



Waves Questions 2

35 Questions

Name: _____

Class: _____

Date: _____

Time:

Marks:

Comments:

Q1.

- (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)

Q2.

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.

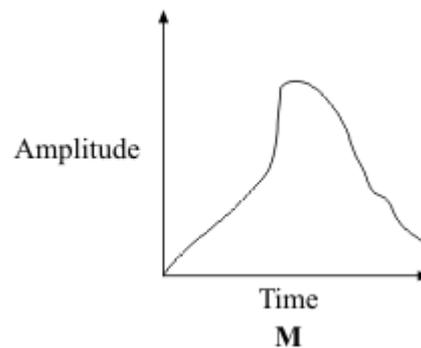
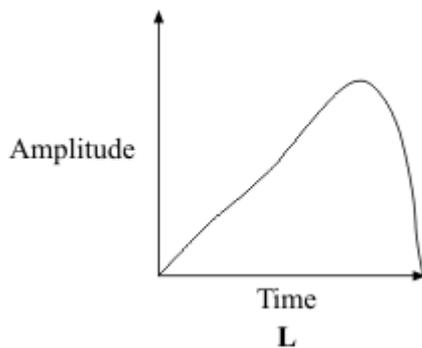
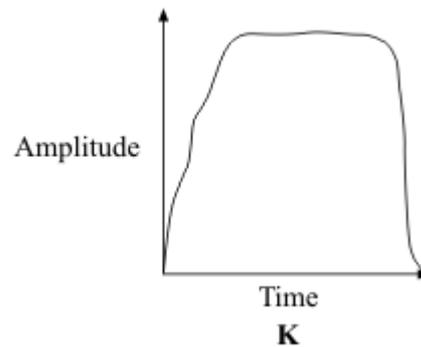
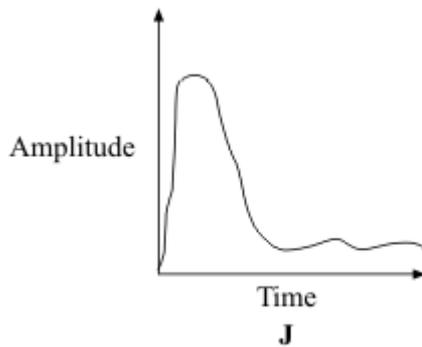
Sound waves are caused by _____

(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 _____

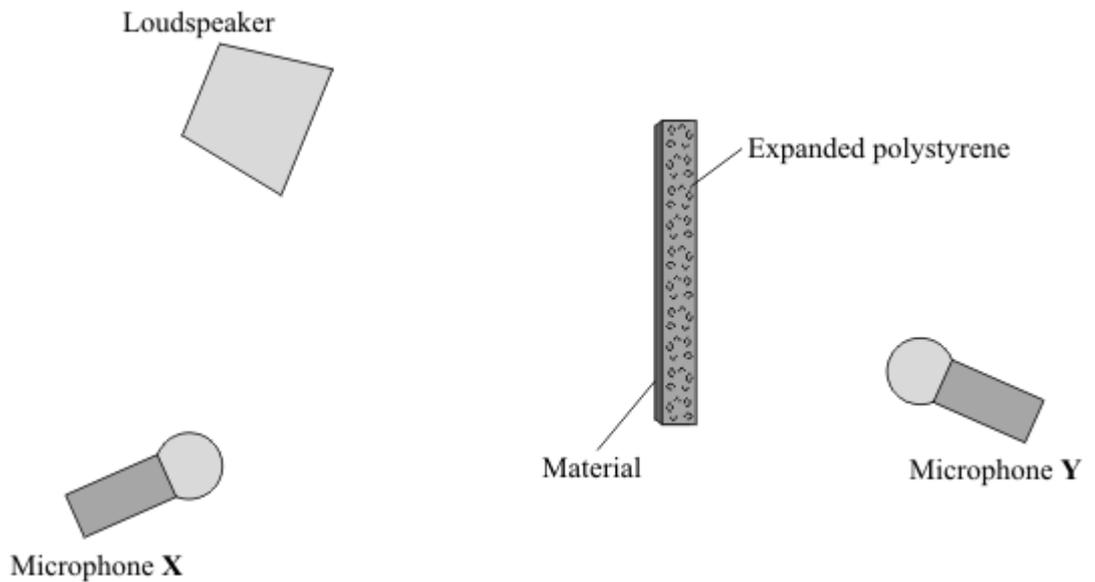
(1)

- (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.

Soundlevel from loudspeaker in arbitrary units	Surface material	Soundlevel 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.

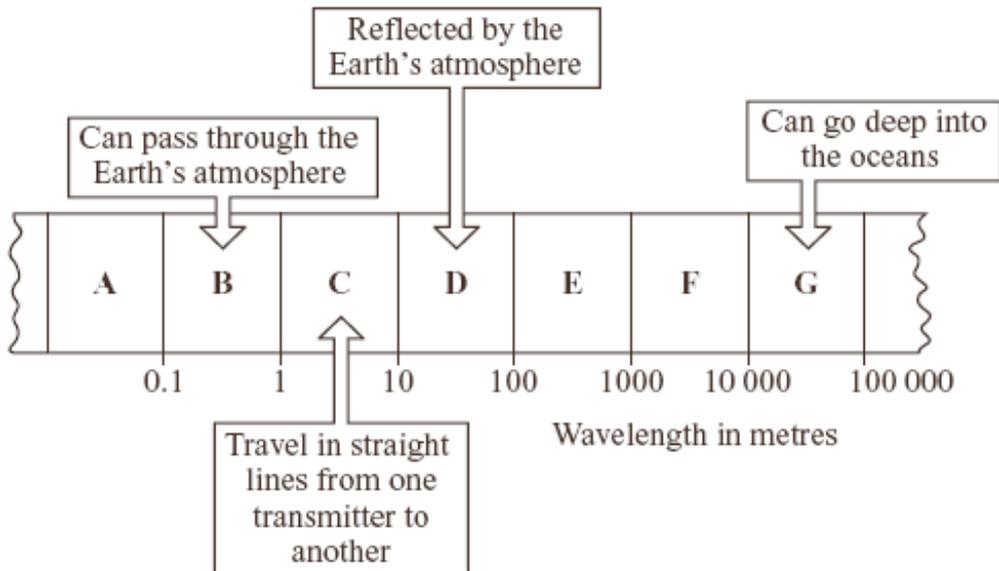
Suggest **one** practical idea to reduce the amount of noise transmitted into the flat through the walls and explain how your idea will work.

(2)
(Total 9 marks)

Q3.

The diagram shows a small part of the electromagnetic spectrum divided into seven sections.

The different properties of the waves in each section make them useful in different ways.



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

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

(1)

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

(1)

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

_____ (1)

(d) the waves with the shortest wavelength?

_____ (1)

(Total 4 marks)

Q4.

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

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

Draw a ring around your answer.

light	microwave	radio
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(1)

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

Look at this information taken from a recent newspaper article.

<ul style="list-style-type: none">• Scientists in Sweden found that the regular use of a mobile phone increases the risk of a cancerous growth between the ear and the brain.• Some people who use mobile phones for a long time complain of headaches and tiredness. The same effect has not been noticed in laboratory tests.• There is no reliable evidence to link using mobile phones with ill health.• The waves from a mobile phone are not strong enough to cause long-term heat damage to cells in the body.
--

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

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

all the scientists get

different
identical
random

 results.

