

The Use of Waves for Communication

Question Paper

Level	GCSE
Subject	Physics
Exam Board	AQA
Unit	P1
Topic	The Use of Waves for Communication
Difficulty Level	Silver Level
Booklet	Question Paper

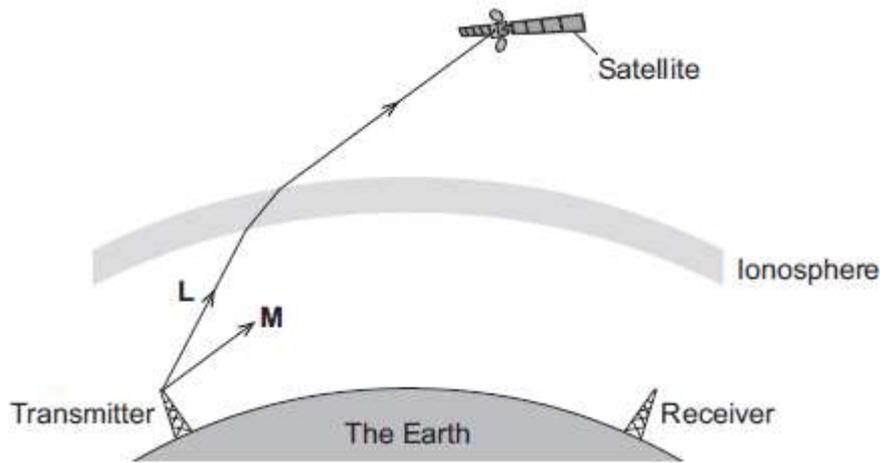
Time Allowed: 127 minutes

Score: /127

Percentage: /100

Q1. Different parts of the electromagnetic spectrum are useful for different methods of communication.

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



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

.....

(1)

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

.....

(1)

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

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

(2)

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

(1)

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

1.....

.....

2.....
.....

(2)
(Total 7 marks)

Q2.A note was played on an electric keyboard.

The frequency of the note was 440 Hz.

(a) (i) What does a frequency of 440 Hz mean?

.....
.....

(1)

(ii) The sound waves produced by the keyboard travel at a speed of 340 m / s.

Calculate the wavelength of the note.

Use the correct equation from the Physics Equations Sheet.

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

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.....
.....

Wavelength = metres

(3)

(b) **Figure 1** shows a microphone connected to a cathode ray oscilloscope (CRO) being used to detect the note produced by the keyboard.

Figure 1

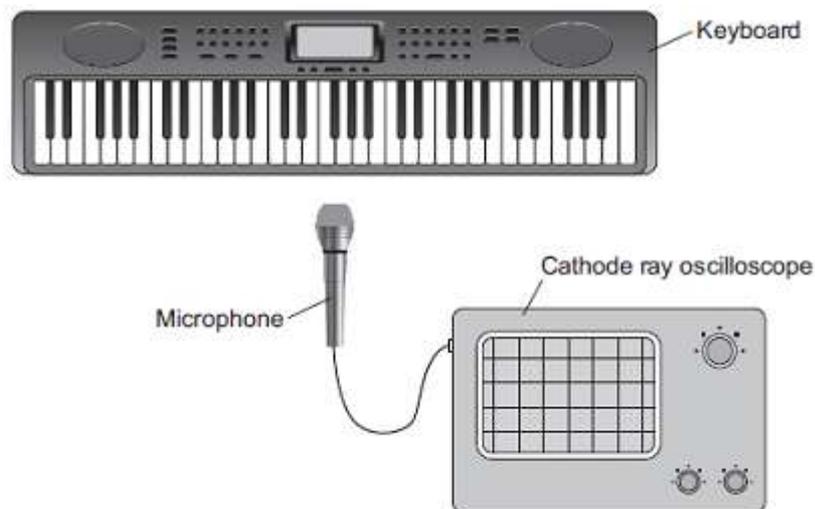
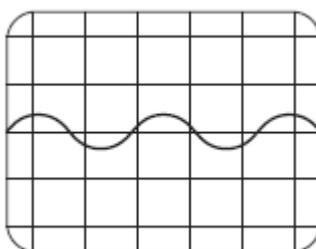


Figure 2 shows the trace produced by the sound wave on the CRO.

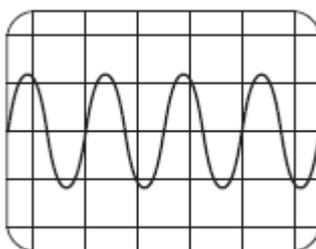
Figure 2



A second note, of different wavelength, was played on the keyboard.

Figure 3 shows the trace produced by the sound wave of the second note on the CRO.

Figure 3



The settings on the CRO were unchanged.

What **two** conclusions should be made about the **second** sound wave produced by the keyboard compared with the **first** sound wave?

Give a reason for each conclusion.

Conclusion 1

.....

Reason

.....

Conclusion 2

.....

Reason

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(4)
(Total 8 marks)

Q3.A doctor uses the radioactive isotope technetium-99 to find out if a patient's kidneys are working correctly.

