PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



EXAM QUESTION PACK

SECTION 3: WAVES (PACK 2)

SCORE	PERCENTAGE
/146	%

STEMUP

These questions belong to Pearson Edexcel, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by Pearson Edexcel. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with Pearson Edexcel and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. Pearson Edexcel has not endorsed, approved or been involved in the production of it. Pearson Edexcel and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

Pearson Edexcel publishes its past papers, mark schemes and examiner reports. Always check the current specification at qualifications.pearson.com before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

X-rays are electromagnetic waves used to obtain images of bones.

An x-ray machine produces x-ray waves with a frequency of 1.25×10^{18} Hz.

(a) Calculate the time period of these x-rays.

(2)

time period = ... s

(b) X-rays have a speed of 3.00×10^{8} m/s in air.

Calculate the wavelength of these x-rays.

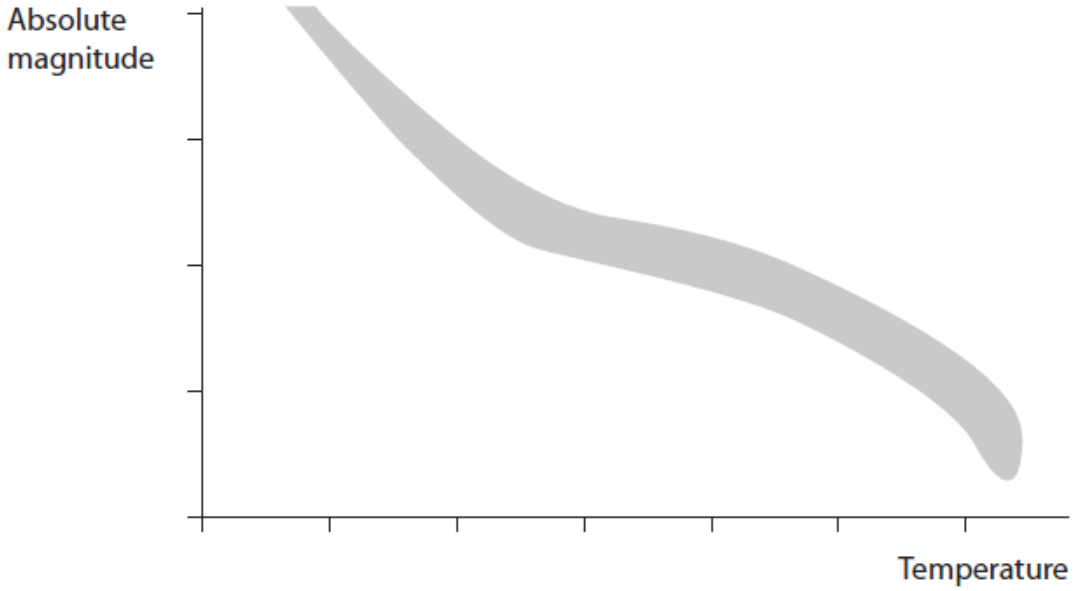
(3)

wavelength = ... m

(Total for question = 5 marks)

Q2.

(a) This is an incomplete Hertzsprung-Russell diagram.



(i) Which of these is in the shaded area of the diagram?

(1)

☒ **A** black holes

☒ **B** main sequence stars

☒ **C** neutron stars

☒ **D** protostars

(ii) On the diagram, draw the area to show the position of white dwarf stars.

Label this area WD.

(1)

(iii) On the diagram, draw the area to show the position of red giant stars.

Label this area RG.

(1)

(iv) State what is meant by the term **absolute magnitude**.

(2)

.....

.....

.....

.....

(b) The Sun emits various parts of the electromagnetic spectrum.

(i) Which part of the electromagnetic spectrum causes damage to human surface skin cells?

(1)

☒ **A** microwaves

☒ **B** radio waves

☒ **C** ultraviolet

☒ **D** visible light

(ii) Which of these increases the risk of damage to human surface skin cells?

(1)

☒ **A** sunbathing

☒ **B** using protective sun cream

☒ **C** very cloudy weather

☒ **D** wearing sunglasses

(Total for question = 7 marks)

Q3.

(a) A student investigates a sound wave with a frequency of 25 000 Hz.

