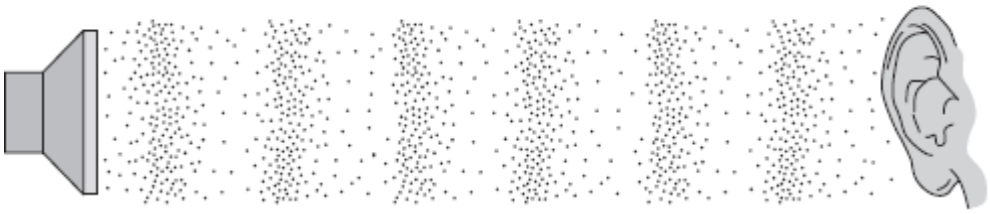
Q5.

A sound wave is an example of a longitudinal wave.

(a) **Figure 1** shows the air particles in a sound wave as the wave travels from a

loudspeaker to an ear.

Figure 1



Write a letter **R** on **Figure 1** to show an area of rarefaction.

(1)

(b) Complete the sentence about longitudinal waves.

The vibrations of the air particles are _____ to the direction of energy transfer.

(1)

(c) A stationary car horn emits a sound wave of frequency 400 Hz.

The wavelength of the wave is 0.85 m.

Calculate the speed of sound.

Use the correct equation from the Physics Equations Sheet.

_____

_____

_____

Speed of sound = _____ m / s

(2)

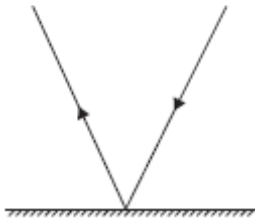
(Total 4 marks)

Q6.

Light rays can be reflected and refracted.

Figure 1 shows how a plane mirror reflects a ray of light.

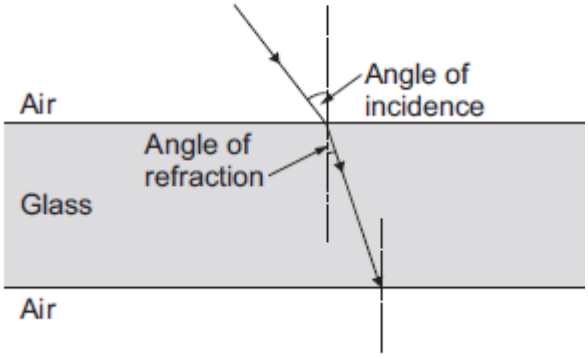
Figure 1



(a) Light is refracted when passing from air into glass.

Figure 2 shows a ray of light as it passes from air into a glass block.

Figure 2



(i) Draw a line on **Figure 2** to show the path of the ray as it leaves the glass block.

(1)

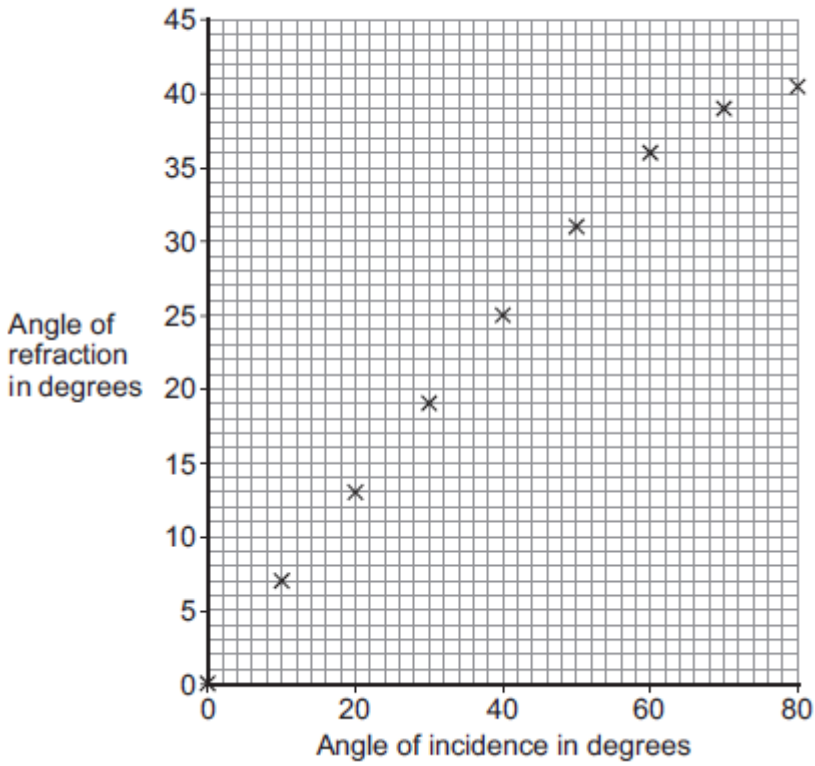
(ii) Name the dashed lines drawn at 90° to the glass in **Figure 2**.

_____

(1)

(b) A student investigated the relationship between the angle of incidence and the angle of refraction as light passes from air into glass. Her results are shown in **Figure 3**.

Figure 3



(i) Draw a line of best fit on **Figure 3**.

(1)

(ii) Use **Figure 3** to describe the relationship between the angle of incidence and the angle of refraction.

_____

_____

_____

_____

(2)
(Total 5 marks)

Q7.

Electromagnetic waves can be diffracted, reflected and refracted.

Infrared, microwaves, radio waves and visible light can all be used for communication.

Draw **one** line from each part of the electromagnetic spectrum to its use.

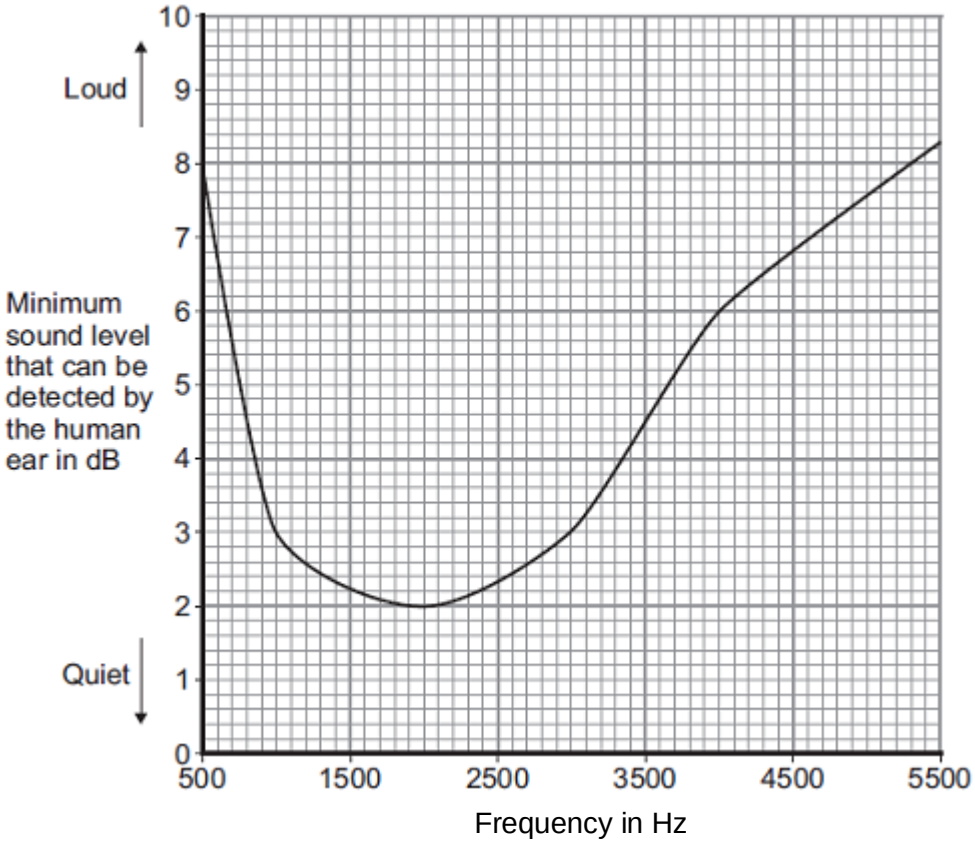
Part	Use
	Photography
Microwaves	
	Remote controls
Radio waves	
	Mobile phones
Visible light	
	TV broadcasts

(3)
(Total 3 marks)

Q8.

The human ear can detect a range of frequencies of sound.
Sound level is measured in decibels, dB.

The figure below shows how the minimum sound level that can be detected by the human ear depends on the frequency of sound.



(a) A sound has a frequency of 2000 Hz.

What is the minimum sound level needed to detect the sound?

Minimum sound level: _____ dB

(1)

(b) Which frequency shown in the figure above would require the loudest sound before it could be heard?

Frequency: _____ Hz

(1)

(c) The lowest frequency of sound the human ear can detect is 20 Hz. The wavelength of a sound wave with a frequency of 20 Hz is 17 metres.

Calculate the speed of a sound wave with a frequency of 20 Hz.

Use the correct equation from the Physics Equations Sheet.

_____

_____

_____

Speed = _____ m / s

(2)

(d) Sound waves can be reflected from a wall.

What name is given to reflected sound waves?

_____

(1)
(Total 5 marks)

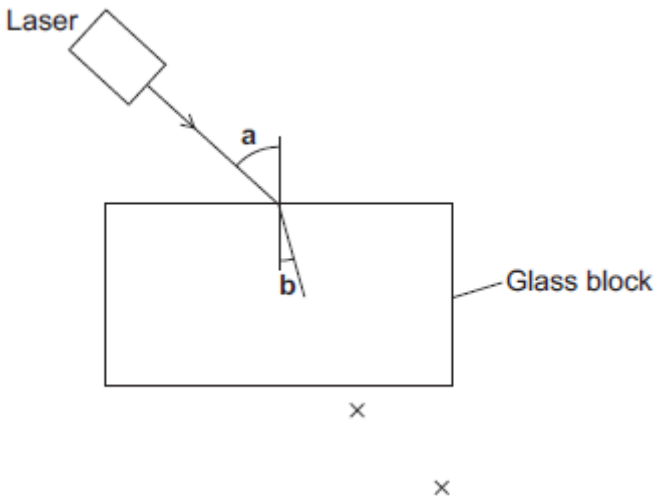
Q9.

A student used a laser to investigate the change of direction of light as it entered a glass block.

The apparatus is shown in **Figure 1**.

The path of a ray of light as it enters the glass block is shown.

Figure 1



(a) The student marked crosses to show the path of the ray of light that left the glass block.

Use a ruler to help you to draw the path of the ray of light through and out of the glass block.

(2)

(b) Light from lasers can damage your eyes.

Suggest **one** safety precaution that the student should have taken during his investigation.