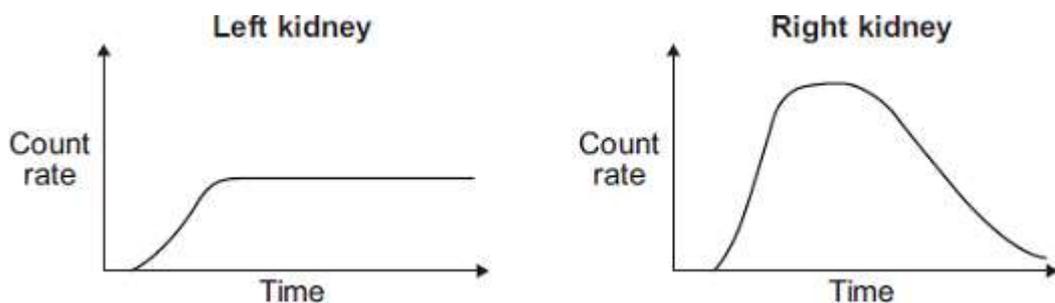


The doctor injects a small amount of technetium-99 into the patient's bloodstream. Technetium-99 emits gamma radiation.

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.

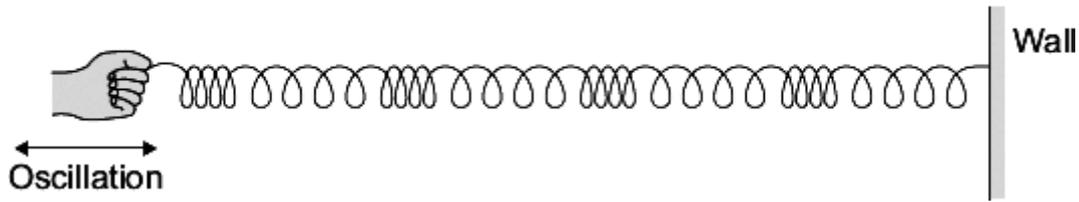
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(3)

(Total 4 marks)

Q4. Diagram 1 shows a longitudinal wave being produced in a stretched spring.

Diagram 1



- (a) A longitudinal wave has areas of compression and areas of rarefaction.

Mark with the letter **C**, **one** area of compression shown in **Diagram 1**.

(1)

- (b) **Diagram 2** shows the apparatus a teacher uses to demonstrate that sound can be reflected.

Diagram 2



- (i) Using a ruler, draw on **Diagram 2** to show how sound from the loudspeaker is reflected by the sheet of metal to the sound sensor.

(2)

- (ii) The teacher replaced the sheet of metal with a sheet of glass.

When he did this, the reading on the sound level meter went down.

Suggest why.

.....

(1)

- (iii) The teacher changed the output from the loudspeaker to increase the amplitude of the sound wave produced.

What effect, if any, does this increase of amplitude have on the loudness of the sound?

Draw a ring around the correct answer.

- makes the sound quieter** **does not change the loudness of the sound** **makes the sound louder**

(1)

- (iv) The loudspeaker produces a sound wave at a frequency of 850 Hz. The wavelength of the sound wave is 0.4 m.

Calculate the speed of the sound wave.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

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

Speed = m/s

(2)

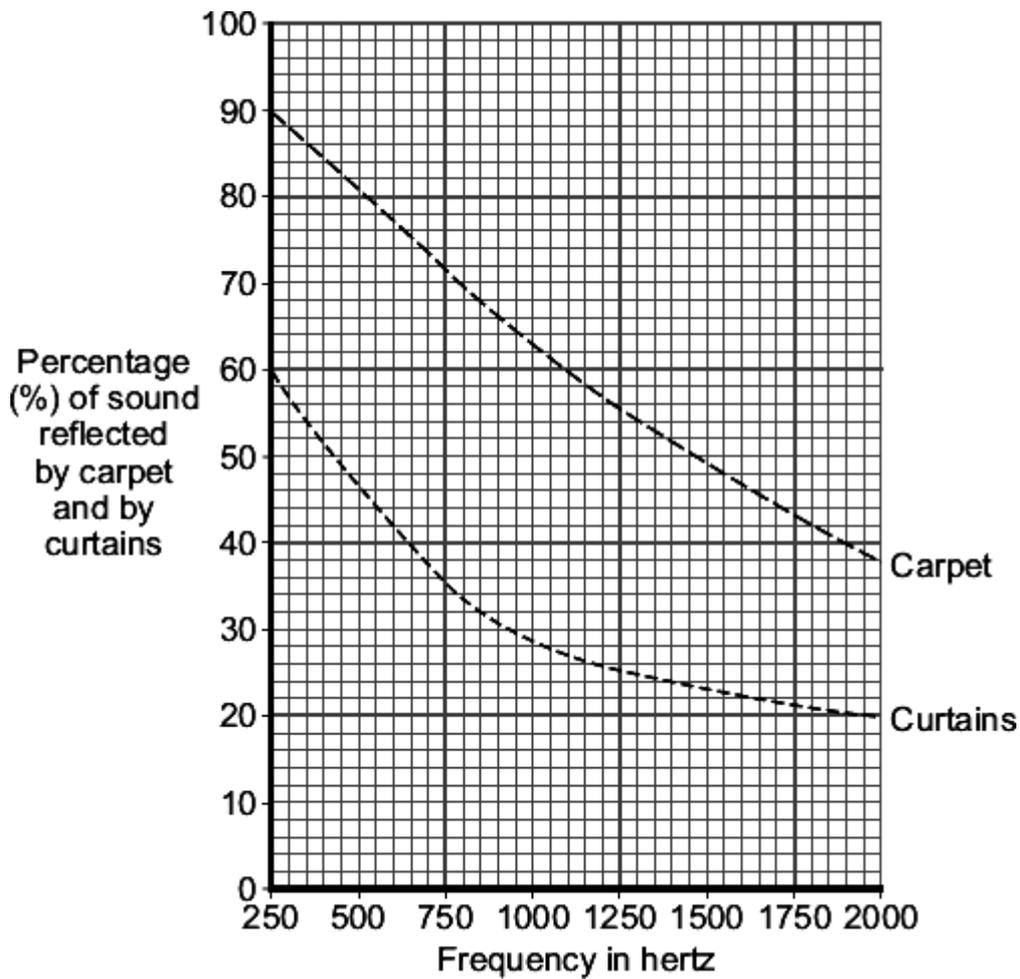
- (c) Music concerts are sometimes performed in sports halls. The concerts can be spoilt because of the sound reflected from the floor and walls.