(1)

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

(2)

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

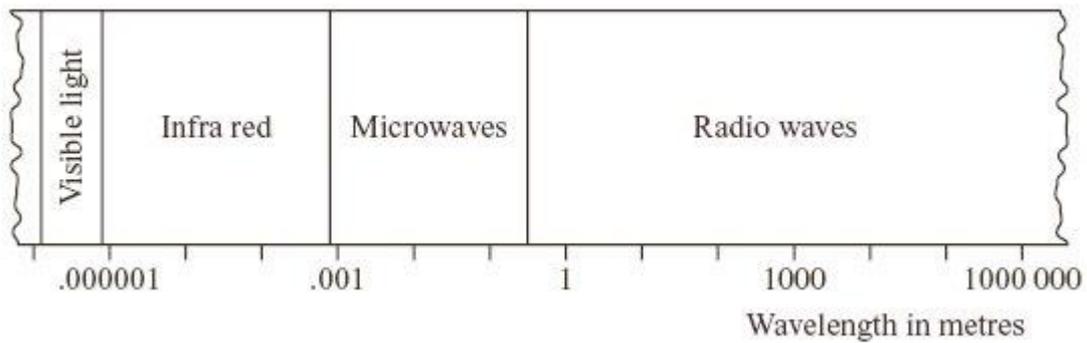
What information in the article supports this view?

(2)

(Total 6 marks)

Q5.

The diagram represents part of the electromagnetic spectrum.



(i) Visible light travels through air at 300 000 000 m/s.

Why can we assume that radio waves travel through air at the same speed as light?

(1)

(ii) A radio station broadcasts at a frequency of 200 kHz.

Calculate the wavelength of the waves broadcast by this radio station. Show clearly how you work out your answer.

Wavelength = _____ m

(2)

(iii) Draw a vertical line on the diagram above to show the position of this radio wave in the electromagnetic spectrum.

(1)

(Total 4 marks)

Q6.

- (a) The new Tetra communications system to be used by the police transmits signals using microwaves of wavelength 75 cm.

Calculate the frequency of the microwaves used by the Tetra system. Show clearly how you work out your answer.

Frequency = _____ hertz

(2)

- (b) Read the following extract from a newspaper and then answer the questions that follow.

Residents of Stag Hill Court, a luxury block of flats, are shocked at the plans to site a mobile phone mast on the roof of the flats. They oppose the mast on health grounds, quoting research in Germany that has found a possible increase in cases of cancer around mobile phone masts.

A spokesperson for the telecoms company said, 'The residents should not worry. The research carried out by our own scientists has found no link between ill health and mobile phone masts'.

This has not reassured the residents, who argue that new independent research is urgently needed.

- (i) Explain why living near a mobile phone mast could cause ill health.

(3)

- (ii) Suggest **two** reasons why the residents have **not** been reassured by the research carried out by the telecoms company.

1. _____

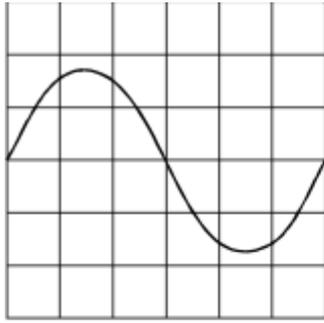
2. _____

(2)

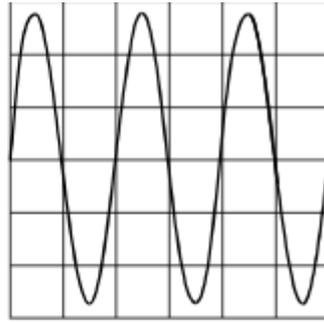
(Total 7 marks)

Q7.

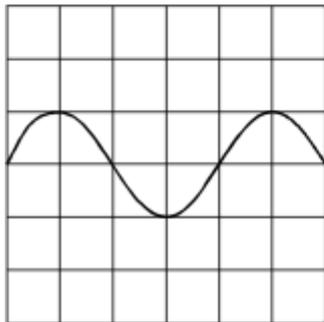
The diagram shows four oscilloscope wave traces. The controls of the oscilloscope were the same for each wave trace.



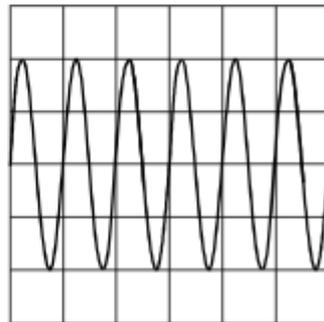
A



B



C



D

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

(i) the largest amplitude, _____

(1)

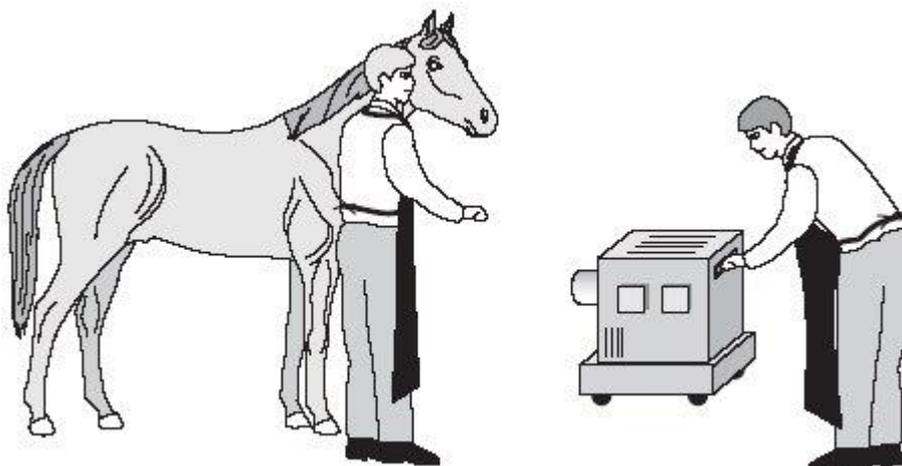
(ii) the lowest frequency? _____

(1)

(Total 2 marks)

Q8.

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



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

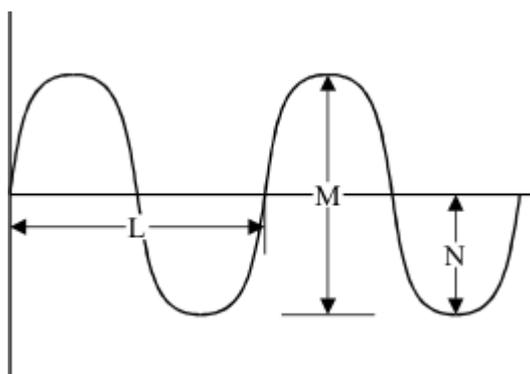
Explain why the lead lining is important.

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

(Total 3 marks)

Q9.

(a) The diagram shows a wave pattern.



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

(i) the wavelength? _____

(ii) the amplitude? _____

(2)

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

(2)
(Total 4 marks)

Q10.

All radio waves travel at 300 000 000 m/s in air.

- (i) Give the equation that links the frequency, speed and wavelength of a wave.

(1)

- (ii) Calculate the wavelength, in metres, of a radio wave which is broadcast at a frequency of 909 kHz. Show clearly how you work out your answer.

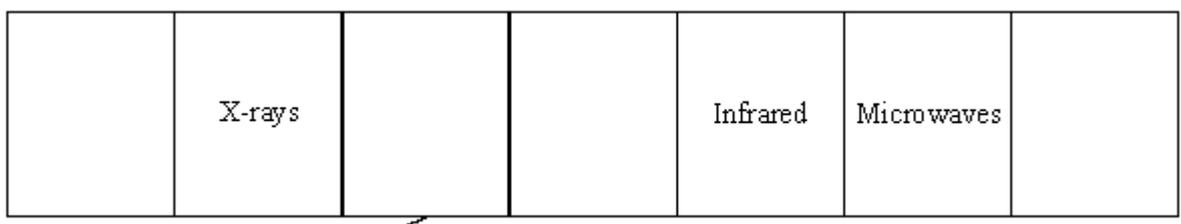
Wavelength = _____ metres

(2)

(Total 3 marks)

Q11.