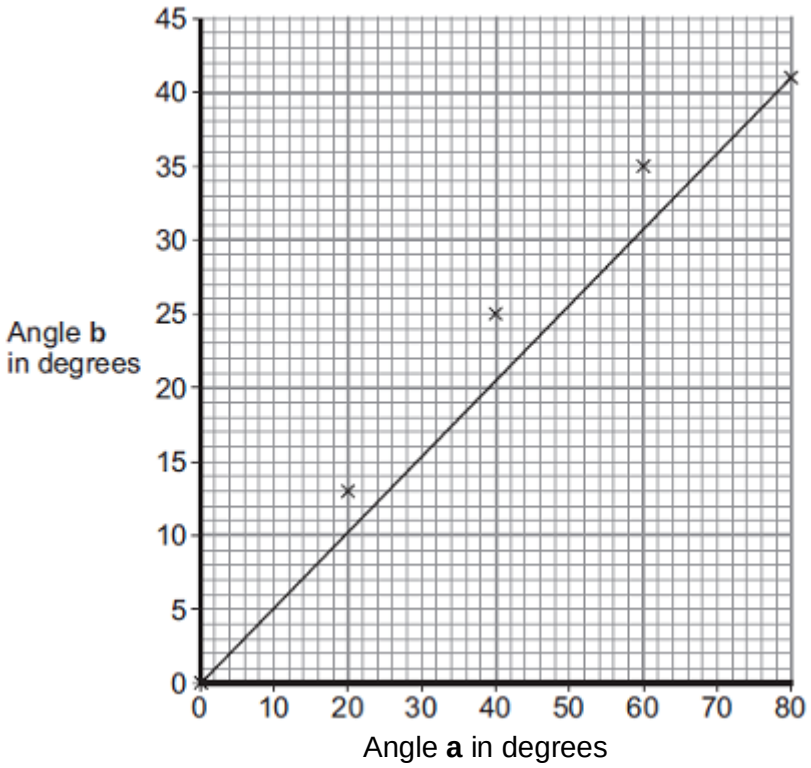
_____

_____

(1)

(c) The student measured **angle a** and **angle b** when the ray of light was incident at 5 different angles. He measured each set of values once. The student's results are shown in **Figure 2**.

Figure 2



(i) The student's line of best fit is **incorrect**.

Give **one** reason why.

_____

_____

(1)

(ii) The student measured 5 different values of **angle a** in his investigation.

Suggest **two** ways the student could improve his investigation.

_____

_____

_____

_____

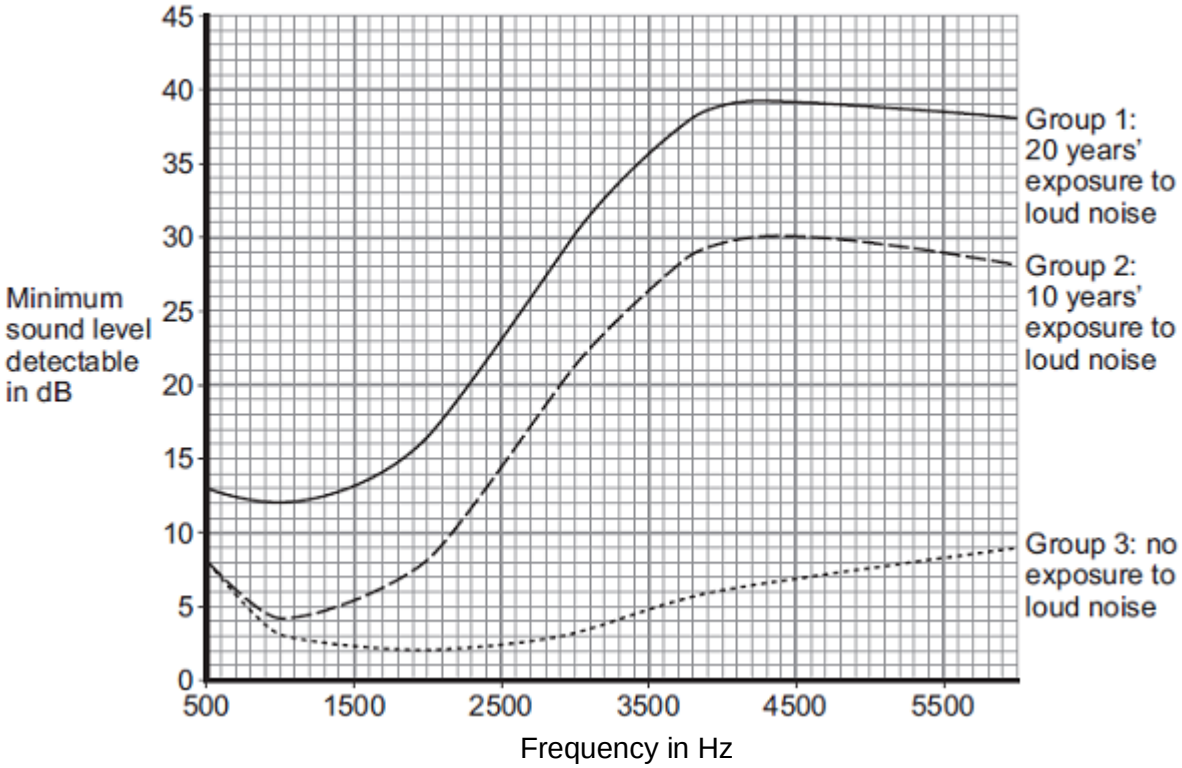
(2)

(Total 6 marks)

Q10.

Exposure to a noisy environment can damage a person's hearing.

The figure below shows the minimum sound level that is needed to detect sounds of different frequencies for three different groups of people.
Sound level is measured in decibels, dB.



(a) Which group of people has the worst hearing?

Group: _____

Use the information from the figure above to give a reason for your answer.

_____

_____

(1)

(b) Give **three** other conclusions that can be made from the figure in part (a).

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 4 marks)

Q11.

A Doppler probe emits high frequency sound waves.

A doctor uses a Doppler probe to measure the pulse rate of an unborn baby in its

mother's womb.

The sound waves have a frequency of 5.24×10^6 Hz.
The mean speed of sound through human body tissue is 1540 m / s.

Calculate the wavelength of the sound wave emitted by this Doppler probe as it travels through human body tissue.

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

Use the correct equation from the Physics Equations Sheet.

_____

_____

_____

Wavelength = _____ m

(Total 3 marks)

Q12.

During the day, the Sun transfers energy to an outdoor swimming pool.

(a) By which method of energy transfer does the pool receive energy from the Sun?

_____

(1)

(b) (i) The mass of water in the pool is 5000 kg. The specific heat capacity of water is 4200 J/kg°C.

Calculate how much energy needs to be supplied to increase the water temperature by 5°C and state the correct unit.

Use the correct equation from the Physics Equations Sheet.

Give the unit.

_____

_____

_____

Energy = _____

(3)

(ii) The Sun supplies energy to the water in the pool at a rate of 16 kJ every second.

Calculate how much time it would take for energy from the Sun to raise the water temperature by 5 °C.

You will need to use your answer to **(b)(i)** and the correct equation from the Physics Equations Sheet.

_____

_____

_____

Time = _____ seconds

(3)

(iii) On one day, the temperature of the pool is 7 °C lower than the air temperature.

The time it takes for the pool temperature to rise by 5 °C is less than the answer to part **(b)(ii)**.

Suggest a reason why.

_____

_____

(1)

(Total 8 marks)

Q13.

The electromagnetic spectrum is made up of electromagnetic waves.

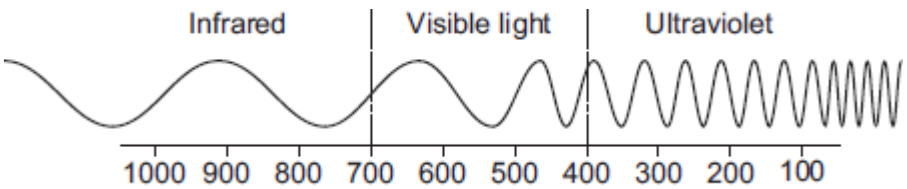
The electromagnetic waves form a continuous spectrum of different wavelengths.

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

All electromagnetic waves are	longitudinal mechanical transverse	waves.

(1)

(b) Part of the electromagnetic spectrum is shown in the diagram.



Wavelength in nm

(i) What is the range of wavelengths the human eye can detect?

The range is from _____ nm to _____ nm.

(2)

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

As the frequency of the waves in the electromagnetic spectrum increases,

the wave speed

decreases.
increases.
stays the same.

(1)

(Total 4 marks)

Q14.

This question is about the properties of light.

(a) Which diagram, **1**, **2** or **3**, shows the path a ray of light takes when travelling from air **into** glass?

Tick (✓) the box under the correct diagram.

Diagram 1

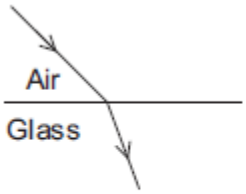


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Diagram 2

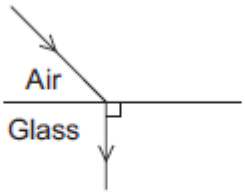

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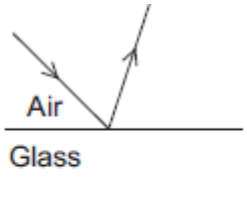
Diagram 3



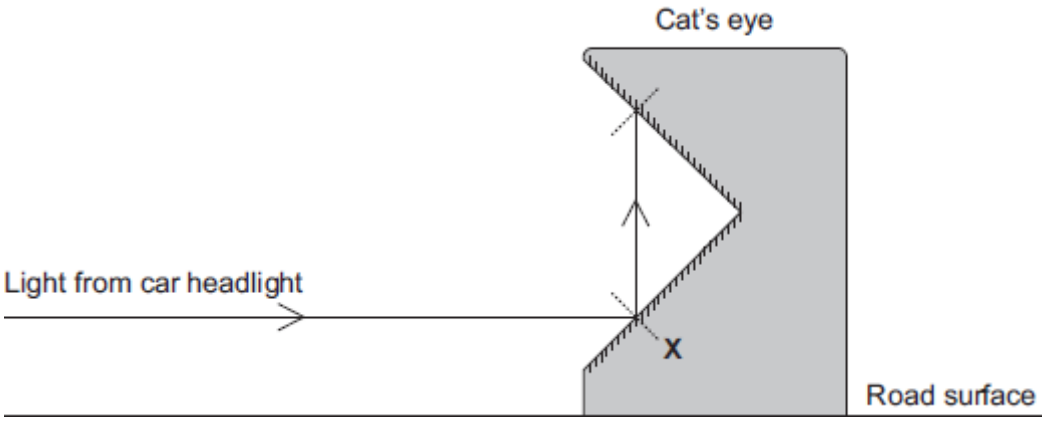
☐

(1)

(b) 'Cat's eyes' are used on roads as markers. They reflect light from car headlights.

Diagram 4 shows the path of a ray of light entering a 'cat's eye'.

Diagram 4



(i) Continue the path of the ray of light on **Diagram 4**.

Show the direction of the ray.

(2)

(ii) What is the name given to the dotted line on **Diagram 4** labelled **X**?