What word is used to describe a reflected sound?

.....

(1)

- (d) The graph shows how the percentage of sound reflected from the floor and from the walls of a large room can be reduced by carpets and by curtains.



- (i) Over which range of frequencies do curtains reduce the percentage of sound reflected the most?

Tick (✓) **two** boxes.

from 250 Hz to 750 Hz

from 750 Hz to 1250 Hz

from 1250 Hz to 1750 Hz

(1)

- (ii) The manager of a sports hall plans to use the hall for regular music concerts. He has enough money to buy either carpet or curtains, but not both.

To improve the sound an audience hears, it would be better to hang curtains on the walls rather than laying a carpet over the floor.

Use the data in the graph to explain why.

.....
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(2)
(Total 11 marks)

Q5. 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?

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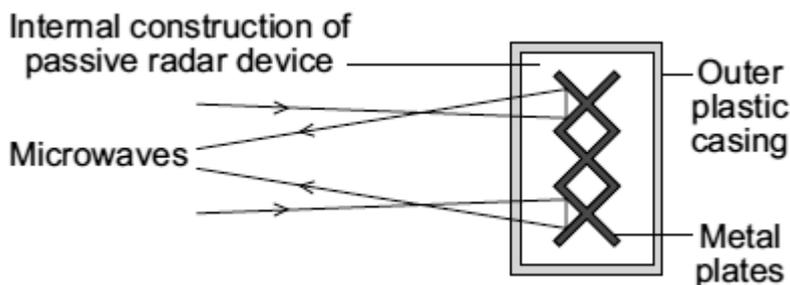
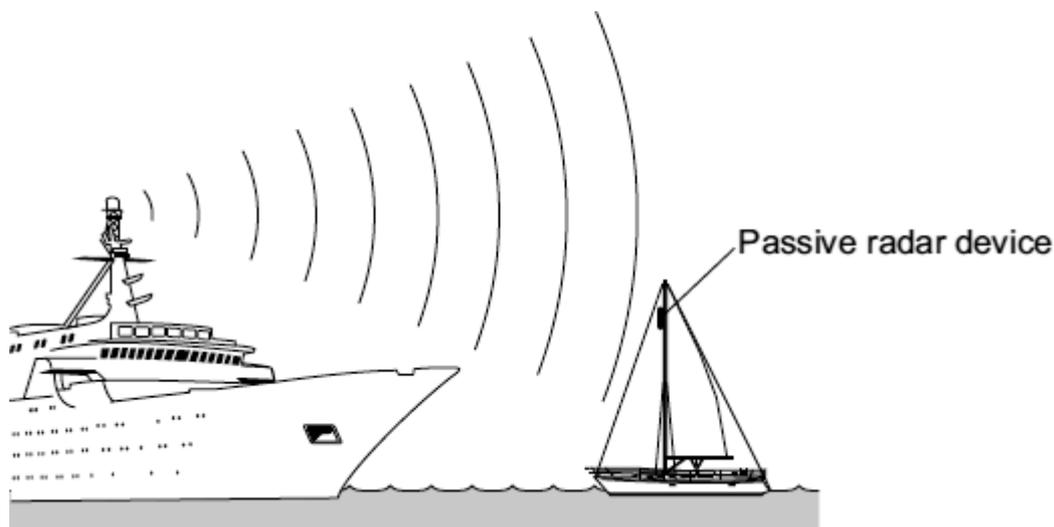
(1)

(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.

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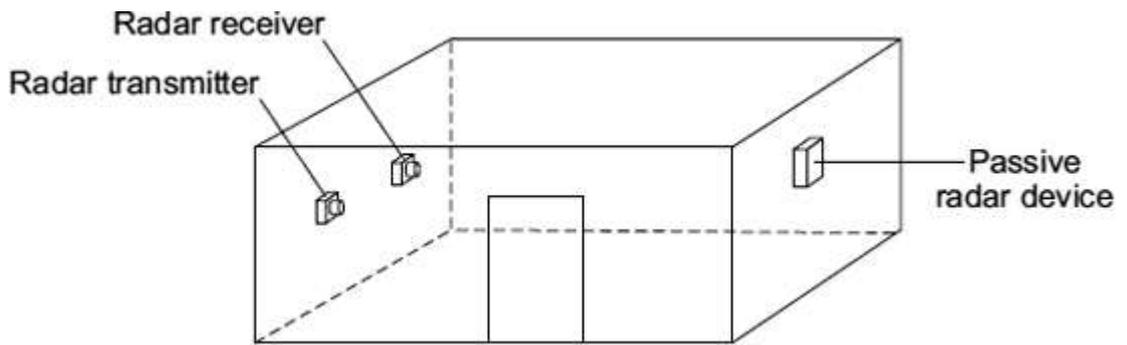
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(2)

- (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)

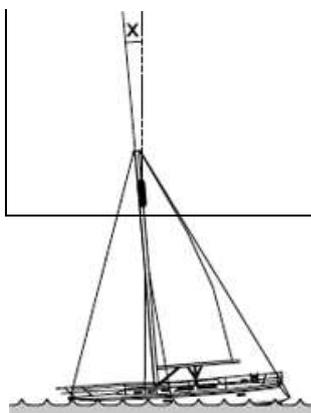
(iii) Why is it important that the measurements are made by an independent group of scientists?