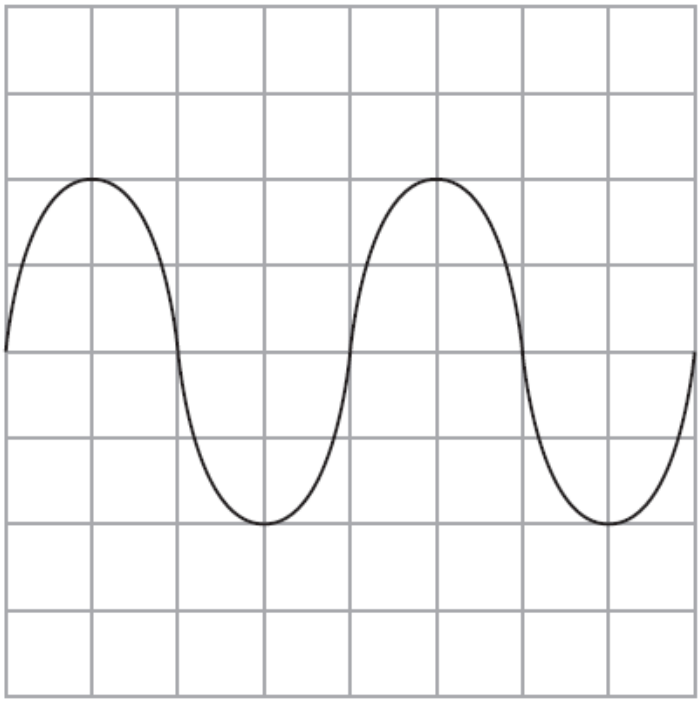
(i) Calculate the wavelength of this sound wave.

[speed of sound = 330 m/s]

(3)

wavelength = ... m

(ii) The oscilloscope trace represents the sound wave.



Oscilloscope settings

y direction: 1 square = 5 V

x direction: 1 square = 0.01 ms

Determine the amplitude of the oscilloscope trace.

(2)

amplitude = ... V

(b) (i) Diagram 1 shows a coil of wire wrapped around a cardboard tube.

The coil is fixed to the cardboard tube.

On diagram 1, draw field lines to represent the magnetic field produced when the current is in the direction shown.

(3)

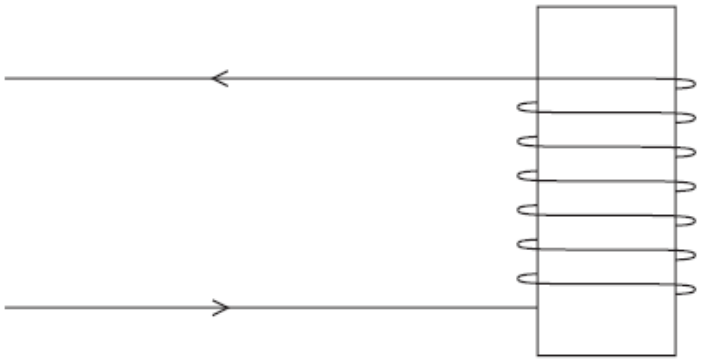


Diagram 1

(ii) Diagram 2 shows a model of a loudspeaker that uses the coil and the cardboard tube.

The cardboard tube is fixed to a thin piece of card, which is clamped at both ends.