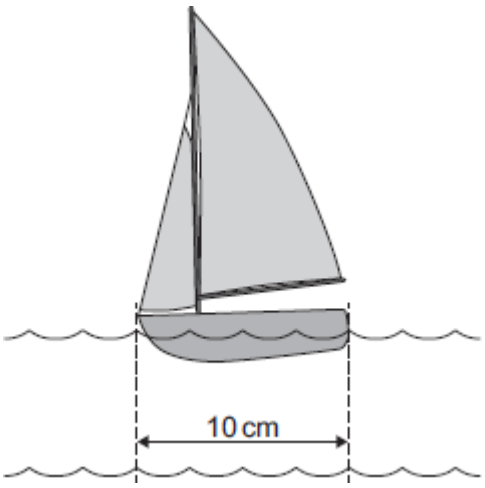
_____

(1)

(Total 4 marks)

Q15.

A scientist tests a design for a sailing boat using a scale model in a tank of water.



(a) Waves are produced on the surface of the water.

Use the diagram to calculate the wavelength of one wave.

_____

_____

Wavelength = _____ cm

(2)

(b) After testing the scale model, a full-size boat is built. This boat is tested at sea.

(i) The waves at sea have a wavelength of 6 m. The frequency of the waves is 0.5 Hz.

Calculate the speed of the water waves.

Use the correct equation from the Physics Equations Sheet.

_____

_____

Speed = _____ m/s

(2)

(ii) Suggest why a scale-model is tested before a full-size boat is built.

_____

_____

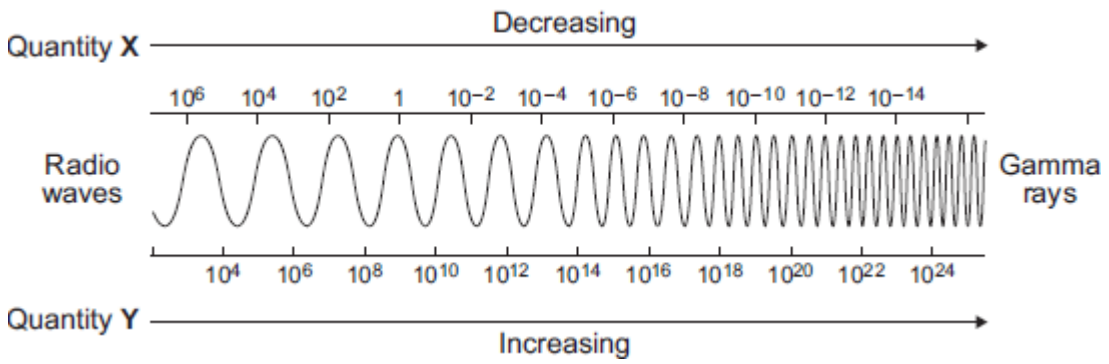
(1)

(Total 5 marks)

Q16.

The electromagnetic spectrum is shown in the diagram below..

Diagram 1



(a) Name quantities **X** and **Y**, and state the units they are measured in.

Quantity **X**: _____ Unit for Quantity **X**: _____

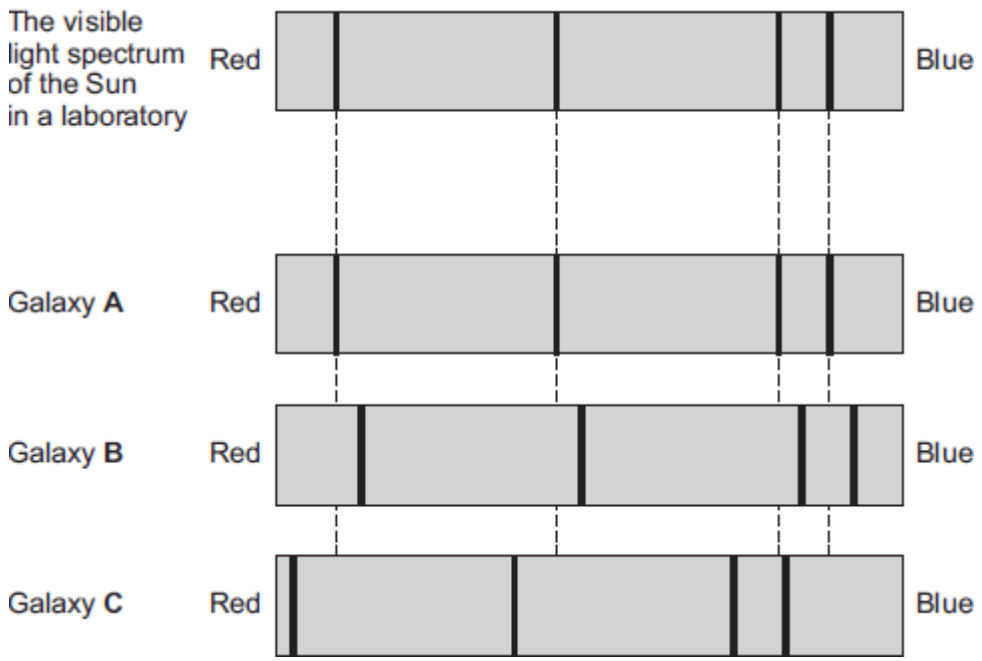
Quantity **Y**: _____ Unit for Quantity **Y**: _____

(3)

(b) The visible part of the electromagnetic spectrum from stars includes dark lines. These lines are at specific wavelengths.

Diagram 2 shows the visible light spectra for three galaxies, **A**, **B** and **C**, compared to the visible light spectrum of the Sun as seen in a laboratory.

Diagram 2



(i) Using evidence from the spectra, what conclusions can be made about the movement of galaxies **A**, **B** and **C** relative to the Earth?

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(ii) Compare the speed of galaxy **B** with the speed of galaxy **C** relative to the observer.

_____

_____

(1)

(iii) Explain why it is **not** valid to make conclusions about all galaxies in the Universe from these spectra.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q17.

A student investigates the infrared radiation being emitted by different coloured surfaces to the surroundings.

(a) Draw a ring around each correct answer to complete the sentences.

(i) All objects emit and

absorb
conduct
insulate

infrared radiation.

(1)

(ii) Compared with cooler objects, hotter objects emit

less
the same amount of
more

infrared radiation.

(1)

(b) The student pours 300 cm^3 of hot water into each of 3 metal cubes and seals the top of each cube.

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

Energy is transferred through the sides of the metal cubes by

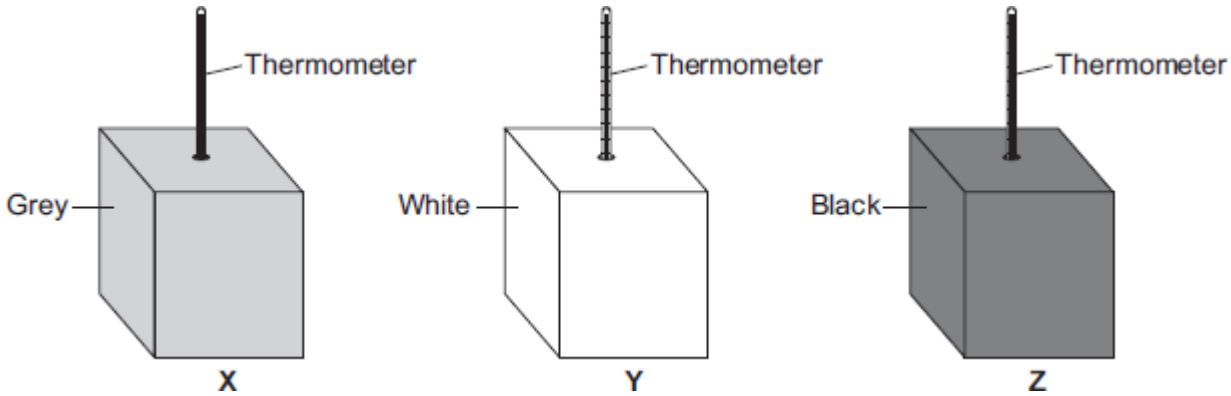
conduction.
convection.
radiation.

(1)

Each cube has the same volume.

Each cube is a different colour.

The temperature of each cube is recorded over 10 minutes.

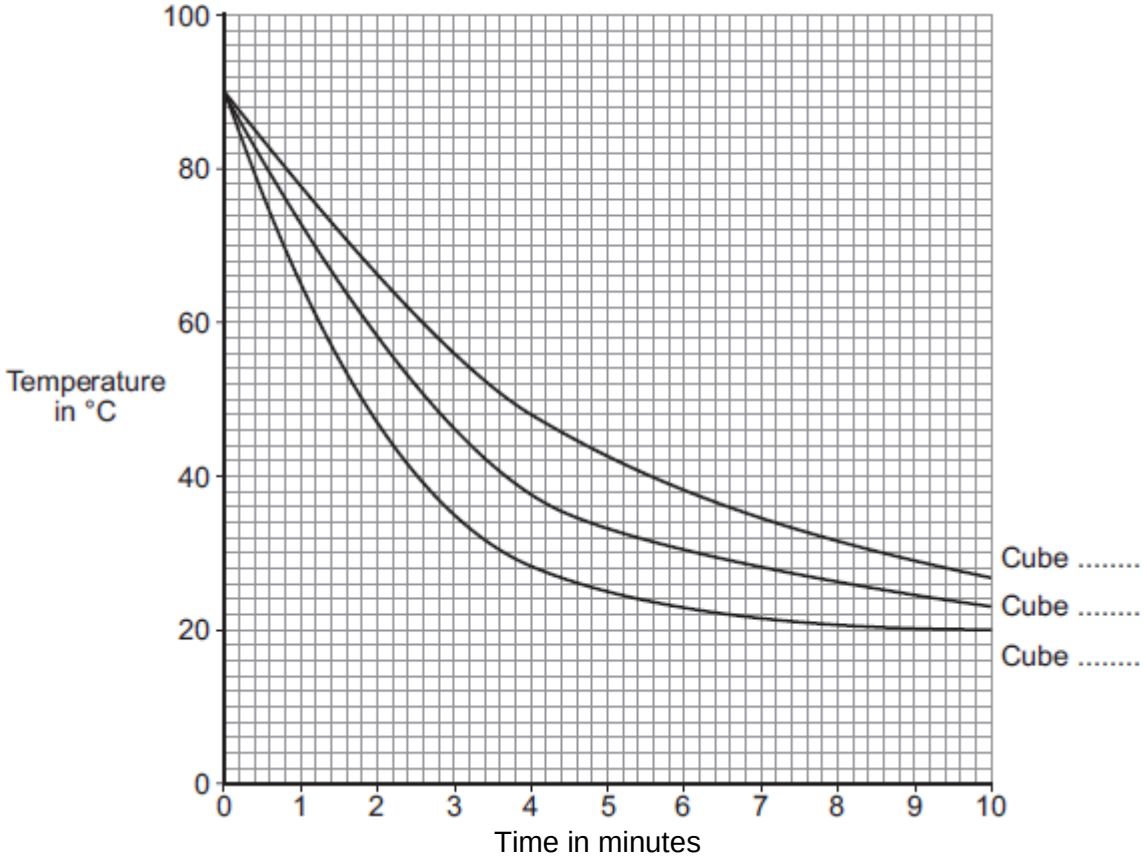


(ii) What is the independent variable in the investigation?

_____

(1)

The results of the investigation are shown on the graph.



(iii) Write the correct letter for each cube, **X**, **Y** or **Z**, next to the lines shown on the graph.

(2)

(iv) All three cubes had the same starting temperature. This was important in the investigation.