.....

(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.

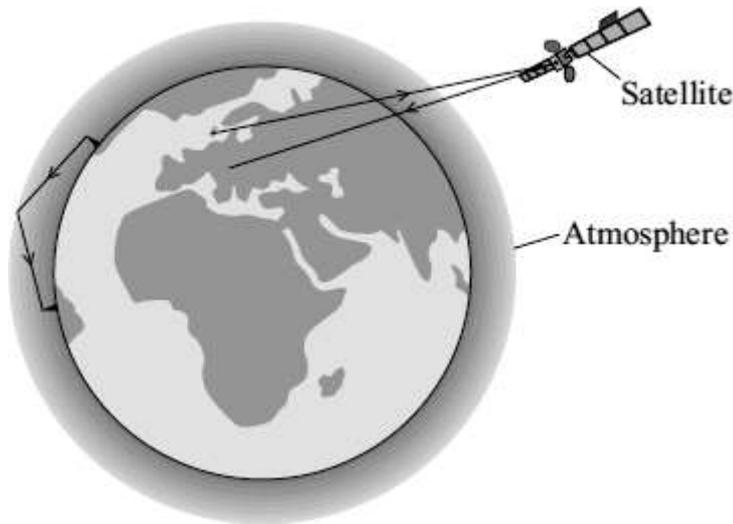
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(1)

(Total 10 marks)

- Q6.** (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) The diagram shows two types of signal that can be used to send information. One of the signals is an analogue signal. The other is a digital signal.



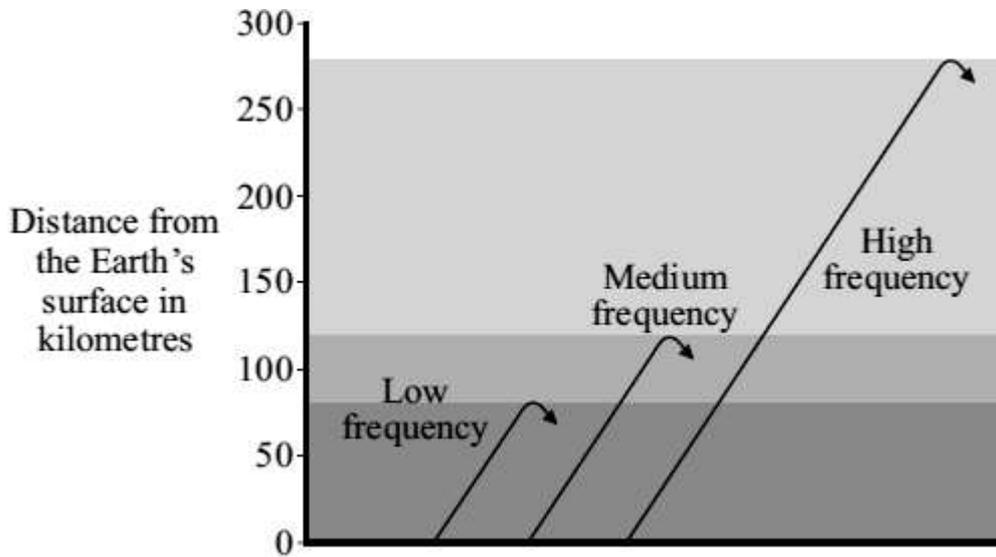
Describe the differences between an analogue signal and a digital signal.

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(2)

(c) 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)

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

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

Use the equation in the box to calculate the frequency, in kilohertz (kHz), of these waves.

$\text{wave speed} = \text{frequency} \times \text{wavelength}$

Show clearly how you work out your answer.

.....

Frequency = kHz

(2)
 (Total 7 marks)

- Q7.** (a) Scientific research carried out in 13 countries has tried to find out if there are any links between using a mobile phone and developing different types of cancer.

About 13 000 people, half with cancer and half in good health, were interviewed about their mobile phone use.

- (i) Suggest why people in good health were interviewed.

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.....
.....

(1)

- (ii) Interviewing 13 000 people gave the researchers a large sample size.

Give **one** advantage, in any research project, of having a large sample size rather than a small sample size.

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.....
.....

(1)

- (b) The following information was included in a newspaper article about the research project.

- It may be difficult to prove there is a link simply by asking people how much they use a mobile phone. People’s memories are not always accurate.
- Scientists in Israel found that people who use a mobile phone a lot are 50% more likely to develop a cancer on the salivary gland just in front of the ears.
- The cost of the research, £20 million, has been partly paid for by mobile phone companies.

• No children were included in the research.

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

Using children in scientific research raises

environmental
ethical
social

 issues.

(1)

(ii) Suggest **two** reasons why some people are concerned that the research was partly paid for by mobile phone companies.

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

(2)

(iii) In Germany, mobile phones that emit very low levels of radiation are marked with a special symbol.

Explain why low emission mobile phones should be marked in this way.

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.....
.....