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



Ultraviolet

Gamma rays

Radio

Light

(2)

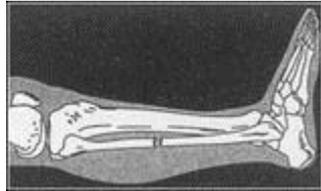
- (b) Complete the following sentence by choosing the correct answer and crossing out in the box the two lines which are wrong.

faster than
the same as
slower than

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

(1)

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



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

(2)

(Total 5 marks)

Q12.

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



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

(1)

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

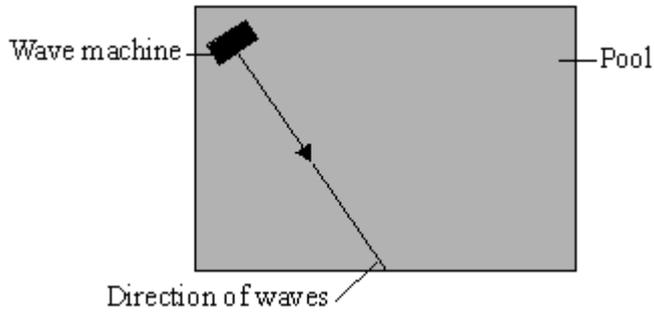
(1)

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

hertz joule watt

(1)

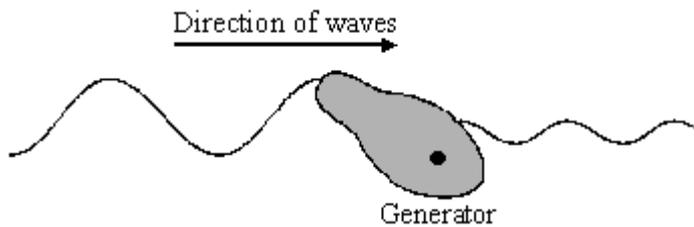
- (b) The diagram shows the direction of the waves across the pool. The waves reflect off the side of the pool.



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

(1)

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



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

The diagram shows that the amplitude of the waves

gets larger
stays the same
gets smaller

 as the waves pass the generator.

(1)

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

(1)

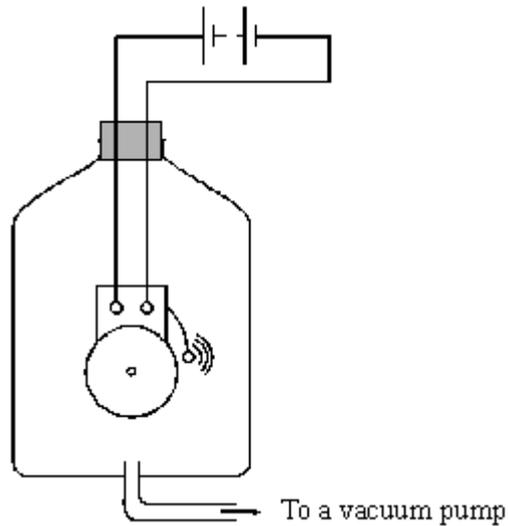
- (iii) Energy from ocean waves could be used to generate electricity. Would this be a renewable or non-renewable energy resource?

(1)

(Total 7 marks)

Q13.

- (a) The diagram shows an electric bell inside a glass jar. The bell can be heard ringing.



In the following sentences, cross out the **two** lines that are wrong in each box.

When all the air has been taken out of the glass jar, the ringing sound will

stop.
get louder.
get quieter.

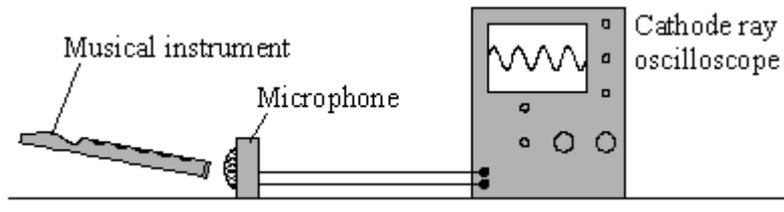
This is because sound

travels faster
travels slower
cannot travel

through a vacuum.

(2)

- (b) The microphone and cathode ray oscilloscope are used to show the sound wave pattern of a musical instrument.



One of the following statements describes what a microphone does. Tick the box next to the correct statement.

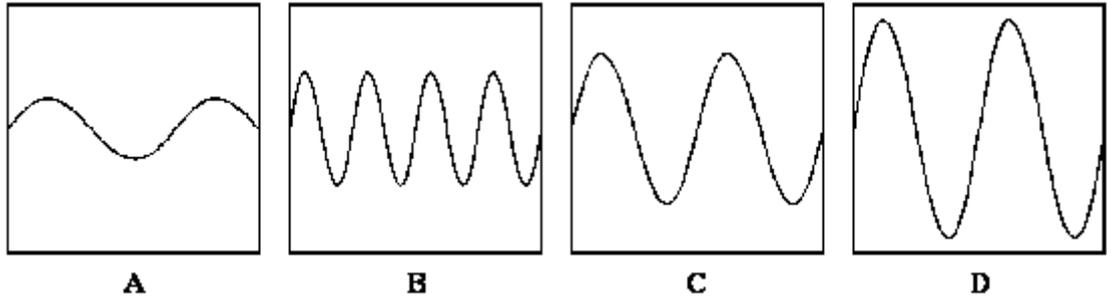
A microphone transfers sound energy to light energy.

A microphone transfers sound energy to electrical energy.

A microphone transfers electrical energy to sound energy.

(1)

- (c) Four different sound wave patterns are shown. They are all drawn to the same scale.



- (i) Which sound wave pattern has the highest pitch?

Give a reason for your answer.

(2)

- (ii) Which sound wave pattern is the loudest?

Give a reason for your answer.

(2)

(Total 7 marks)

Q14.

Microwaves are used to transmit signals to the satellite. The microwaves have a wavelength of 0.6 metres (m) and travel through space at a speed of 300 000 000 metres per second (m/s).

- (i) Write down the equation which links frequency, wavelength and wave speed.

(1)

- (ii) Calculate the frequency of the microwaves. Show clearly how you work out your answer and give the unit.

Frequency = _____

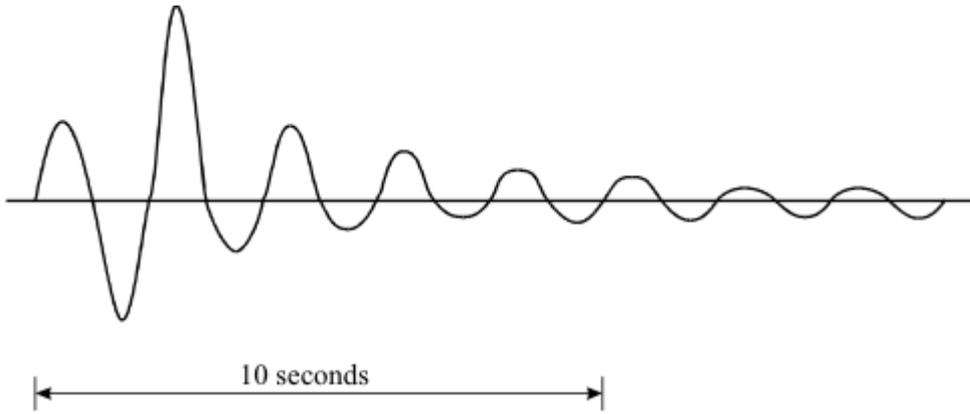
(3)

(Total 4 marks)

Q15.

The vibration caused by a P wave travelling at 7.6 km/s has been recorded on a seismic

chart.



- (i) How many waves are produced in one second?

_____ (1)

- (ii) Write down the equation which links frequency, wavelength and wave speed.

_____ (1)

- (iii) Calculate the wavelength of the P wave. Show clearly how you work out your answer and give the unit.

Wavelength = _____ (2)

(Total 4 marks)

Q16.