Suggest why.

_____

_____

(1)

(v) Some variables are kept the same in an investigation.

What name is given to these variables?

_____

(1)

(Total 8 marks)

Q18.

An athlete runs in a marathon race. As he runs, his body gets hotter.

His body produces sweat to help him cool down.

(a) Explain in terms of particles, how sweating helps the athlete to cool down.

(4)

(b) At the end of the race, the athlete is covered with a ‘space blanket’ made from shiny foil to prevent him from cooling too quickly.

He wraps the space blanket around his body to reduce energy transfer to the surroundings.

How does the space blanket reduce energy transfer to the surroundings?

_____

_____

_____

_____

_____

_____

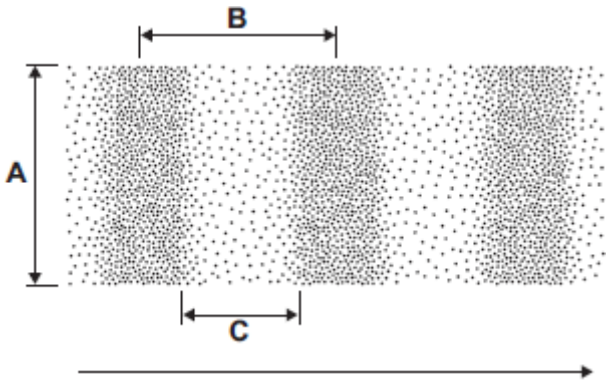
(3)

(Total 7 marks)

Q19.

Sound waves are mechanical waves.

The diagram shows the disturbance of air particles in the path of a sound wave at an instant in time.



(a) (i) Which labelled arrow, **A**, **B** or **C**, correctly identifies the wavelength of the sound wave?

Arrow: _____

(1)

(ii) What type of wave is a sound wave?

Draw a ring around the correct answer.

electromagnetic **longitudinal** **transverse**

(1)

(b) Two students investigate the reflection of sound waves from a building.

One student hits two metal bars together to produce a sound wave.

The second student starts a stop clock when the metal bars are hit together and stops the stop clock when she hears the echo.

The students want to calculate the time it takes the sound wave to travel to the building.

(i) Why must the students divide the time on the stop clock by 2 to calculate the time it takes the sound wave to travel to the building?

_____

_____

(1)

(ii) The students divide each time by 2 and record their results in a table.

	Trial 1	**Trial 2**	**Trial 3**	**Mean**
Time in seconds	0.33	0.27	0.30	

Calculate the mean of the 3 results.

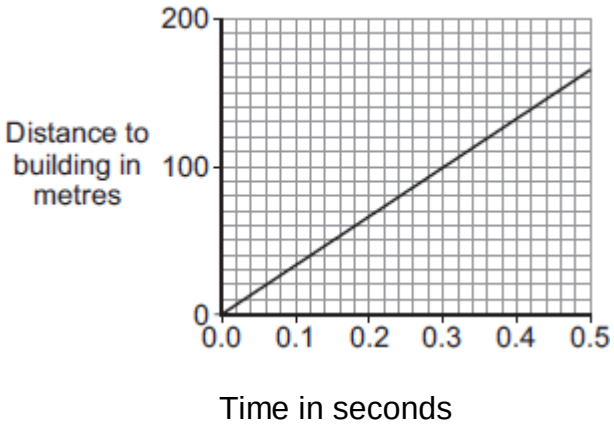
Write the mean in the table.

_____

_____

(2)

(iii) The time taken for the sound wave to reach the building, from different distances, is shown in the graph.



Use the mean time from the table to determine the distance to the building.

_____

Distance = _____ m

(1)

(iv) The students see differences between the results.

Choose **one** improvement the students could make to the investigation.

Tick (✓) **one** box.

Improvement	**Tick (✓)**
Decrease the distance between the students and the building.	
Use a sound sensor and a datalogger to measure the time.	
Play a long note on a musical instrument instead of using metal bars.	

(1)

(v) The students listen to the echo. The echo is quieter than the sound heard when the metal bars are hit together.

How does the amplitude of the echo compare with the amplitude of the sound wave produced by the metal bars?

_____

_____

(1)

(Total 8 marks)

Q20.

Electromagnetic waves form a continuous spectrum.

Three parts of the electromagnetic spectrum are:

- gamma rays
- infrared
- visible light.

(a) Place the parts in order of increasing energy.

Increasing energy

→

_____ _____ _____

(2)

(b) The parts of the electromagnetic spectrum all have different properties.

Draw a ring around the correct answer to complete each sentence.

frequency.

(i) The number of waves passing a point in 1 second is called the

speed.
wavelength.

(1)

(ii) All parts of the electromagnetic spectrum travel at the same speed

through

a vacuum.
glass.
water.

(1)

(c) The different parts of the electromagnetic spectrum are used for different methods of communication.

Complete the table by giving an example of a use of each part of the electromagnetic spectrum for communication.

Part of electromagnetic spectrum	**Use for communication**
Infrared	
Microwave	
Radio wave	
Visible light	

(4)
(Total 8 marks)

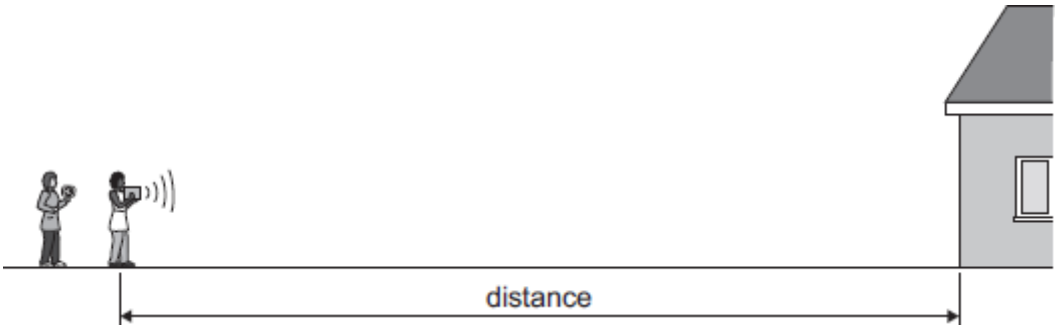
Q21.

Two students investigated the reflection of sound waves from a building.

One student used a signal generator connected to a loudspeaker to produce a short, high-pitched sound wave.

The second student used a stop clock to measure the time taken for the sound wave to return to the students.

The students repeated the experiment at different distances from the building.



(a) Sound is a longitudinal wave.

How is a longitudinal wave different from a transverse wave?

_____

_____

_____

_____

(2)

(b) The students' results are shown in the table.

	Trial 1	**Trial 2**	**Trial 3**
Time in seconds	0.40	0.59	0.92
Distance in metres	50.0	100.0	150.0

(i) What was probably the biggest source of error in the students' investigation?

Give a reason for your answer.

_____

_____

_____

_____

(2)

(ii) The signal generator was set at a frequency of 1.2 kHz.

The speed of sound in air, when the students did the investigation, was 340 m/s.

Calculate the wavelength of the sound wave generated by the speaker.

Use the correct equation from the Physics Equations Sheet.

_____

_____

_____

Wavelength = _____ m

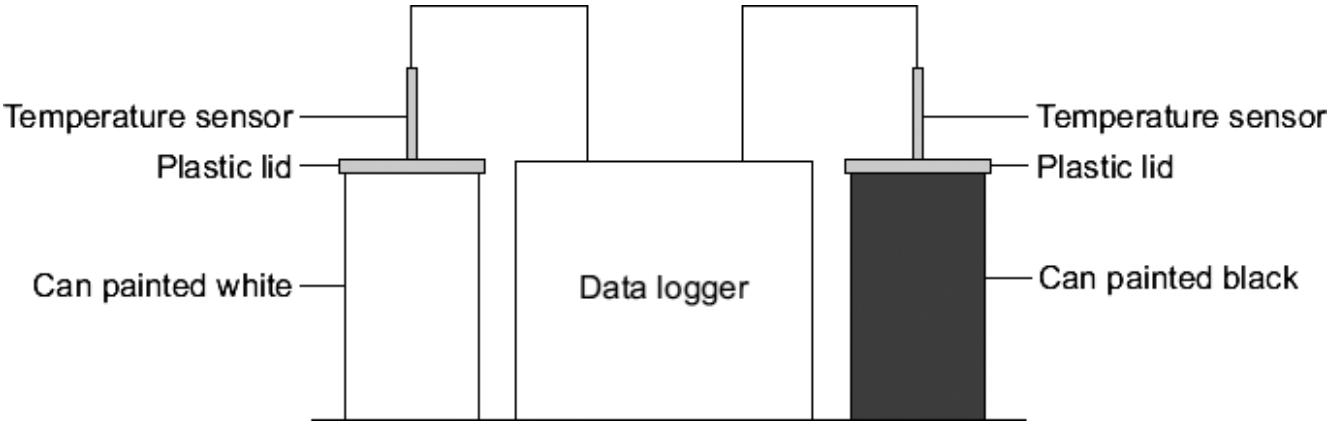
(3)

(Total 7 marks)

Q22.

A student investigated the emission of infrared radiation from two cans.

- The two cans were the same size.
- One can was painted white and the other can was painted black.
- The student poured the same volume of boiling water into each can.
- A data logger recorded the temperature in each can for the next 14 minutes.



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

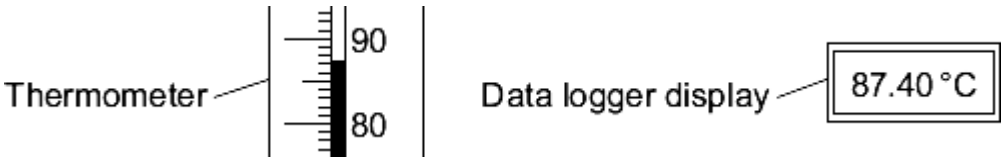
The plastic lids prevent energy loss by

conduction.
convection.
infrared radiation.

(1)

(b) The data logger takes two temperature readings each second, and then plots a graph for the student.

The student could have used a thermometer to measure the temperature.