(2)

(Total 7 marks)

Q8. The diagram shows a plane mirror used by a dentist to see the back of a patient's tooth.



(a) Use a ruler to draw a ray of light on the diagram to show how the dentist is able to see the tooth labelled **Z**.

(3)

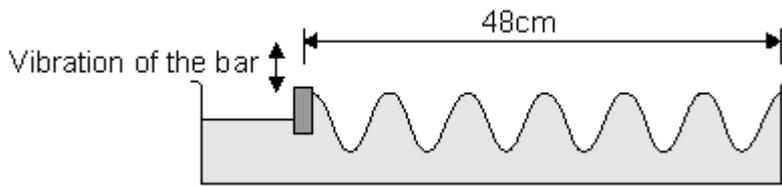
(b) Describe the image formed by a plane mirror.

.....
.....

(2)

(Total 5 marks)

Q9. Water waves can be made by vibrating a wooden bar up and down in a tray of water.
The bar moves up and down at a frequency of 5 hertz.



- (a) Calculate the speed, in cm/s, of the water waves.

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

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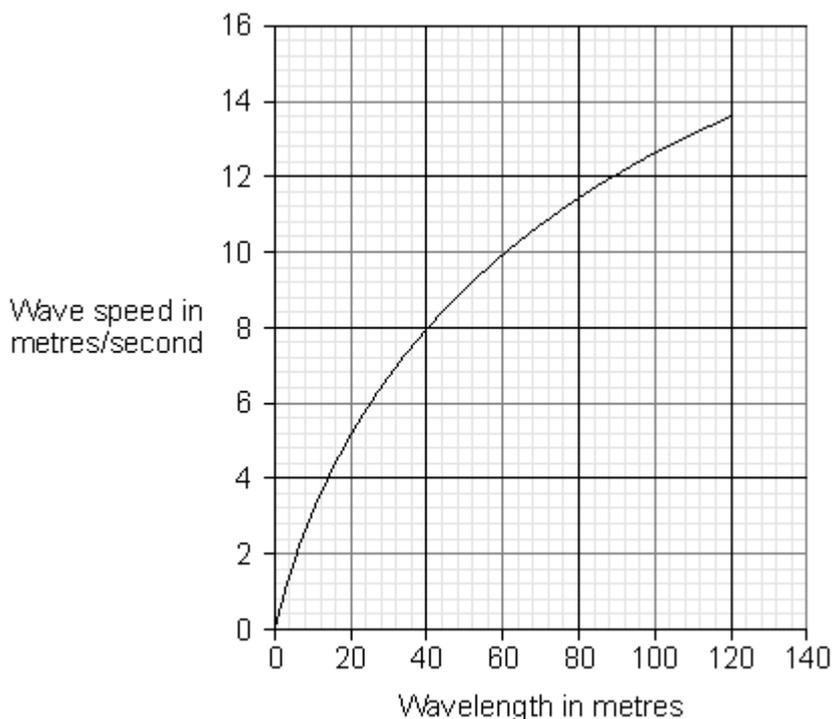
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Wave speed = cm/s

(3)

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



Use the graph to predict a speed for waves with a wavelength of 140 m.

Show clearly how you have used the graph to work out your answer.

Speed of waves = m/s

(2)
(Total 5 marks)

Q10. (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	issues involved in using
	environmental	
	ethical	

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?

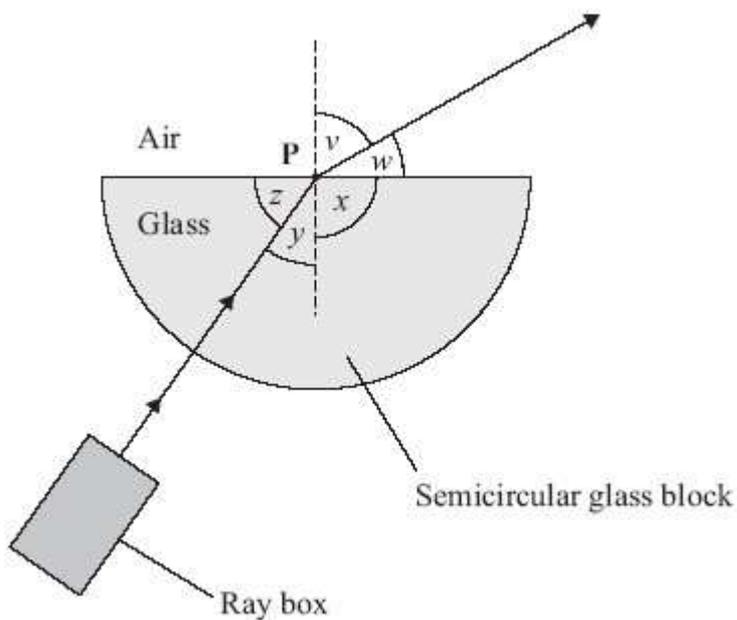
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(1)

(Total 6 marks)

Q11. A student uses a ray box and a semicircular glass block to investigate refraction.



(a) What is the vertical dashed line called?

.....

(1)

(b) Which angle, v , w , x , y or z , is the angle of refraction?

.....

(1)

(c) Why has refraction taken place?

.....

.....

(1)

(d) In an investigation, a student always aims the light from the ray box at point **P**. She moves the ray box to give different values of angle v . She records angle y for each of these values. The table shows her results.

Angle v measured in degrees	Angle y measured in degrees
30	19
40	25
50	31
60	35
70	39
80	41

The student studies the data and comes to the following conclusion.