After a person is injured a doctor will sometimes ask for a photograph to be taken of the patient's bone structure, e.g. in the case of a suspected broken arm.

- (i) Which type of electromagnetic radiation would be used to take the photograph?

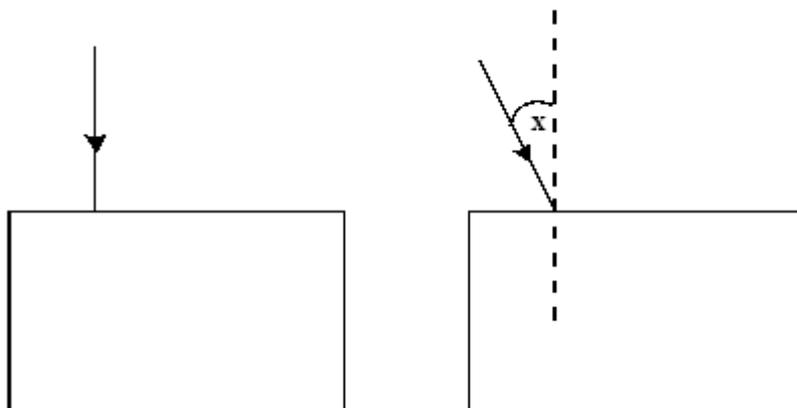
_____ (1)

- (ii) Describe the properties of this radiation which enable it to be used to photograph bone structure.

(2)

Q17.

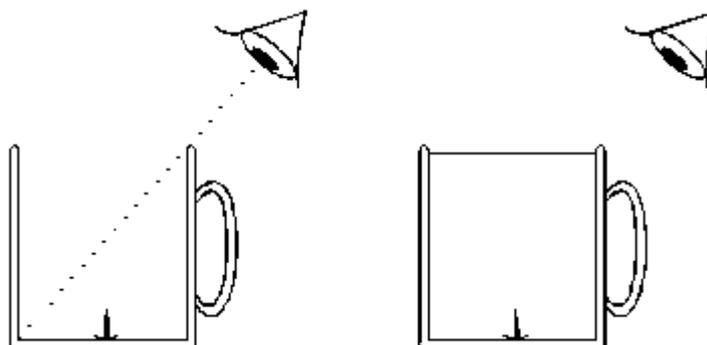
(a) The diagrams show rays of light. Each ray strikes a surface of a glass block.



- (i) On the diagram draw the path of each ray through the glass block and out into the air again.
- (ii) Label another angle on the diagram which is equal to the angle marked X. Label this angle Y.

(4)

(b) The diagrams show two beakers. Both beakers have a drawing pin inside as shown.



The first beaker is empty. The eye cannot see the drawing pin.
The second beaker is full of water and the eye can see the drawing pin.

Explain how the eye is able to see the drawing pin in the second beaker. You may add to the diagram if it helps your answer.

(3)

(Total 7 marks)

Q18.

Radio waves, ultra-violet, visible light and X-rays are all types of electromagnetic

radiation.

(a) Choose wavelengths from the list below to complete the table.

$3 \times 10^{-8} \text{ m}$ $1 \times 10^{-11} \text{ m}$ $5 \times 10^{-7} \text{ m}$ 1500 m

TYPE OF RADIATION	WAVELENGTH (m)
Radio waves	
Ultra-violet	
Visible light	
X-rays	

(4)

(b) Microwaves are another type of electromagnetic radiation.

Calculate the frequency of microwaves of wavelength 3 cm.

(The velocity of electromagnetic waves is $3 \times 10^8 \text{ m/s}$.)

(4)

(Total 8 marks)

Q19.

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.

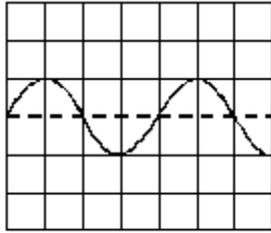


Diagram **X**

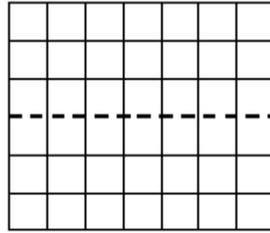


Diagram **Y**

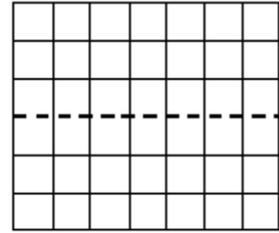


Diagram **Z**

- (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

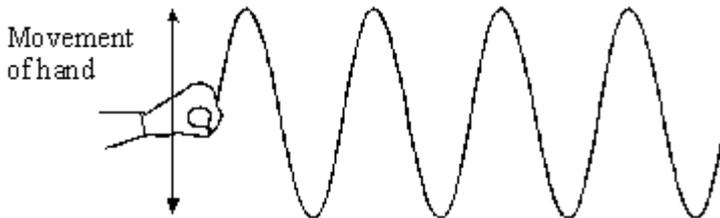
- (i) A musical note with a high frequency sounds _____ than one with a low frequency.
- (ii) A noise of small amplitude sounds _____ than one with large amplitude.

(2)

(Total 5 marks)

Q20.

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)

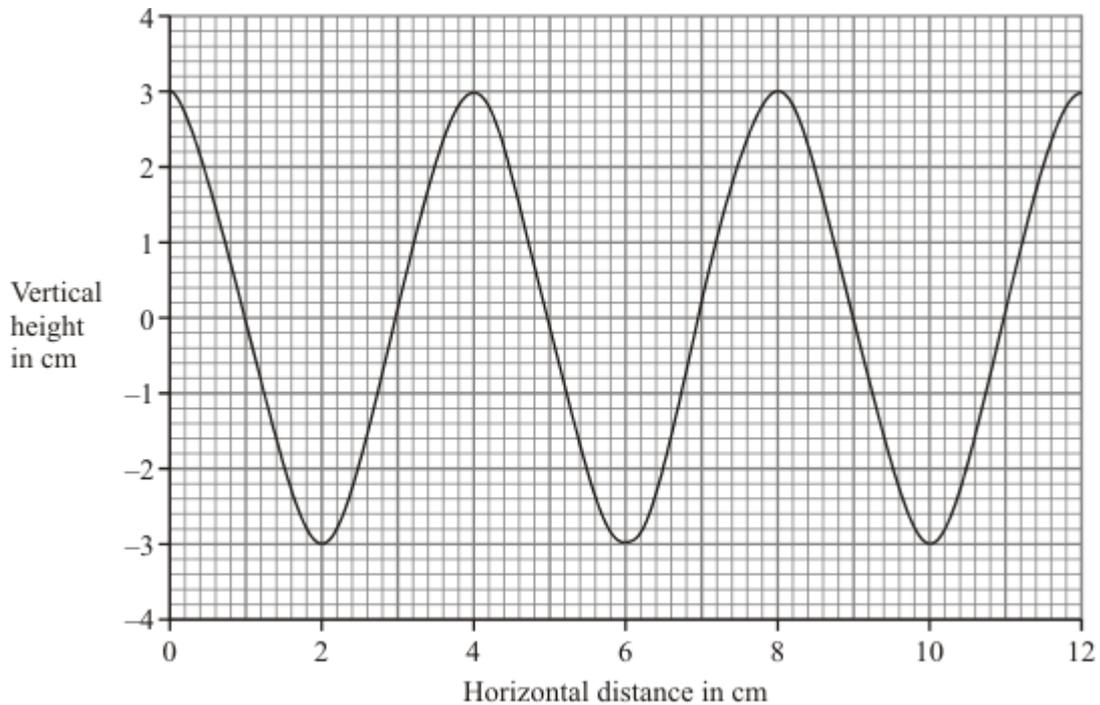
- (b) The wavelength of the wave is 0.1 m. Its frequency is 2 Hz.

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

Speed of wave _____

Q21.