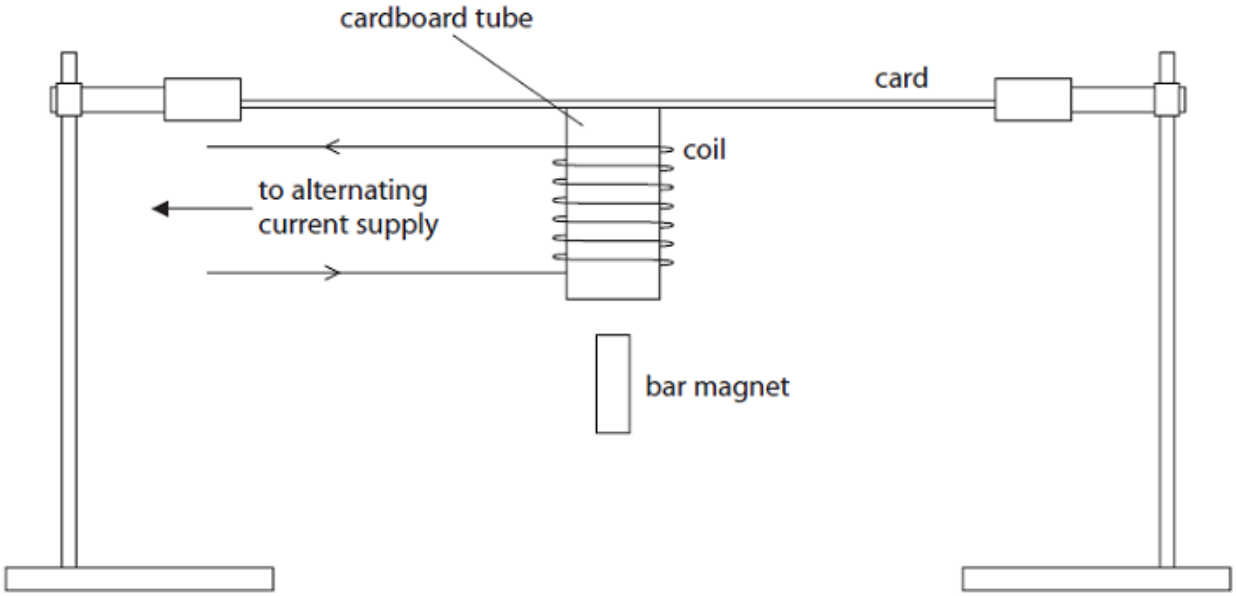


Diagram 2

The student holds a bar magnet near the bottom of the cardboard tube.

Explain why this causes the loudspeaker to produce a sound.

(3)

.....

.....

.....

.....

.....

.....

(iii) When the frequency of the alternating current is 10 kHz, the student hears a sound.

The student increases the frequency of the alternating current to 25 kHz.

Explain why the student cannot hear a sound now, even though the card is still vibrating.

(2)

.....

.....

.....

.....

(iv) Suggest a change to the apparatus that would increase the loudness of the sound when the frequency of the
alternating current is 10 kHz.

(1)

.....

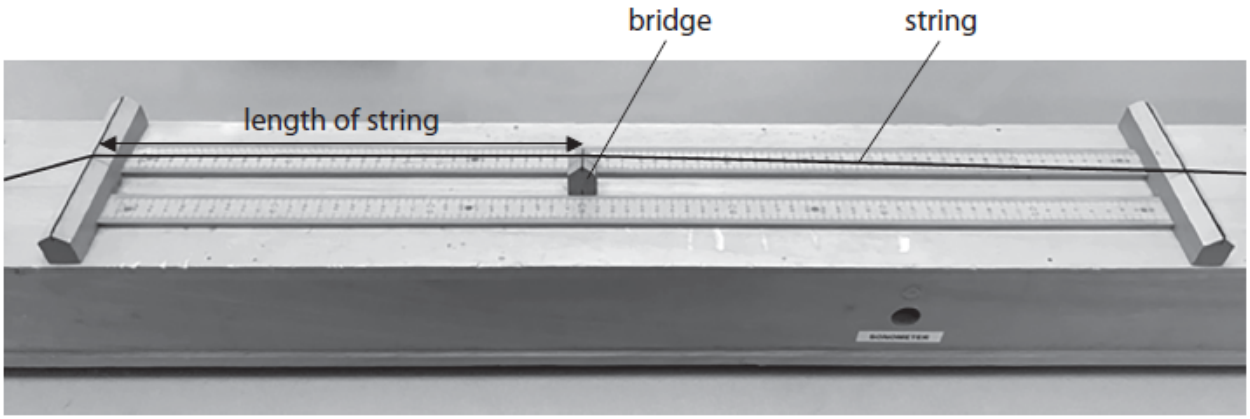
.....

(Total for question = 14 marks)

Q4.

A sonometer is a piece of equipment used to investigate the frequency of waves on a string.

The photograph shows a sonometer.



The string is under tension. When the string is plucked it vibrates to produce a sound wave.

(a) Describe how an oscilloscope should be used to measure the frequency of the sound wave from the sonometer.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) A student investigates how the frequency of sound from the sonometer varies with the length of the string.

This is the student's method.