Angle y is directly proportional to angle v .

Her friend says that this conclusion is **not** correct.

- (i) Use data from the table to explain why the conclusion is **not** correct.

.....
.....

(2)

- (ii) Write a correct conclusion for the experiment.

.....
.....

(1)

- (iii) Why is your conclusion only valid when angle v is between 30° and 80° ?

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.....

(1)

(Total 7 marks)

Q12. When sound waves reach a material, some of the energy of the sound is reflected and some is transmitted through the material.

(a) Complete the sentence.

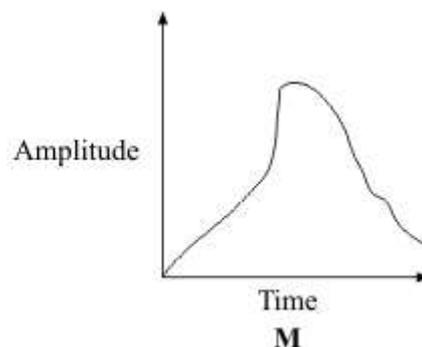
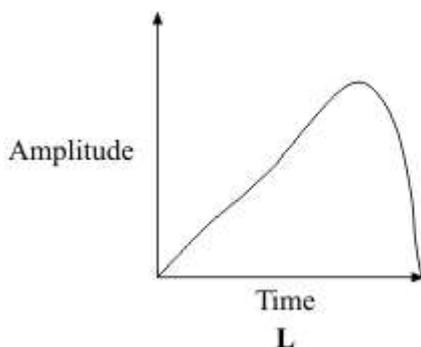
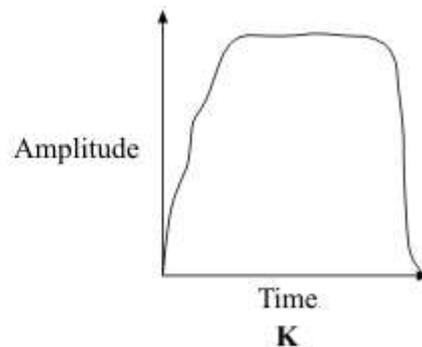
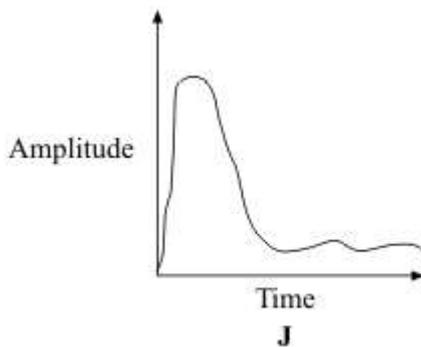
Sound waves are caused by

(1)

(b) The graphs **J**, **K**, **L** and **M** represent the sound energy reflected from a surface.

The graphs are all drawn to the same scale.

Which graph shows the greatest total sound energy output from the surface?



Graph

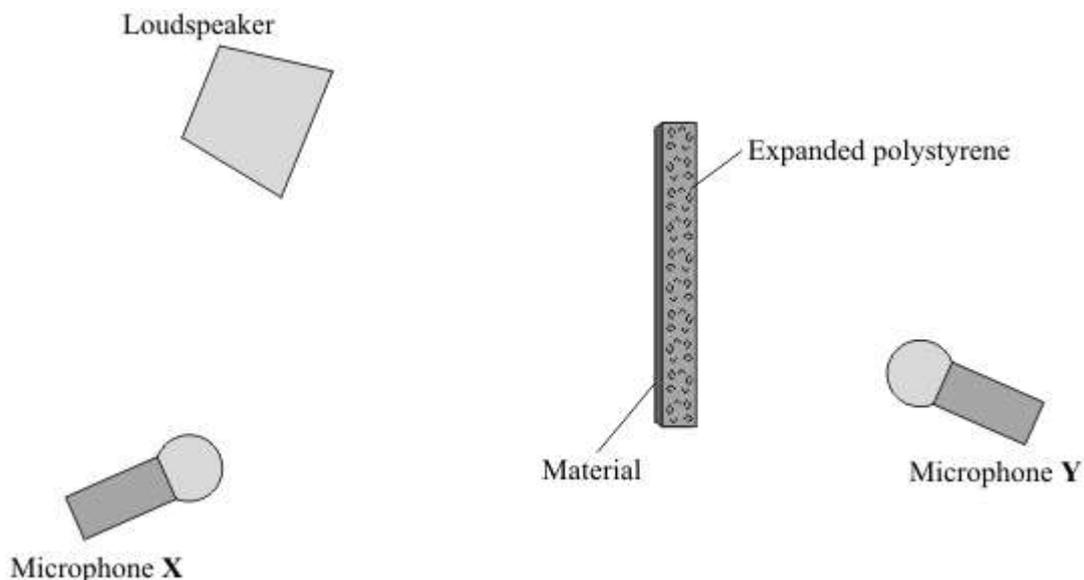
(1)

- (c) The proportion of the sound energy which is reflected or transmitted depends on the material which receives the sound.

A student investigates different materials.

The diagram shows how a student sets up her equipment.

- (i) Using a pencil and ruler to draw on the diagram, show how microphone X receives reflected sound.



(2)

- (ii) The student tests four materials. Each sheet of material is 1 mm thick. This has been glued onto a block of expanded polystyrene.

Why does the student use the same size of expanded polystyrene block and the same sound level for each test?