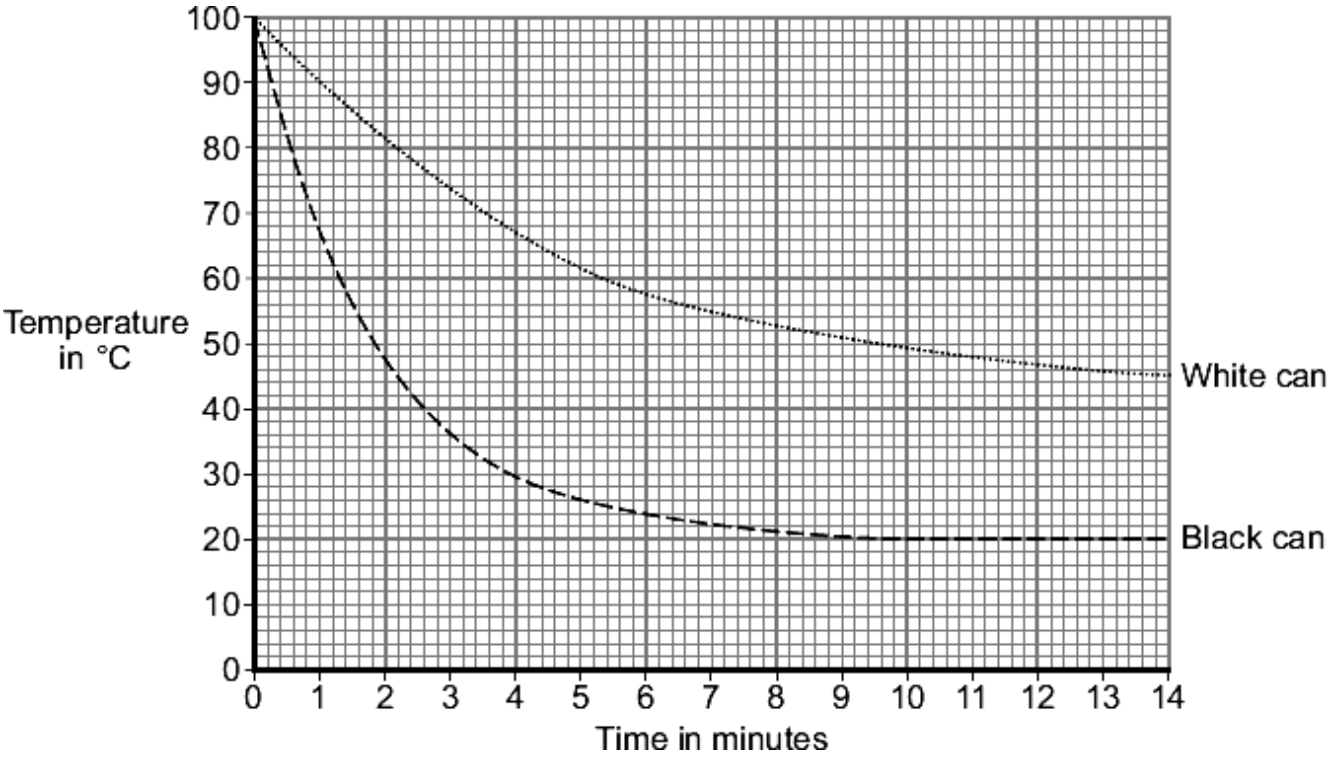
Give **two advantages** of using a data logger instead of the thermometer

1. _____

2. _____

(2)

(c) The graph shows the student's results.



(i) Explain the difference in temperature between the water in the two cans after 14 minutes.

_____

_____

_____

_____

(2)

(ii) The student decided to repeat the investigation using a can painted grey.

On the graph, draw a line for the results you would expect for the can painted grey.

(2)

(Total 7 marks)

Q23.

Waves have many different properties.

(a) Draw a ring around the correct answer in the boxes to complete each sentence.

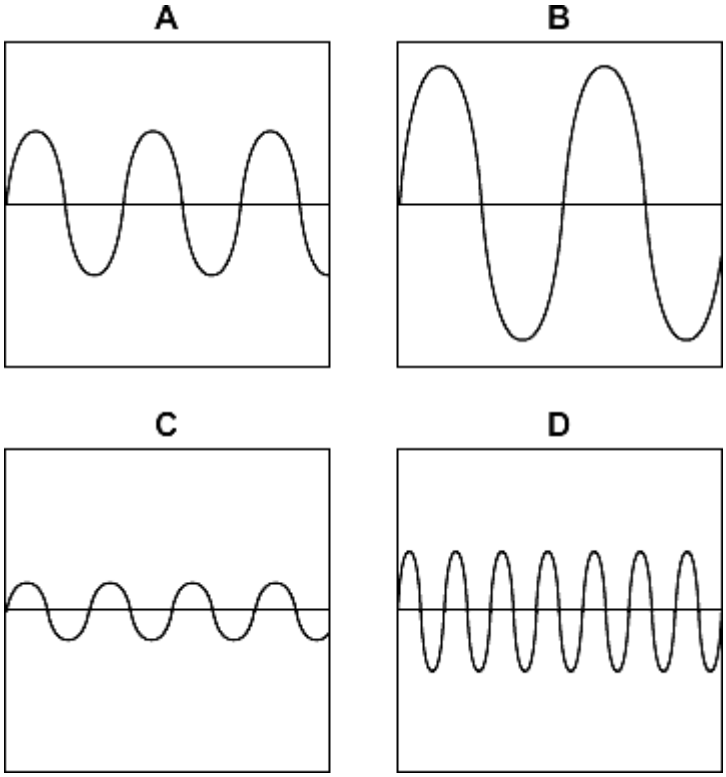
Light waves	are longitudinal. are transverse. may be either longitudinal or transverse.
Sound waves	are longitudinal. are transverse.

may be either longitudinal or transverse.

(2)

(b) Diagrams **A**, **B**, **C** and **D** show oscilloscope traces of four different sound waves.

The oscilloscope settings are the same each time.



(i) Give the letter of the loudest sound.

(1)

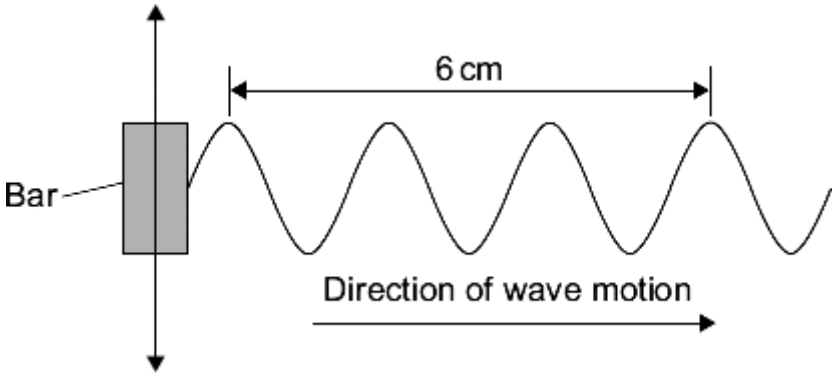
(ii) Give the letter of the highest pitch sound.

(1)

(Total 4 marks)

Q24.

A ripple tank is used to investigate the behaviour of water waves.
A bar moves up and down to make the waves.



(a) What is the wavelength of each wave in the diagram?

Draw a ring around the correct answer.

2 cm **3 cm** **6 cm**

(1)

(b) The ripple tank produces 10 waves in 2 seconds.

What is the frequency of the waves?

_____

_____

Frequency = _____ hertz

(1)

(c) The bar is made to move faster.

It now produces waves with:

- a frequency of 20 hertz
- a wavelength of 0.5 cm.

Calculate the speed of the water waves in cm/s.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

_____

_____

_____

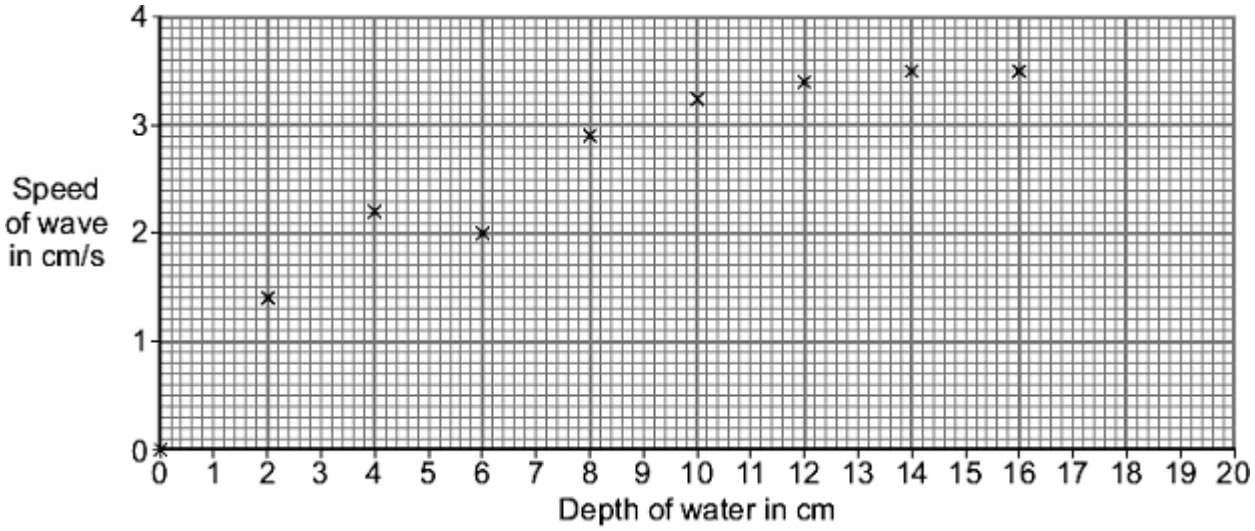
_____

Speed = _____ cm/s

(2)

(d) A student uses the ripple tank to investigate the relationship between depth of water and speed of waves.

The graph shows the student's results.



(i) There is one anomalous result.

On the graph, draw a ring around this anomalous result.

(1)

(ii) On the graph, draw a line of best fit

(1)

(iii) Use your line of best fit to find the speed of the wave at a depth of 20 cm.

Wave speed = _____ cm/s

(1)

(Total 7 marks)

Q25.

(a) The diagram shows the electromagnetic spectrum.

Two types of wave have been missed out.

Write the names of the missing waves in the empty boxes.

	X-rays	Ultraviolet rays		Infrared rays	Microwave	Radio waves

(2)

(b) Different types of waves are used by different types of communications equipment.

Draw **one** line from each situation in **List A** to the wave used to communicate in **List B**.

List A Situation	**List B Wave used to communicate**
	Microwave
TV remote control	

	Infrared rays
Satellite TV	
	Radio waves
Terrestrial TV	
	Ultraviolet rays

(3)
(Total 5 marks)

Q26.

Electromagnetic waves behave differently in different situations.

Electromagnetic waves travel at a speed of 3×10^8 m/s in a vacuum.

Microwave radiation has a wavelength of 2 cm.

Calculate the frequency of microwave radiation.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

_____

_____

_____

_____

Frequency = _____ hertz
(Total 2 marks)

Q27.

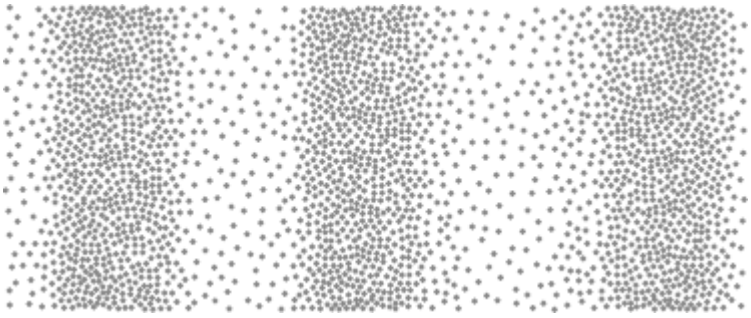
Sound waves cause oscillations in the air. Sound waves are longitudinal.

(a) In which direction are the oscillations of the particles compared to the direction of transfer of energy?

_____

(1)

(b) The diagram shows the disturbance of air molecules in the path of a sound wave at one point in time.