- apply a constant tension force to the string
- pluck the string and measure the frequency of the sound wave produced
- move the bridge to change the length of the string
- pluck the string and measure the new frequency of the sound wave produced

Repeat the method for different lengths of string.

(i) Give a control variable for the student's investigation.

(1)

.....

(ii) The table shows the student's results.

String length in cm	Frequency in Hz			
	Test 1	Test 2	Test 3	Mean
20	105	104	108	106
40	53	54	52	53
60	36	32	35	
80	25	28	26	26
100	22	20	21	21
120	20	17	18	18
140	15	15	14	15

Calculate the mean frequency for a string length of 60 cm.

(2)

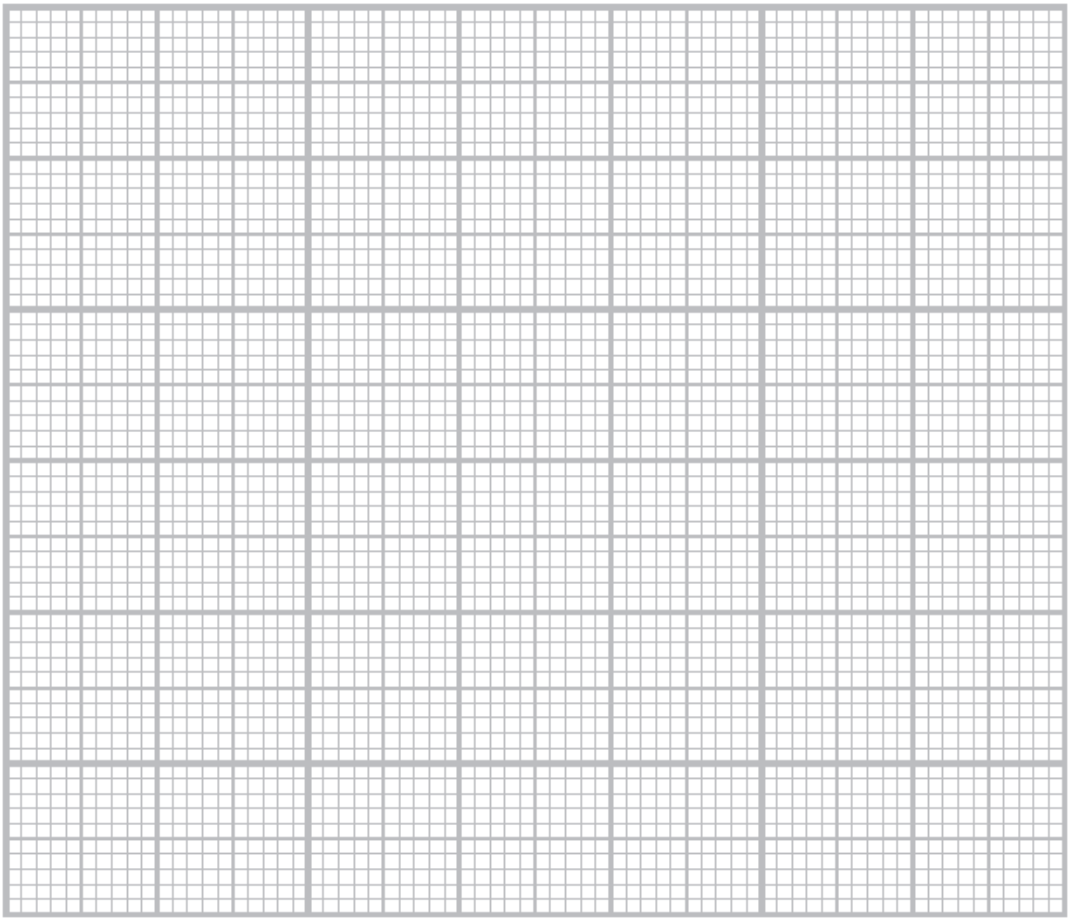
mean frequency = ... Hz

(iii) Plot a graph of the mean frequency and string length data on the grid.

(3)

(iv) Draw the curve of best fit.

(1)



(v) Determine the string length needed to produce a sound wave of frequency 75 Hz.

(1)

string length = ... cm

(vi) The student cannot hear the sound from the sonometer for some of the string lengths tested.