.....
.....

(1)

- (iii) The table shows the readings for the sound level transmitted to microphone Y.

Sound level from loudspeaker in arbitrary units	Surface material	Sound level transmitted to microphone Y in arbitrary units
60	paper	39
60	plaster	18
60	cloth	31
60	wood	15

[A] Which surface material transmits the smallest proportion of the sound?

.....

(1)

[B] What proportion is this?

.....

(1)

(d) People living in a flat have very noisy neighbours who are always playing loud music.

Suggest **one** practical idea to reduce the amount of noise transmitted into the flat through the walls and explain how your idea will work.

.....

(2)

(Total 9 marks)

Q13. Telephone messages are sent by various means.

(a) Name the devices used to change:

(i) sound vibrations into electrical vibrations.

.....

(ii) electrical vibrations into sound vibrations.

.....

(2)

(b) Explain how information is transferred from one telephone to another when:

(i) both the telephones are mobile phones.

.....

.....

(ii) both telephones are directly linked by copper wiring.

.....

.....

(iii) both telephones are directly linked by optical fibres.

.....

.....

(3)

- (c) The amplitude of the wave carrying the message is reduced during transmission. What effect will this have on the sound produced at the other telephone?

.....

(1)

(Total 6 marks)

Q14. Most young people can hear sounds in the frequency range 20 Hz to 20 000 Hz.

- (a) Tick the box beside the statement which best describes frequency.

the maximum disturbance caused by a wave

the number of complete vibrations per second

the distance between one crest of a wave and the next one

the distance travelled by a wave in 1 second

(1)

- (b) Diagram X shows a trace on an oscilloscope screen.

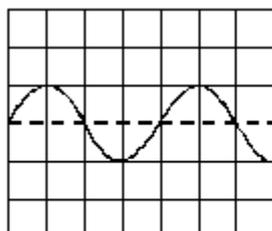


Diagram X

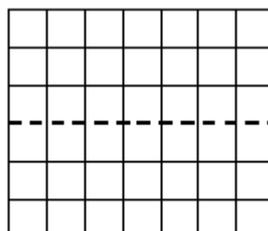


Diagram Y

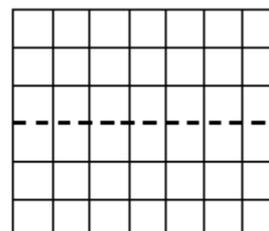


Diagram Z

- (i) Draw a trace on diagram Y which has a higher frequency than that shown in diagram X.

- (ii) Draw a trace on diagram Z which has a larger amplitude than that shown in diagram X.

(2)

- (c) Choose words from the list below to complete the following sentences.

higher louder lower quieter

- (i) A musical note with a high frequency sounds than one with a low frequency.

- (ii) A noise of small amplitude sounds than one with large amplitude.

(2)
(Total 5 marks)

Q15. The diagram shows a wave travelling along a rope.



(a) On the diagram:

- (i) show the wavelength and label it **W**;
- (ii) show the amplitude and label it **A**.

(2)

(b) The wavelength of the wave is 0.1 m. Its frequency is 2 Hz.

Calculate the speed of the wave. Show clearly how you work out your answer and give the unit.

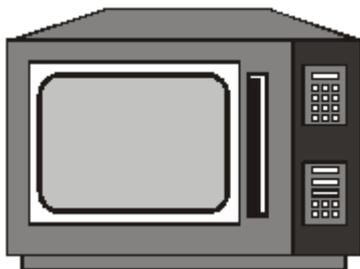
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Speed of wave

(3)

(Total 5 marks)

Q16. Microwave ovens can be used to heat many types of food.



(i) Describe, in as much detail as you can, how microwaves heat food.

.....

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

(2)

(ii) Microwaves have a frequency of 10 000 million Hz. Their wavelength is 0.03 m.

Calculate the speed of microwaves.

Show clearly how you work out your answer.

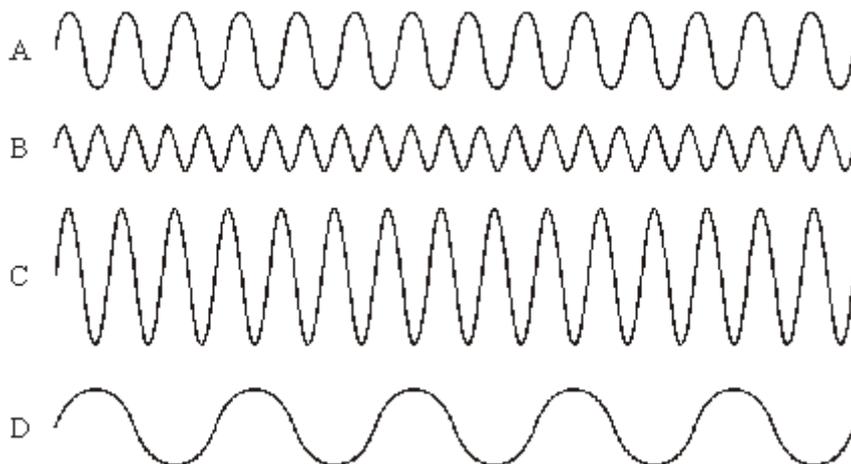
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Speed of microwaves..... m/s

(2)

(Total 4 marks)

Q17. The diagram shows oscilloscope traces of four waves, **A**, **B**, **C** and **D**. All four waves are drawn to the same scale.