The diagram shows a water wave drawn to scale.



(a) What is the wavelength of this water wave? _____ cm (1)

(b) What is the amplitude? _____ cm (1)

(c) Twelve waves pass an observer in four seconds.

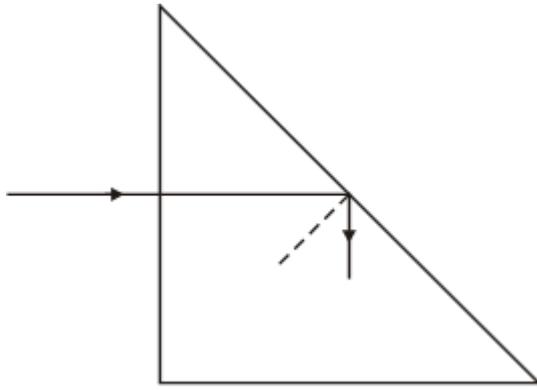
What is the frequency of the waves? Show clearly how you work out your answer and give the unit.

Frequency = _____

Q22.

Glass prisms are used in many optical devices.

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



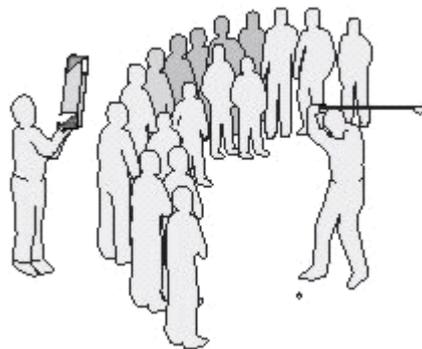
To gain full marks for this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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

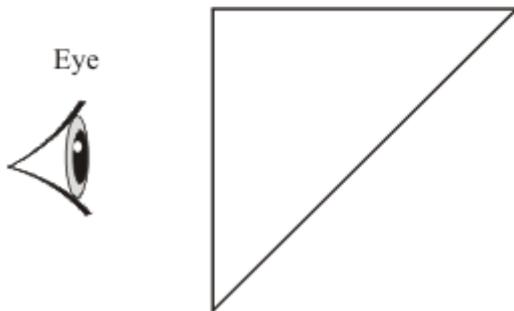
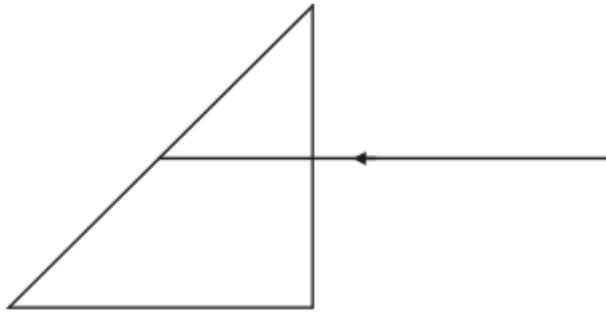
angle	critical	normal
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(3)

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



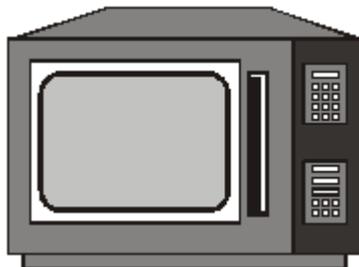
A periscope contains two glass prisms.
Complete the diagram to show the ray of light reaching the person's eye.



(3)
(Total 6 marks)

Q23.

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.

Speed of microwaves _____ m/s

(2)
(Total 4 marks)

Q24.

The table gives the frequencies of sound that different animals can hear.

Animal	Lowest frequency it can hear in Hz	Highest frequency it can hear in Hz
Human	64	23 000
Dog	67	45 000
Mouse	1 000	91 000
Rat	200	76 000
Cat	45	64 000
Tuna	50	1 100
Canary	250	8 000
Chicken	125	2 000

(a) (i) Which animal can hear the lowest sound frequency?

(1)

(ii) Which animal can hear the smallest range of frequencies?

(1)

(b) (i) What is the name given to sound frequencies higher than those that humans can hear?

(1)

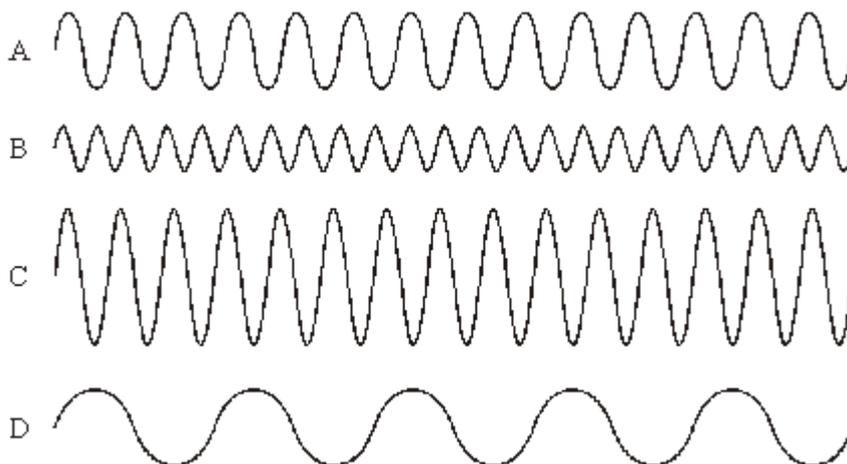
(ii) Give **one** industrial use of this type of sound.

(1)

(Total 4 marks)

Q25.

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)

Q26.

- (a) The student is using a microphone connected to a cathode ray oscilloscope (CRO).



The CRO displays the sound waves as waves on its screen. What does the microphone do?

(2)

- (b) The amplitude, the frequency and the wavelength of a sound wave can each be either increased or decreased.

(i) What change, or changes, would make the sound quieter?

(1)

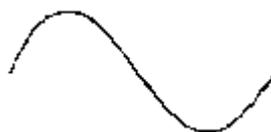
(ii) What change, or changes, would make the sound higher in pitch?

(1)

(Total 4 marks)

Q27.

Some students made a small hand-turned a.c. generator, similar to a bicycle dynamo. They connected it to the Y plates of a cathode ray oscilloscope, CRO, and turned the generator slowly. The trace on the CRO looked like this:



They then turned the generator faster and the trace looked like this:



(a) Why did the trace on the CRO show:

(i) an increase in frequency;

(1)

(ii) a decrease in wavelength;

(1)

(iii) an increase in amplitude?

(1)

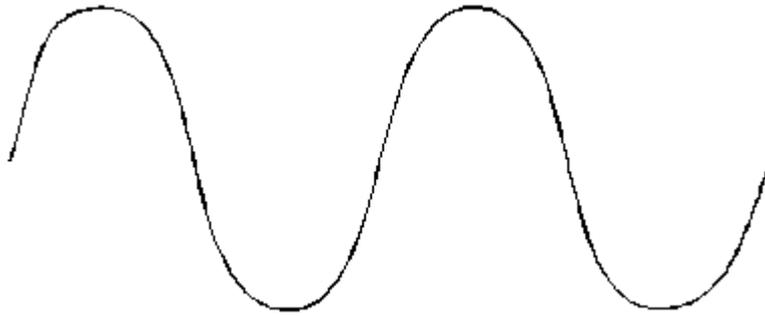
(b) One way to alter the output from the generator is to change the speed of turning. State **two** other ways to adapt parts of the generator to increase its output.

(2)

(Total 5 marks)

Q28.