Explain which of the string lengths produce sounds that humans cannot hear.

(2)

.....

.....

.....

.....

(Total for question = 14 marks)

Q5.

This question is about sound waves.

(a) Describe an experiment to measure the speed of sound in air.

You may draw a diagram to help your answer.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

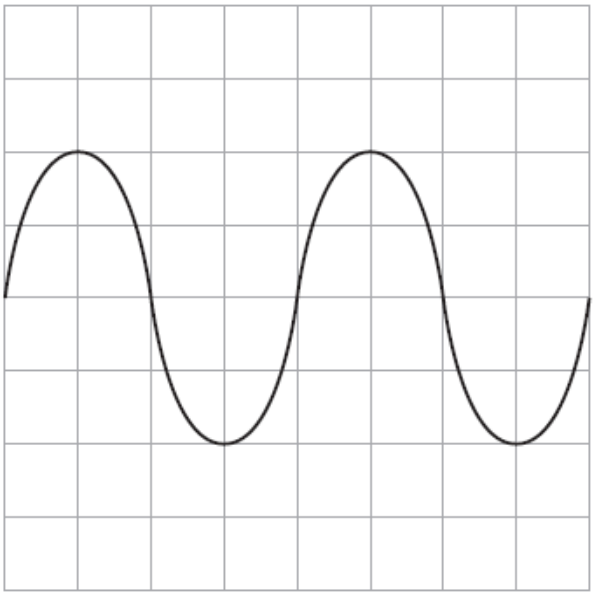
.....

.....

.....

(b) An oscilloscope can be used to determine the frequency of a sound wave.

The diagram shows an oscilloscope trace of a sound wave.



Oscilloscope settings

y direction: 1 square = 1 V

x direction: 1 square = 0.25 ms

(i) Calculate the period of this sound wave.

(3)

period = ... s

(ii) Calculate the frequency of this sound wave.

(2)

frequency = ... Hz

(Total for question = 10 marks)

Q6.

Magnetic Resonance Imaging (MRI) machines can take scans of the inside of a patient.

(a) There is an electromagnet inside the MRI machine.

Describe the construction of an electromagnet.

You may draw a diagram to help your answer.

(4)

.....

.....

.....

.....

.....

.....

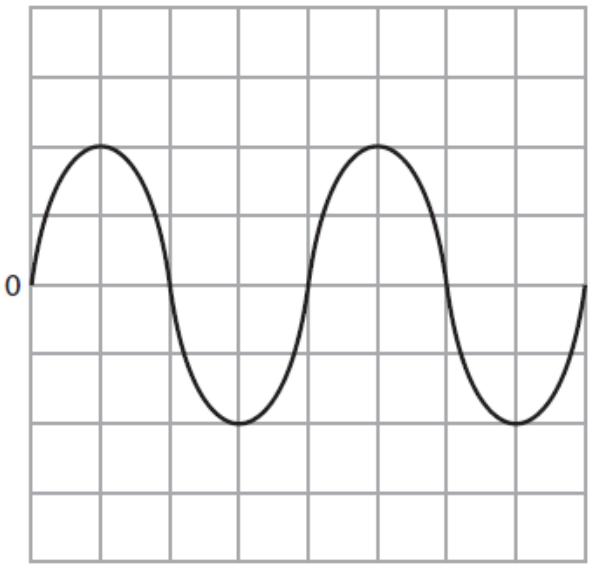
.....

.....

.....

(b) During the scan, music can be played through a loudspeaker to the patient.

The oscilloscope trace in the diagram represents a sound played to the patient.



Oscilloscope settings:

y direction: 1 square = 0.5 V

x direction: 1 square = 0.5 ms

(i) Determine the period of the sound wave.

(3)

period = ... s

(ii) Calculate the frequency of the sound wave.

(2)

frequency = ... Hz

(iii) Deduce whether humans can hear the sound wave.

(2)

.....

.....

.....

.....

(iv) The current in the loudspeaker is alternating current (a.c.).

Give the evidence from the oscilloscope trace to support this statement.

(2)

.....

.....

.....

.....

(v) Draw the circuit symbol for an a.c. power supply.

(1)

(Total for question = 14 marks)

Q7.

Two students do an experiment to measure the speed of sound in air.