(i) Label the diagram with the letter **R**, in an area of rarefaction.

(1)

(ii) Label the diagram to show one complete wavelength.

(1)

(Total 3 marks)

Q28.

The different parts of the electromagnetic spectrum are shown below.

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

(a) Name a part of the electromagnetic spectrum with:

(i) a longer wavelength than microwaves: _____

(1)

(ii) greater energy than X-rays: _____

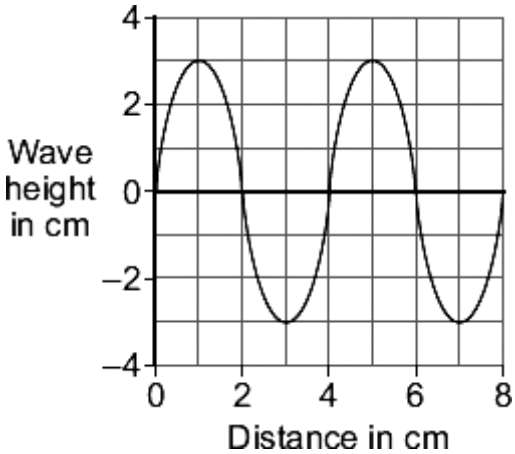
(1)

(iii) a higher frequency than ultraviolet: _____

(1)

(b) The properties of water waves can be measured easily in a school lab.

The diagram shows information about waves.



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

_____

(1)

(ii) What is the wavelength of each wave in the diagram?

_____ cm

(1)

(iii) What is the amplitude of the waves?

_____ cm

(1)

(iv) Complete the sentence below.

The oscillations of the waves in the diagram are perpendicular to the direction of energy transfer. They are called _____ waves.

(1)

(Total 7 marks)

Q29.

(a) Sound and light are different types of waves.

Give **two** similarities and **two** differences between sound waves and light waves.

_____

_____

_____

_____

_____

_____

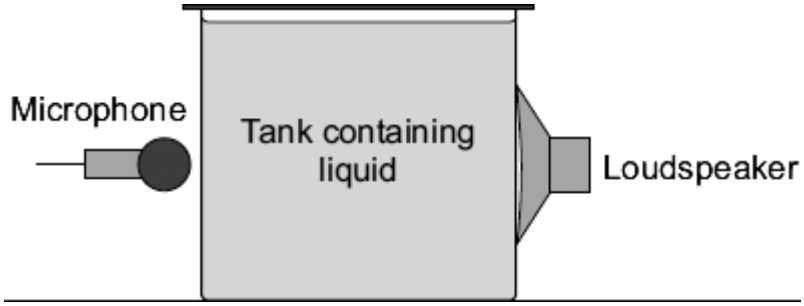
_____

_____

(4)

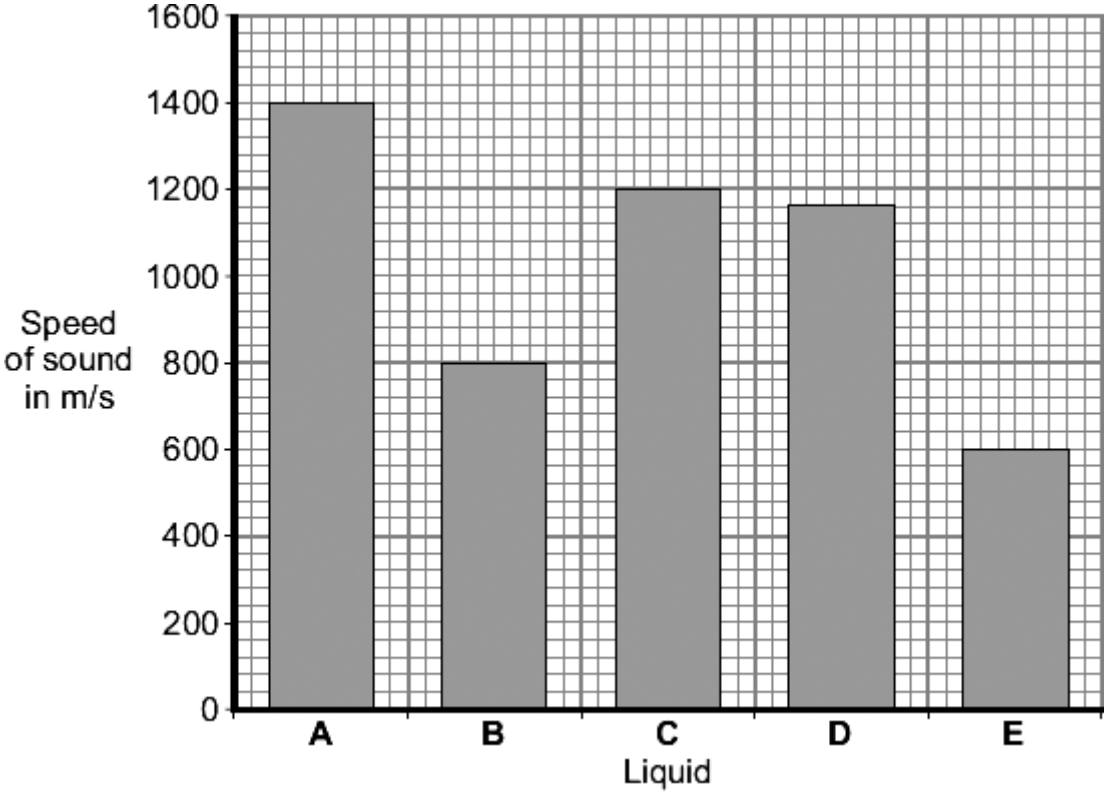
(b) A student does an experiment to investigate the speed of sound in different liquids.

The student uses the apparatus shown.



A loudspeaker makes a sound wave. The sound wave travels through the liquid in the tank. The time it takes to travel this distance is used to calculate the speed of sound.

The bar chart shows the student's results.



(i) When a sound wave with a frequency of 4800 hertz passes through one of the liquids, it has a wavelength of 0.25 m.

Calculate the speed of the wave and identify the liquid used.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

_____

_____

_____

_____

_____

Speed = _____ m/s

The liquid used was _____

(3)

(ii) The student's hypothesis was:
'There is a link between the density of a liquid and the speed of sound in the same liquid.'

Liquid	Density in g/cm^3	Speed of sound in m/s
Ethoxyethane	0.71	985

Ethanol	0.80	1150
Kerosene	0.82	1300
Water	1.00	1500
Mercury	13.50	1450

Use the information in the table to decide whether the student's hypothesis was completely correct or not.

Was the student's hypothesis completely correct?

Draw a ring around your answer. **Yes** / **No**

Give reasons for your answer.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q30.

Some TV signals are transmitted to a satellite in space and back to Earth. A satellite dish is fixed to a house. The satellite dish receives the TV signal. Microwaves are used for satellite TV transmission.

Photograph supplied by iStockphoto/Thinkstock

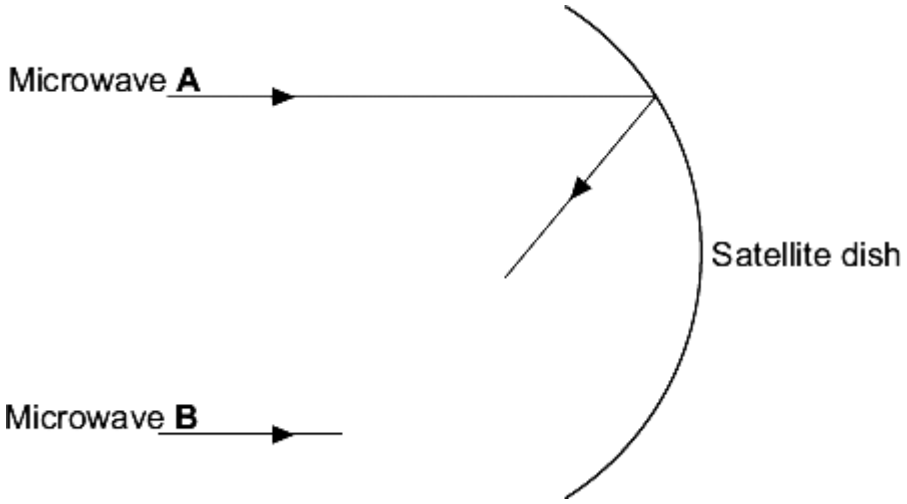
(a) Why are microwaves used, rather than radio waves, to transmit TV signals to and from satellites in space?

_____

_____

(1)

(b) The shape of the satellite dish allows microwaves to be focused at the receiver. The diagram shows how microwave **A** is reflected by the satellite dish.



(i) Complete the diagram to show how microwave **B** is reflected by the satellite dish.

(1)

(ii) Draw on the diagram where the receiver should be placed.

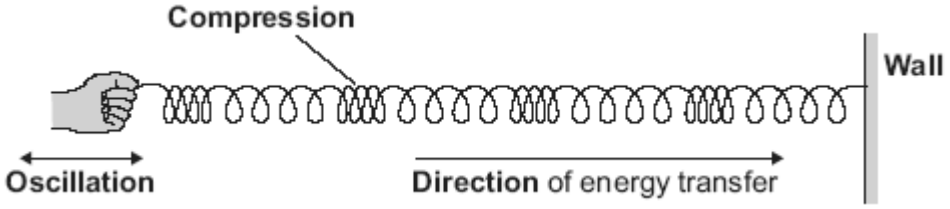
For the receiver, use this symbol: ☐

(1)

(Total 3 marks)

Q31.

(a) The diagram shows a longitudinal wave being produced in a stretched spring.



(i) Use the bold words from the diagram to complete the following sentence. Put only **one** word in each space.

A longitudinal wave is one in which the _____ causing

the wave is parallel to the _____ of energy transfer.

(2)

(ii) Name the type of energy that is transferred by longitudinal waves.

_____

(1)

(b) The diagram shows water waves made by a wave machine in a swimming pool.

Every second, two waves go past a person standing in the swimming pool.

The waves have a wavelength of 0.8 metres.

Calculate the speed of the water waves.

Write down the equation you use, and then show clearly how you work out your answer.

Give the correct unit in your answer.