- (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 _____

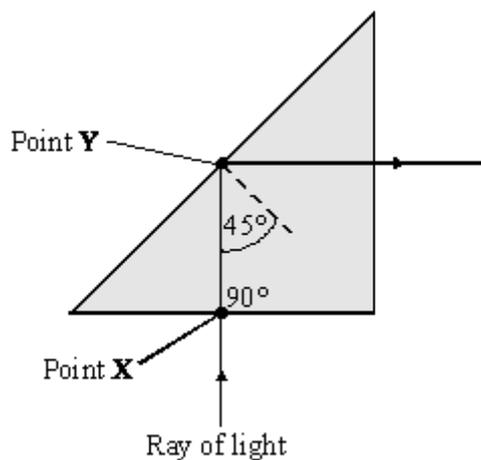
Use _____

(2)

(Total 5 marks)

Q29.

The diagram shows a glass prism.



- (i) Explain why refraction has **not** occurred at point X.

(1)

- (ii) (A) Give the full name for the process which has occurred at point Y.

(1)

- (B) Explain why this process has occurred.

(2)

(Total 4 marks)

Q30.

- (i) Use the words frequency, wavelength and wave speed to write an equation which shows the relationship between them.

(1)

- (ii) Calculate the speed of a sound wave with a frequency of 250 Hz and a wavelength of 1.3 m.

Show how you get to your answer and give the unit.

Speed = _____

(2)

(Total 3 marks)

Q31.

Explain fully why pregnant women should not normally have X-rays of the lower body.

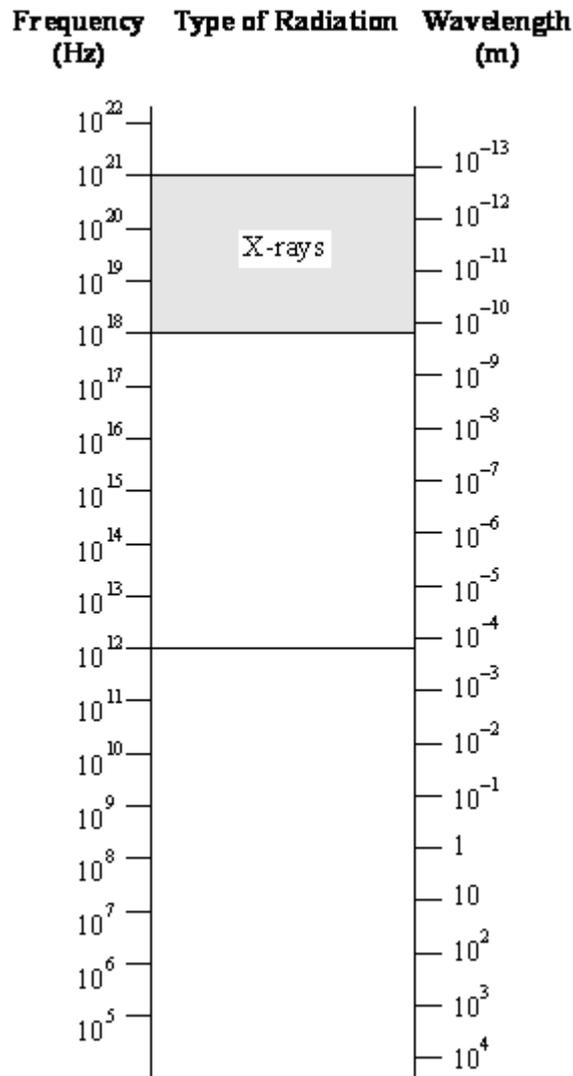
(Total 4 marks)

Q32.

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:

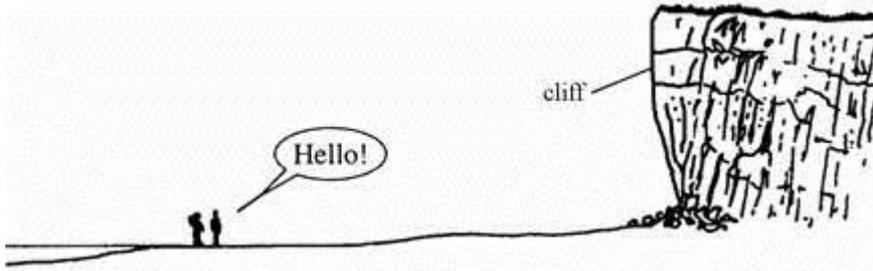
- gamma* radiation, which has shorter wavelengths than X-rays;
- radio* waves which have wavelengths longer than 0.1m;
- the *visible* spectrum which has wavelengths from 400 nm (violet) to 700 nm (red);
- ultraviolet* radiation (i.e. radiation with a higher frequency than violet light);
- microwaves*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

(Total 7 marks)

Q33.

Two friends are standing on a beach.

When they shout they can hear themselves a second later.



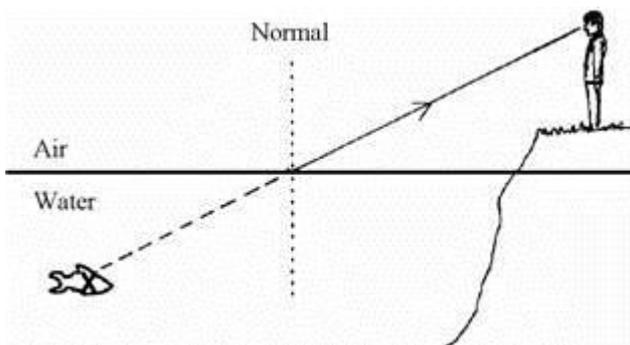
Explain, as fully as you can, why this happens.
 (You may answer on the diagram if you want to.)

(Total 2 marks)

Q34.

A man is walking along the bank of a river.

He sees a fish which seems to be at X.



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

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

(2)

(b) Complete the sentence.

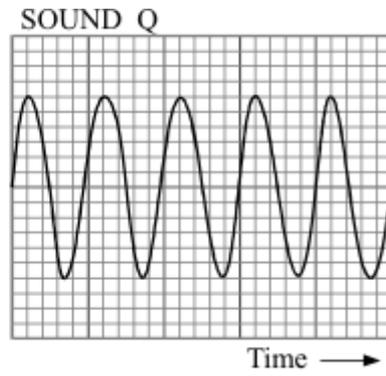
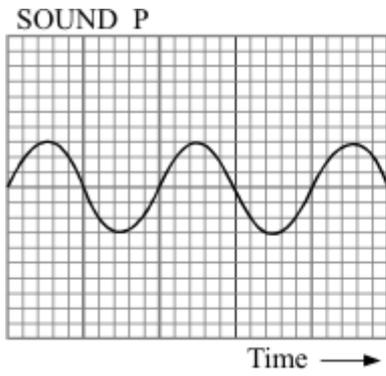
The ray of light is _____ as it passes from the water into the air.

(1)

(Total 3 marks)

Q35.

The diagram shows the oscilloscope traces of two different sounds P and Q. The oscilloscope setting is exactly the same in both cases.



P and Q **sound** different.
 Write down **two** differences in the way they sound.
 Explain your answers as fully as you can.

1. _____

2. _____

(Total 5 marks)

Mark schemes

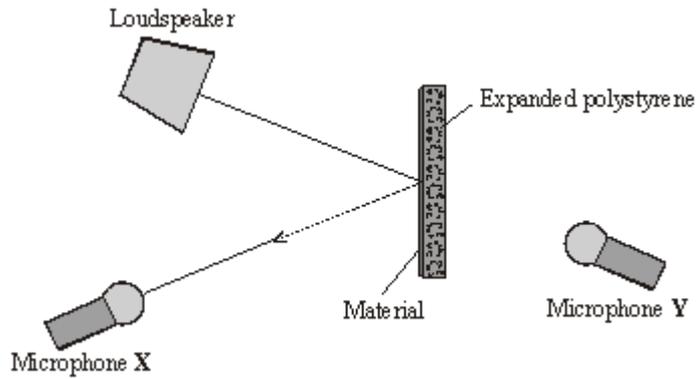
Q1.

- (a) C or 0.18 mm 1
- (b) 0.6 m
allow 1 mark for correct transformation and substitution
allow 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
- or** it gets hotter 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]

Q2.