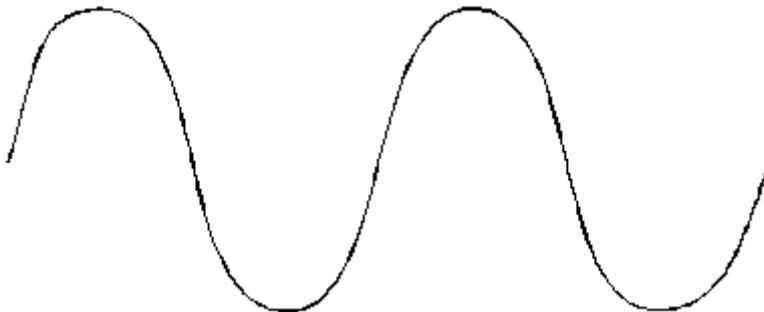


Which wave has:

- (a) the longest wavelength;
- (b) the greatest amplitude;
- (c) the highest frequency?

(Total 3 marks)

Q18. (a) On the wave drawn below, mark the amplitude and wavelength.



(2)

(b) A wave is said to have a frequency of 25 Hz.

Explain what the term *frequency* means.

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

(1)

(c) From the electromagnetic spectrum, give the name and use of a radiation of lower frequency than light.

Name

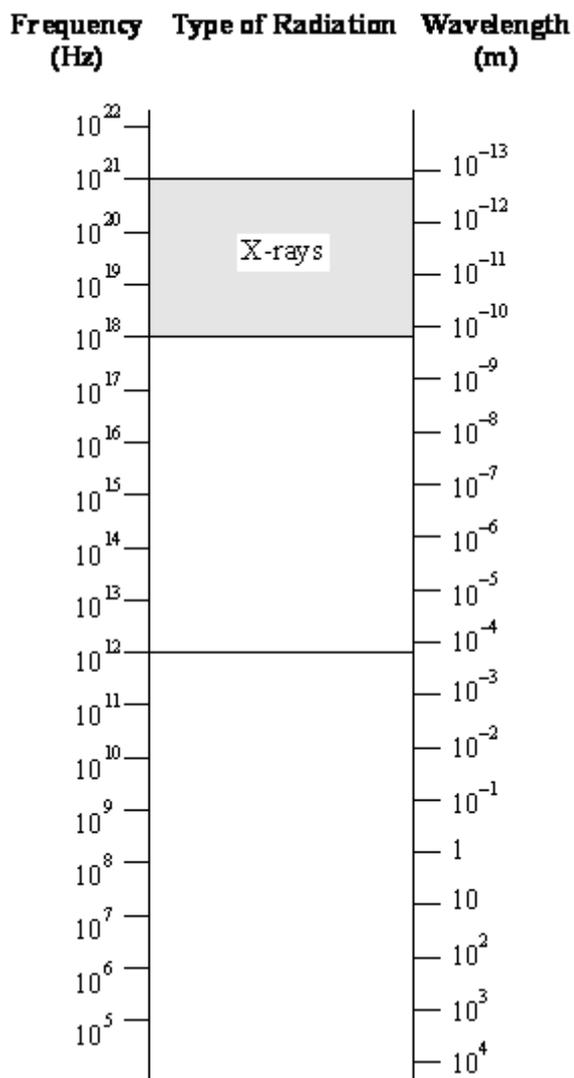
Use

(2)

(Total 5 marks)

Q19. The diagram below shows the range of wavelengths and frequencies for all the types of radiation in the electromagnetic spectrum.

X-rays, which have frequencies in the range 10^{18} – 10^{21} Hz are already marked on the diagram.

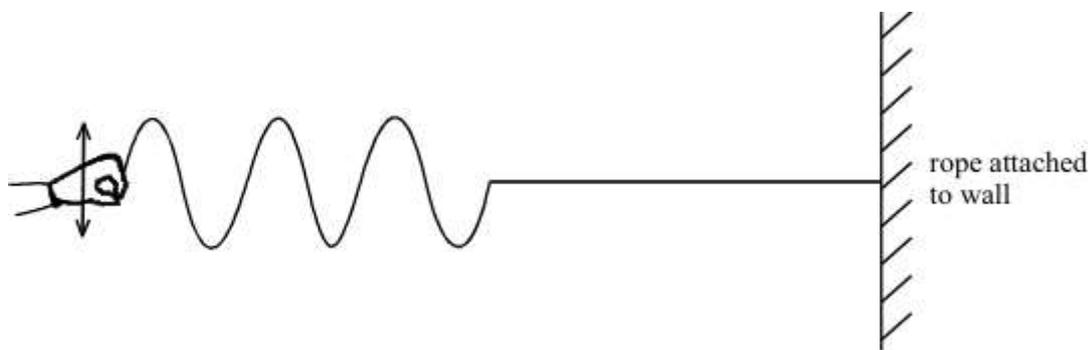


Complete the diagram by adding the following:

- (a) *gamma* radiation, which has shorter wavelengths than X-rays;
- (b) *radio* waves which have wavelengths longer than 0.1m;
- (c) the *visible* spectrum which has wavelengths from 400 nm (violet) to 700 nm (red);
- (d) *ultraviolet* radiation (i.e. radiation with a higher frequency than violet light);
- (e) *microwaves* which have a shorter wavelength than radio waves and *infrared* radiation which has a higher frequency than microwaves;
- (f) an *FM* radio programme on 92MHz. (Show this with an arrow →)

(Total 7 marks)

Q20. 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)