_____

_____

_____

_____

_____

_____

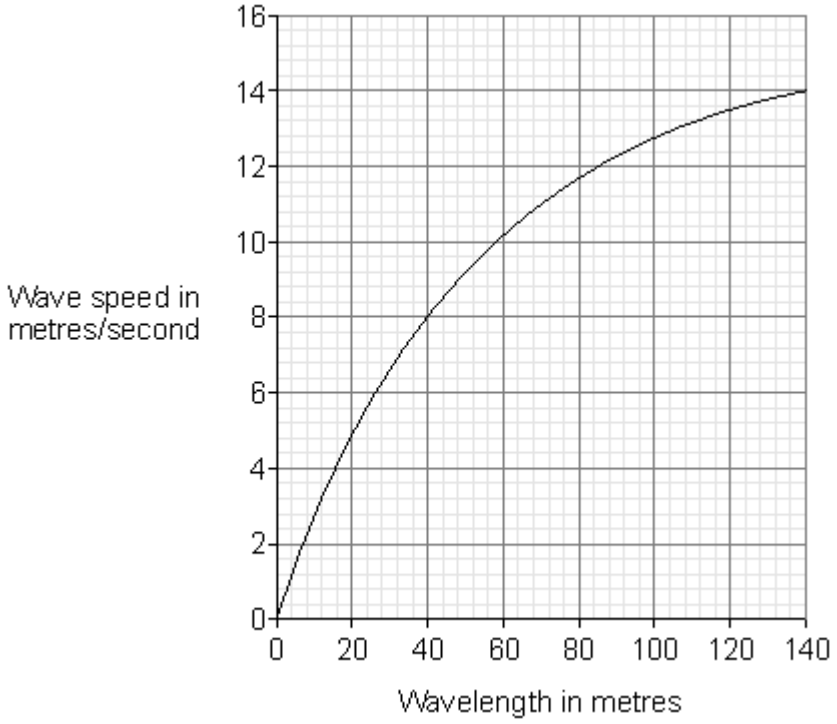
_____

_____

Wave speed = _____

(3)

(c) The graph shows how the speed of deep ocean waves depends on the wavelength of the waves.



What can you conclude from the graph?

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

Mark schemes

Q1.

D

gains 1 mark

but E (D + E = 1)

gains 2 marks

[2]

Q2.

X-rays $\left\{\begin{matrix}\text{infrared}\\ \text{radiation}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{radio}\\ \text{waves}\end{matrix}\right\}$

for 1 mark each

[3]

Q3.

(a) ray shown refracted (to rhs or along normal)

gains 1 mark

but

ray shown refracted <u>away from</u> 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]

Q4.

(a) (i) a horizontal distance indicated and labelled

gains 1 mark

but

horizontal distance indicated between identical points on adjacent waves (to within 3-4mm) and labelled

gains 2 marks

2

(ii) peak ↔ trough indicated*

gains 1 mark

but

peak / trough ↔ mean indicated*

(to within 1-2mm either end)*

gains 2 marks
(allow 1 mark if both lines unlabelled or 2 marks if both lines accurately drawn and unlabelled)

2

(b) • 1.5

• hertz / Hz **or** (waves / cycles) per second

for 1 mark each
(do not allow wavelength / hertz per second)

2

[6]

Q5.

(a) one of the areas where particles are spread out labelled R

1

(b) parallel

1

(c) 340 (m / s)

*allow **1** mark for correct substitution*
i.e. speed = 400 × 0.85 provided that no subsequent steps are shown

2

[4]

Q6.

(a) (i) a ray drawn leaving the block parallel to the incident ray

straight, continuous line judged by eye

*do **not** accept a ray of light with an arrow towards the block*

1

(ii) normal

1

(b) (i) a smooth <u>curve</u> drawn through the points

1

(ii) as the angle of incidence increases the angle of refraction increases

allow correct description of their answer to (i)

ignore the angle of incidence is always larger than the angle of refraction

1

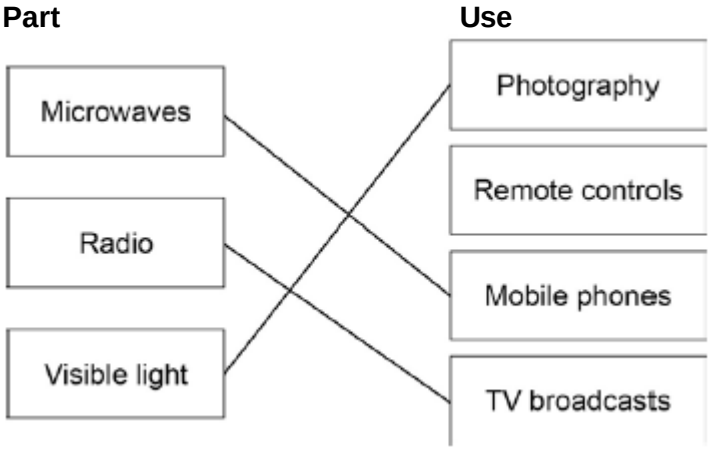
it is a non-linear graph
or
not directly proportional

allow a correct description of the graph / points

1

[5]

Q7.



any extra line negates mark

3

[3]

Q8.

(a) 2(dB)

1

(b) 5500(Hz)

1

(c) 340(m / s)

allow 1 mark for correct substitution (20 x 17) provided no subsequent step

2

(d) echo(es)

1

[5]

Q9.

(a) *straight line continued through glass block to meet edge of the block*

do not allow dotted / dashed lines

judge by eye

1

straight line drawn through crosses *to meet the edge of block*

judge by eye

ignore reflection within the block

ignore 'normal' line

1

(b) *any **one** from*

- safety / dark glasses

  ignore goggles / glasses
  unqualified
- safety / dark goggles

  ignore special goggles / glasses
  ignore sunglasses / eye protection
- don't look at laser (directly)

allow don't shine laser into someone's eyes

1

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

- too many points above line
  allow line of best fit only goes through 2 points
  allow line doesn't go through most points
  allow line should go through more / most points
  allow 3 points have been ignored
- no points below the line
- line should be curved
  allow there should be equal numbers of points on both sides of line

1

(ii) any **two** from:

- use smaller interval between readings
  eg allow go up in 10's
- take readings at more angles
  allow take readings at different angles / named angles
- repeat the experiment / readings *and calculate a mean*
  allow repeat the experiment to identify anomalies
- use a narrower ray of light
  ignore take more readings
  ignore compare results (with other students)

2

[6]

Q10.

(a) Group 1

ignore figures
reason only scores if group correct

Reason: Loudest sound needed for person to notice it.

allow louder sound
allow exposed to loud noise for longest / longer

1

(b) any **three** from:

ignore Group 1 has the worst hearing
ignore figures unqualified

- the *longer* the exposure (to loud sounds) the greater the hearing loss
- no exposure / *Group 3* has the best hearing
  allow better
- hearing worsens (significantly) for frequencies above 1000Hz (or converse).
  ignore hearing is worse at high frequencies
- the first 10 years exposure has more of an effect than the next 10 years
  allow 10 years exposure to loud noise has no effect on hearing at 500 Hz

3

[4]

Q11.

0.000294 or 2.94×10^{-4} (m)

*a correct answer given to an incorrect number of significant figures gains **2** marks*

*eg 2.939×10^{-4} (m) **or** 2.93×10^{-4} (m)*

***or** 0.0002939 (m) **or** 0.000293 (m)*

***or** 2.9×10^{-4} (m) **or** 0.00029 (m)*

***or** 3×10^{-4} (m) **or** 0.0003 (m)*

*allow **1** mark for correct substitution*

1540 = 5 2400 000 × λ

***or** 1540 = 5.24×10^{6} × λ*

provided no subsequent step

***or** allow **1** mark for correct substitution and rearrangement*

$$\lambda = \frac{1540}{5\,240\,000}$$

or

$$\lambda = \frac{1540}{5.24 \times 10^{6}}$$

provided no subsequent step

an answer of 2.94 gains one mark only

an answer given to an incorrect number of s.f. and including a rounding error gains one mark only

eg 2.938×10^{-4} (m)

3

[3]

Q12.

(a) radiation

ignore infra red, IR, or heat

1

(b) (i) 105 000 000

(E = mcθ)

accept answers in standard form eg. 1.05×10^{8}

*E = 5000 × 4200 × 5 gains **1** mark*

Unit mark is independent, but must match value given for full marks

if no other marks gained 1 mark for any correct unit of energy

2

J / joules

not lower case j

allow Joules

allow units in words eg kilojules

*allow 105 000 kJ or 105 MJ for **3** marks. These figures must have units.*

allow units written as words Eg. kilojoules

not KJ, kj, mJ, Mj

1

(ii) 6600(s) / 6560(s) / 6563(s) / 6562.5(s)

(E = Pt)

allow ecf from (b)(ii)

allow answers in minutes and hours provided correct and unit changed on answer line

eg. 109 / 110 minutes or 1.8 hours

*if correct answer given with incorrect unit, maximum mark of **2** eg 6600 minutes*

*105 000 000 = 16 000 × t gains **1** mark*

*t = 105 000 000 / 16 000 gains **2** marks*

*t = 105 000 000 / 16 gains **1** mark*

or

6 562 500(s) gains 2 marks

3

(iii) energy gained from surroundings / air

allow heat

ignore air is warmer or pool is colder

1

[8]

Q13.

(a) transverse

1

(b) (i) 700

in either order

1

400

1

(ii) stays the same

1

[4]

Q14.

(a) 1st box ticked

1

(b) (i) continuous reflected ray parallel to incident ray (by eye)

1

an arrow shown correctly

arrow must be drawn on a continuous ray reflected by top mirror

1

(ii) normal

1

[4]

Q15.

(a) 2.5(cm)

*10 / 4 for **1** mark*

2

(b) (i) 3 (m/s)

*allow 0.5 × 6 for **1** mark*

2

(ii) any **one** from:

- cheaper
- (easier) to make adjustments
- easier to handle
- external conditions can be controlled
- for safety
- fit for purpose

allow to see if it works / floats / has faults

1

[5]

Q16.

(a) X = wavelength

1

Y = frequency

1

wavelength in metres / m and frequency in hertz / Hz

*both units correct for **1** mark (independent of first two marking points)*

correct units must match correctly named quantities

allow Hertz

allow multiples of the units eg kHz, km (or in words)

1

(b) (i) galaxy A is stationary (relative to Earth / us)

1

galaxy B is moving towards (Earth / us)

allow 1 mark for identifying galaxies B and C are moving in opposite directions

1

galaxy C is moving away from (Earth / us)

*allow **1** mark if say <u>all</u> moving away / towards **or** stationary*

1

(ii) galaxy C is fast<u>er</u> (than galaxy B)

allow converse statement

*do **not** accept galaxy C <u>expanding</u> faster*

1

(iii) sample is too small

accept three is too few

allow not enough evidence

ignore inaccurate, invalid, anomalous

1

compared to the size of the population

accept there are a very large number of galaxies in the Universe

*allow A, B and C are moving differently (from each other) for **1** mark*

1

[9]

Q17.

(a) (i) absorb

1

(ii) more

1

(b) (i) conduction

1

(ii) colour (of cube)

allow colour (of box)

1

(iii) Cube Y

*all three in correct order for **2** marks*

Cube X

Cube Z

*one or two correct for **1** mark*

allow grey for X

allow white for Y

allow black for Z

2

(iv) results can be compared

accept start temperature affects rate of energy transfer

or

start temperature affects how quickly the cube cools down

ignore fair test / reliability / accuracy / control variable / valid

1

(v) control (variable)

allow controls / controlled

1

[8]

Q18.

(a) energy transferred from athlete / skin / body to water / sweat

allow water / sweat heated by athlete

1

(so) more energetic (water / sweat) particles escape (from the liquid)

accept particles with higher speeds escape (from the liquid)

1

water / sweat <u>evaporates</u>

accept particles escape from the (surface of the) liquid

1

(which) lowers the <u>average</u> energy of (remaining) water / sweat particles

allow reference to the total energy of the liquid reducing

allow lowers the athlete's <u>temperature</u>

ignore cool down

1

(b) any **three** from:

accept IR / radiation / heat / infrared / energy throughout

- the blanket traps air
- air is an insulator

  accept for 2 marks trapped air reduces conduction / convection
- space blanket reflects infrared radiation (back to the body)

  ignore incident solar radiation

  ignore reflects light

  ignore bounces off
- space blanket is a poor emitter / radiator of infrared radiation

  *do **not** accept does not emit infrared radiation*

3

[7]

Q19.