- (a) (mechanical) vibration(s)
***not** just 'particles knocking into each other'*
not reference to 'sound particles' 1
- (b) K 1
- (c) (i) reflected by the material from loudspeaker to microphone X 1
- shown by straight lines with angle of incidence = angle of reflection
(by eye) **and** at least one arrow in the correct direction
*do **not** credit if the direction is contradicted by any incorrect arrow / may be shown by waves / wavefronts in the direction of straight lines*
ignore any sound to Y or which 'misses' the material
example



1

(ii) any **one** from:

- so (the student) can compare results
- so only one (independent) variable
- to get reliable / accurate results
- because (the expanded) polystyrene absorbs some of the sound
do not credit just 'so it's a fair test'

1

(iii) **[A]** wood

1

[B] either 0.25 or 1/4 or 25 % or 15/60 or 1: 3

do not credit 1 : 4

1

(d) practical suggestion

1

appropriate reason / explanation

example line / panel the walls with wood / plasterboard /
increase the thickness of the plaster (on the walls) (1)
(this) will absorb / reflect (back) (most / some of) the sound
(1)

*credit legal suggestions for attempting to limit the noise
made by the neighbours*

example ask the neighbours to make less noise (1)
by limiting the time(s) music played (1)

do not credit reference to 'sound particles' for second mark

1

[9]

Q3.

(a) B

1

(b) G

1

(c) D

1

(d) A

1

[4]

Q4.

- (a) (i) microwave 1
- (b) (i) identical 1
- (ii) • increased risk of cancerous growth (between ear and brain) 1
- complaints of headaches and tiredness 1
- (iii) any **two** from: 2
 - tests in a laboratory did not give effects of tiredness or headaches
 - waves not strong enough to cause long term heat damage to cells
 - evidence to link mobile phones and ill health is not reliable

[6]

Q5.

- (i) all electromagnetic waves travel at the same speed through a vacuum, (so assume same speed in air) 1
accept 'all parts of spectrum' for electromagnetic waves
- (ii) 1500 (m) 2
allow 1 mark for correct transformation and substitution
allow 1 mark for using 200 000 Hz
answers 1 500 000 = 1 mark
- (iii) line drawn at correct position 1
anywhere between 1000 and next section (10 000)
accept their value for (a)(ii) drawn in the correct position

[4]

Q6.

- (a) 400 000 000 2
or
correct equivalent
*allow 1 mark for correct transformation **and** substitution (of 75)*
answer 4 000 000 gains 1 mark only
- (b) (i)

any mention of alpha, beta, gamma waves scores **0** marks

emit / uses / transmit / receive microwaves
accept radiation for microwaves throughout
ignore radio waves

1

some microwave / energy absorbed by / enters the body
ecf for their given electromagnetic wave
do **not** accept goes through the body

1

raises temperature of (body) cells / tissue / water
accept reference to water molecules vibrating faster
accept it could cause mutation / harm / kill cells
do **not** accept answers in terms of ionisation
ignore references to cancer

1

(ii) any **two** from:

- research (may be) biased
or may have been misled in the past
accept not independent
or may be lying
- some research suggests a link
- long-term effect not proven / studied
accept not studied for long enough
- residents may not have seen the research

2

[7]

Q7.

(i) B

1

(ii) A

1

[2]

Q8.

Quality of written communication

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

1

X-rays do not go through lead

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

1

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

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

1

[3]

Q9.

(a) (i) L

1

(ii) N

1

(c) the answer should be in the form:

not inside the eye

either for **both** marks an arrangement which could demonstrate visibly
light travels in straight lines

full credit should be given for answer presented as a diagram

and

an explanation of how it shows the straightness

or for one mark

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

examples

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

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

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

ray box type experiment using mirrors/prisms, etc

beams on paper or in smoke

torch beams through smoke

example devices:–

–pinhole camera (qualification may get second mark)

–periscope

–optical fibre

*–reflection 'in a **mirror***

2

[4]

Q10.

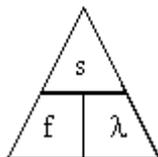
(i) speed = frequency \times wavelength

accept the equation rearranged

*accept v **or** $s = f \times \lambda$*

do not allow w for wavelength

do not accept



unless subsequent calculation correct

1

(ii) 330 (m)

allow 1 mark for

$$\lambda = \frac{300\,000\,000}{909\,000}$$

or $300\,000\,000 = 909\,000 \times \lambda$

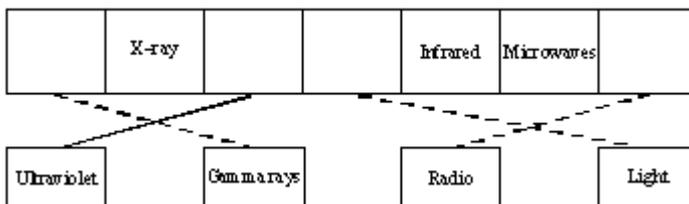
or answer of 330000(m) or 330033(m)

2

[3]

Q11.

(a) all **three** correct



one only correct, 1 mark only

allow names in boxes

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

2

(b) the same as

1

(c) any **two** from:

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

2

[5]

Q12.

(a) (i) 3

1

(ii) 1

accept a definition of frequency ignore units

- (iii) hertz 1
- (b) straight line in correct direction 1
judge by eye (from 'a' of waves to 's' of across) ignore arrow
accept equal angles shown on waves 1
- (c) (i) gets smaller 1
- (ii) kinetic 1
accept movement
- (iii) renewable 1

[7]

Q13.

- (a) stop 2
accept any indication
 cannot travel
- (b) middle box ticked 1
accept a tick next to the statement even if not in the box
*do **not** accept two ticks*
- (c) (i) B 2
 highest frequency
accept most waves (in box)
accept 'squashed together'
*do **not** accept 'squashed'*
accept 'close (together)'
accept shortest wavelength
- (ii) D 2
 largest amplitude
*accept tallest **or** highest wave*
*do **not** accept biggest wave*
*do **not** accept 'high' wave*

[7]

Q14.

- (i) wave speed = frequency × wavelength 1
accept correct transformation
accept $v = f \times \lambda$
accept s for speed

accept $m/s = Hz \times m$

accept  if subsequent use of  is correct

1

(ii) 500 000 000

credit for **1** mark correct transformation in words **or** numbers
or correct substitution

2

Hertz

3 marks for 500 000k Hz **or** 500 MHz

numerical answer **and** unit must be consistent for full credit

1

[4]

Q15.

(i) 0.5

1

(ii) wave speed = frequency \times wavelength

accept $v = f \times \lambda$

accept s for v

accept $m/s = Hz \times m$

accept



providing subsequent method correct

1

(iii) 15.2 km

both numerical answer and unit are required for both marks

numerical answer and unit must be consistent

allow **1** mark for 15.2 with incorrect or no unit

allow **2** marks for an answer of 1.52 km if the answer to
(b)(i) was given as 5

r 1 mark for correct transformation

or 1 mark for correct use of speed = distance/time

unit on its own gains no credit

2

[4]

Q16.

(i) X-rays or gamma rays

for 1 mark

1

(ii) passes through flesh;
stopped by bone/absorbed

for 1 mark each

2

[3]

Q17.

- (a) (i) Ignore arrows on rays
perpendicular rays goes straight in and out
other ray refracts towards normal (not along)
emerges parallel incident ray (by sight) if refraction correct (ignore reflections)

for 1 mark each

3

- (ii) emergent angle marked Y if emerges parallel to right of normal

for 1 mark

1

- (b) straight ray to water surface refracts/bends
straight to eye/towards surface on right image correctly shown
or states the same mark prose only of diagram incomplete

any 3 for 1 mark each

3

[7]

Q18.

- (a) radio – 1500
ultra violet 3×10^{-8}
visible – 5×10^{-7}
X-rays – 1×10^{-11}

4

- (b) 1×10^{10} Hz 10^{10} HzOK
for 4 marks

else 1×10^{10}
for 3 marks

else $3 \times 10^8/0.03$
for 2 marks

else $v = \text{frequency} \times \text{wavelength}$ or $3 \times 10^8 = 0.03f$
any answer with unit Hz scores 1, 2 or 3

for 1 mark

4

[8]

Q19.

- (a) number of complete vibrations per second

for 1 mark

1

- (b) (i) correct trace (more waves), *ignore amplitude*

for 1 mark

1

- (ii) correct trace (higher amplitude), *ignore frequency*

for 1 mark

1

- (c) (i) higher

for 1 mark

1

(ii) quieter

for 1 mark

1

[5]

Q20.

(a) any two successive peaks labelled **W**

accept any 2 points on same part of adjacent waves
correct by eye

1

half 'height' of wave labelled **A**

correct by eye

N.B. at least one of the answers must be labelled

1

(b) 0.2

correct answer with no working = 2

allow 1 mark for $s = f \times w$ or correct working i.e., 2×0.1

N.B. correct answer from incorrectly recalled relationship = 0

2

m/s (unit)

independent mark do **not** allow mps **or** mHz

1

[5]

Q21.

(a) 4

1

(b) 3

1

(c) 3

correct answer with no working = 2

allow 1 mark for $f = \text{number} \div \text{time}$

or correct working i.e., $12 \div 4$

N.B. correct answer from incorrectly
recalled relationship / substitution = 0

2

Hz / hertz

accept HZ, hz, hZ

allow waves / cycles per second

allow wps, w/s, cps, c/s

1

[5]

Q22.

(a) Quality of written communication:

Correct use of 2 of the words, angle, critical, normal and reflection

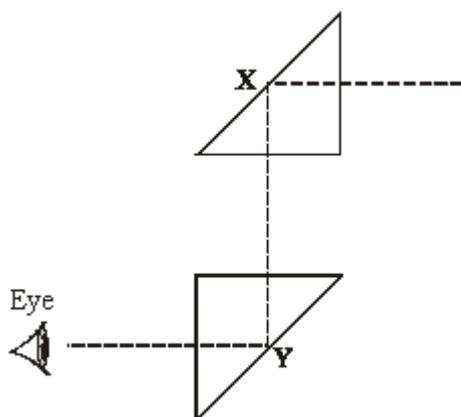
1

any **two** from

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

2

(b)



1 mark for reflection at **X** if ray would reach the lower prism

1 mark for subsequent reflection at **Y**

1 mark for subsequent ray emerging from prism in direction of front of eye

accept dotted **or** dashed lines

ignore any arrows

3

[6]

Q23.

- (i) absorbed by water / water heated

1

hot water heats (rest of) food / idea of particle vibration

1

- (ii) 300 000 000 / 3×10^8

correct answer with no working = 2

allow 1 mark for $s = f \times w$ **or** correct working i.e., $10000 (000000) \times 0.03$

N.B. correct answer from incorrectly recalled relationship / substitution = 0

2

[4]

Q24.

- (a) (i) cat

1

- (ii) tuna

1

- (b) (i) ultrasound
allow ultrasonic 1
- (ii) cleaning / quality control / flaw detection / medical scanning /
animal scaring / sonar 1

[4]

Q25.

- (a) **D** 1
- (b) **C** 1
- (c) **B** 1

[3]

Q26.

- (a) changes the sound wave(s)
to a varying **or** changing (electric) potential difference **or** p.d. **or** voltage
or current **or** to an irregular alternating current or a.c. **or** transfers
sound energy to electrical energy (1) mark is vibrations **or** pulses **or** of
sound **or** in air become electrical waves
*do not credit just 'to electricity' **or** 'to a.c'* 2
- (b) (i) decrease **or** reduce the amplitude
accept less amplitude nothing else added 1
- (ii) increase the frequency **or** decrease
wavelength
accept higher frequency nothing else added 1

[4]

Q27.

- (a) (i) more turns **or** waves per second
*accept spinning **or** turning **or** faster* 1
- (ii) less time spent cutting field lines
*accept shorter time in field **or** when the frequency increases
(the wavelength decreases)* 1
- (iii) more energy given
*accept more KE put in
accept a higher voltage produced
do not credit more power* 1

- (b) more coils 1
- more powerful magnets
- accept put in better bearings*
- do not credit reduce friction or add soft iron core*

1

[5]

Q28.

- (a) amplitude marked as approximately half a wave height
- great precision is not required*

1

wavelength marked as a trough to trough distance **or** a peak to peak distance

accept an equivalent repeat distance anywhere on the wave

1

- (b) the number of waves each second
- accept cycles per second accept 25 waves pass each second*

1

- (c) any **pair** from
- microwave cooking **or** communication **or** mobile phone
- radio communication **or** entertainment
- infra-red cooking **or** heating **or** remote control **or** security **or** night sights **or** thermal imaging
- accept sensible specific uses*

2

[5]

Q29.

- (i) (incident) ray along the normal
- or (incident) ray at 90° (to the surface)*

1

- (ii) (A) total internal reflection
- all three words required do not credit total internal refraction*

1

- (B) **EITHER**
- angle of incidence is greater than the critical angle
- or angle of incidence is greater than 42°*

2

- OR**
- angle of incidence is 45°

1

[4]

Q30.

- (i) (wave) speed = frequency \times wavelength
or any correctly transposed version
 accept $v = f \times \lambda$
or transposed version
 accept $m/s = 1 / s \times m$
or transposed version

or  *or* 
but only if subsequently used correctly

1

- (i) 325

1

metres per second

or m / s or 0.325 km/s for 2 marks

1

[3]

Q31.

idea that X-rays cause mutations
gains 1 mark

but X-rays can cause/increase chance of mutations
gains 2 marks

mutations usually harmful/produce abnormal growth
 serious effect on growing foetus/rapidly growing cells
each for 1 mark

[4]

Q32.

- (a) gamma rays above x-rays
for 1 mark
- (b) upper radio wave boundary correct ($10^{-1}m$) ($\pm 1mm$)
for 1 mark
- (c) visible radiation/light
- within the middle third of a wavelength band
 - in the correct wavelength range ($10^{-6} - 10^{-7}m$)
each for 1 mark
- (d) ultraviolet between *visible radiation and X-rays
for 1 mark
- (e) microwaves above *radio waves and below *infra red
 (*not necessarily immediately)
for 1 mark
- (f) between $10^8Hz + 10^7Hz$ and nearer to 10^8Hz than to 10^7Hz

gains 1 mark

[7]

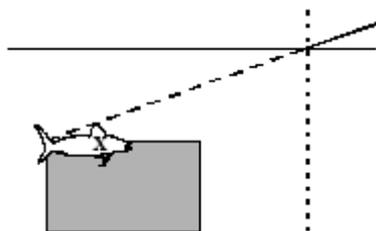
Q33.

- idea that (in words or on diagram)
- sound reflects / bounces off cliff
- returns the way it came / produces an echo
each for 1 mark

[2]

Q34.

- (a) line (from fish) to complete ray to eye
[mark awarded even if begins outside the box]
[credit only if fish shown to left of normal]
- fish within the region shown or X or start of ray
(i. e. not necessarily directly below x) each for 1 mark



2

- (b) bent/refracted/deviated/speeded up
for 1 mark

1

[3]

Q35.

- Q is louder
- Q is higher (pitch/note but not frequency)
[if loudness and pitch both mentioned but direction wrong / absent credit 1 mark]
- louder because bigger amplitude/height
- higher pitch because higher frequency/shorter wavelength/waves closer together
- factor of 2 mentioned w.r.t either
(NB converse answer for P)
each • for 1 mark

[5]