(a) (i) B

1

(ii) longitudinal

1

(b) (i) the sound wave travels to the building and back

allow (because) it is an echo

1

(ii) 0.30 / 0.3

*allow **1** mark for*

$$\frac{0.30 + 0.27 + 0.33}{3}$$

or

$$\frac{0.9}{3}$$

2

(iii) 100 (m)

allow ecf from (b)(ii) with a tolerance of ± 10 (m)

1

(iv) use a sound sensor and a datalogger to measure the time

1

(v) (amplitude of echo is) smaller

ignore quieter

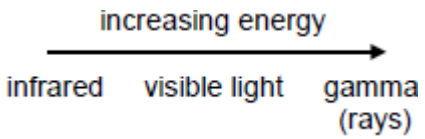
allow lower

1

[8]

Q20.

(a)



*3 correct = **2** marks*

*1 or 2 correct = **1** mark*

allow IR for infrared

allow visible or light for visible light

2

(b) (i) frequency

1

(ii) vacuum

1

(c) IR - remote control / fibre optic

ignore phones and cables unless qualified

1

microwave - <u>mobile</u> phone / satellite (TV)

1

radio – (terrestrial) TV / radio <u>transmissions</u>

allow walkie talkies

1

visible light – photography / fibre optic

allow valid examples of communication using visible light
e.g. traffic lights, sign language

1

[8]

Q21.

(a) any **two** from:

- (longitudinal) oscillations are parallel to the direction of energy transfer
- (transverse) oscillations are perpendicular / 90° to the direction of energy transfer

  allow vibrations for oscillations

  allow correct description of particle movement for oscillation

  allow direction of wave for direction of energy transfer
- (longitudinal waves) show areas of compression and rarefaction

  marks can be gained from correctly labelled diagrams

  ignore references to need for a medium to travel through

2

(a) (i) reaction time

allow a description of reaction time

allow measuring the time

1

(as) time measured is very small

allow (as) sound travels quickly

1

(ii) 0.28(3)

*an answer of 283(.3) gains **2** marks*

*allow correct substitution and unit conversion for **2** marks 340 =1200 λ **or** 340 / 1200 = λ provided no subsequent step shown*

*allow correct substitution for **1** mark 340 =1.2 λ **or** 340 / 1.2 = λ provided no subsequent step shown*

3

[7]

Q22.

(a) convection

1

(b) any **two** from:

- easier / clearer to read **or** reading error less likely / takes readings for you
- greater resolution / temperature displayed to two decimal places

  ignore precision / accurate / reliable / sensitivity
- more frequent readings

  ignore readings every second / plots graph / quicker
- more data
- live graphical representation

  allow references to safety

  allow no need to open lid (thus preventing cooling)

2

(c) (i) black is a better <u>emitter</u> / <u>radiator</u> of energy / infrared radiation

allow heat

for full marks there must be a comparison in terms of emission / radiation

*allow **1** mark for: temperature of black can decreases faster / more*

or

water in black can has reached room / constant temperature whilst water in white can is still cooling

or

correct description of temperature drop in both cans after 14 minutes

2

(ii) (any) line drawn between the white can and black can lines on graph **starting at 100** (°C)

1

line shows the same trend as white can line **or** black can line

second mark only scores if first marking point correct

*do **not** award this mark if line shows intentional rise at any point*

1

[7]

Q23.

(a) (light waves) are transverse

1

(sound waves) are longitudinal

1

(b) (i) B

1

(ii) D

1

[4]

Q24.

(a) 2 cm

1

(b) 5 (hertz)

ignore incorrect units

1

(c) $v = f \times \lambda$

10 (cm/s)

*allow correct substitution for **1** mark (20 × 0.5) **or** (2 × 5)*

2

(d) (i) point at 6 cm on x-axis should be circled

1

(ii) line of best fit drawn through points ignoring anomalous point at 6 cm

line should be a curve through every point (including 0) except anomalous point

tolerance ±1 square at each cross

ignore line after 16 cm

*do **not** accept straight lines joining crosses*

1

(iii) 3.5 (cm/s)

tolerance ± half a square from students line

allow ecf from (d)(ii)

if no extrapolation accept 3.5

1

[7]

Q25.

(a) *correct order only*

gamma (rays)

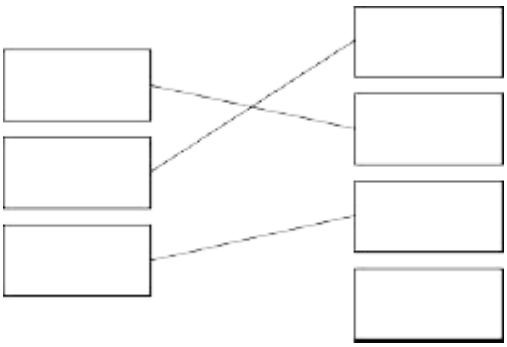
allow waves

1

(visible) light

1

(b)



extra line from statement cancels the mark

1
1
1

[5]

Q26.

$v = f \times \lambda$

1.5×10^{10} (hertz)
or
15 000 000 000

*allow **1** mark for correct substitution and transformation*
(3×10^8 / 0.02)
*allow **1** mark for 1.5×10^8*
***or** 150 000 000*

2

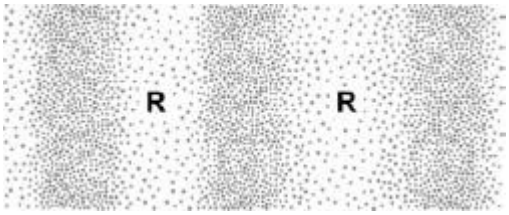
[2]

Q27.

(a) same / parallel to

1

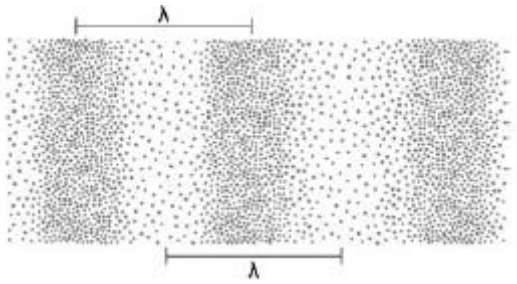
(b) (i) letter R where the particles are furthest apart



1

(ii) student correctly indicates one wavelength

wavelength may be from one rarefaction to the next or from one compression to the next



1

[3]

Q28.

(a) (i) radio (waves)

1

(ii) gamma (rays)

accept γ

*do **not** accept* α

1

(iii) X-rays
or
gamma (rays)

accept γ

*do **not** accept* α

1

(b) (i) 2

1

(ii) 4(cm)

1

(iii) 3(cm)

ignore + or – in front of 3(cm)

1

(iv) transverse

1

[7]

Q29.

(a) any **two** similarities and any **two** differences

read whole answer to ensure that there are no contradictory statements which negates that mark

ignore reference to senses in similarities and differences

similarities

- (both can be) reflected
- (both can be) refracted

  allow both travel through any correctly named solid / gas / liquid
- (both can be) diffracted

- (both) interfere
- (both) transfer energy

  ignore both are types of energy / waves / oscillations
- (both exhibit) Doppler effect

  *do **not** accept statements like both are transverse as a similarity*

differences

- light can travel through a vacuum
  or
  sound cannot travel through a vacuum

  allow sound requires a medium / particles to travel through
- (different) speed / velocity
- one is longitudinal and one is transverse

  accept light is faster than sound

  *do **not** accept sound is transverse and light is longitudinal*

  allow correct description:

  (longitudinal) the oscillations / vibrations are parallel to / same direction as (the direction of energy transfer)

  and

  (transverse) the oscillations / vibrations are 90° to / perpendicular to (the direction of energy transfer)
- sound is a mechanical wave / caused by vibrations and light is an electromagnetic wave

  accept sound waves have a longer wavelength / lower frequency

  *if no other marks gained allow **1** mark for any correct difference(s) where the waves are not specified*

  eg one is transverse

  eg have different wavelengths / frequencies

4

(b) (i) *working must be shown for **3** marks*

4800 x 0.25

1

1200(m/s)

1

(liquid) C

ignore water / named liquid

1

(ii) (yes / no)

ignore yes / no, marks are for the explanation

speed increases as density increases

allow positive correlation

allow the more dense the liquid the less time (for sound to travel through)

ignore they both increase

ignore there was no pattern

1

but, mercury should have a (much) greater speed given the higher density

allow mercury does not fit the pattern / is an anomaly

1

[9]

Q30.

(a) *accept 'they' as referring to microwaves*

microwaves can travel through the atmosphere / ionosphere

accept not reflected by ionosphere

or

radio waves cannot (escape from the atmosphere)

allow cannot penetrate / travel through

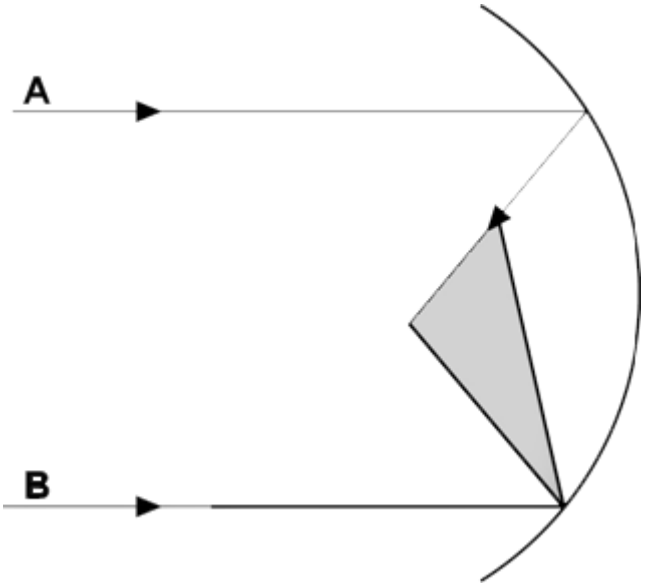
ignore frequency / wavelength

ignore reference to speed of waves

1

(b) (i) straight continuous lines drawn to show microwave B reflected by satellite dish

reflected ray should be within limits of grey area



1

(ii) receiver drawn using rectangle symbol where microwaves A and B meet / cross over

allow ecf from (b)(i)

if (b)(i) not attempted no marks can be awarded for (b)(ii)

if lines do not meet / cross over allow receiver where extended lines would meet

allow any clear indication where receiver should be

1

[3]

Q31.

(a) (i) oscillation

1

direction

1

correct order only

(ii) sound

1

(b) 1.6

*allow **1** mark for correct substitution into correct equation ie 2 × 0.8*

2

m/s

1

(c) as the wavelength increases so does the wave speed

1

extra information, eg wave speed increases faster between 0-40 m than between 100-140 m

1

or

not in proportion

[8]