They use two blocks of wood that make a loud noise when hit together.

They do their experiment outside in a wide-open space.

(a) Describe how the students should use their equipment to measure the speed of sound in air.

You may draw a diagram to support your answer.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) The table shows the students' results.

Distance in m	Time in s			
	Trial 1	Trial 2	Trial 3	Mean
50	0.46	0.35	0.49	0.43
100	0.50	0.38	0.62	0.50
150	0.42	0.64	0.57	0.54
200	0.68	0.59	0.60	0.62
250	0.58	0.79	0.75	0.71
300	0.90	0.86	0.84	

(i) Calculate the mean time for the last row in the table.

(2)

mean time = ... s

(ii) The students think that some of their time readings are anomalous.

State how the students should deal with these anomalous readings.

(1)

.....

.....

(iii) Explain which distance in the table is likely to give the most accurate value for the speed of sound in air.

(2)

.....

.....

.....

.....

.....

(Total for question = 10 marks)

Q8.

The photograph shows an oscilloscope.



© dny3d/Shutterstock

An oscilloscope can be used to determine the frequency of a sound wave.

(a) (i) Name the piece of equipment that should be used with an oscilloscope to detect a sound wave.

(1)

.....

(ii) Describe how an oscilloscope can be used to measure the time period of a sound wave.

(2)

.....

.....

.....

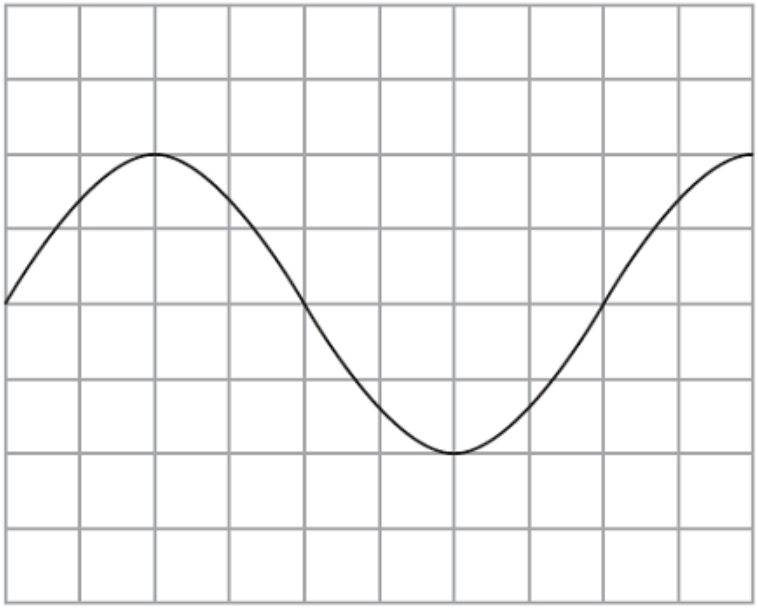
.....

.....

.....

(b) Diagram 1 shows an oscilloscope screen when a sound wave is detected.

It also shows the settings of the oscilloscope.



Oscilloscope settings

y direction: 1 square = 2 V
x direction: 1 square = 5×10^{-6} s

Diagram 1

(i) Determine whether the sound can be heard by humans.

Include a calculation of frequency in your answer.

(4)

.....

.....

(ii) The oscilloscope settings are changed, as shown in Diagram 2.



Oscilloscope settings

y direction: 1 square = 1 V
x direction: 1 square = 1×10^{-5} s

Diagram 2

On Diagram 2, draw the wave that would be displayed on the oscilloscope screen if the same sound wave is detected using these new settings.

(2)

(Total for question = 9 marks)

Q9.

The refractive index, *n*, of a material can be calculated using this formula.

$$n = \frac{\sin(i)}{\sin(r)}$$

(a) A student uses this method to determine the refractive index of a material.

- draw around a semi-circular block of material
- shine a light ray towards the centre of the straight edge of the semi-circular block
- use a pencil and a ruler to mark the positions of the incident ray and the refracted ray
- remove the block
- draw a normal where the ray was incident on the block
- measure the angle of incidence and angle of refraction
- calculate the refractive index using the formula

Repeat the method for different angles of incidence.

(i) Name the independent variable in this investigation.

(1)

.....

(ii) The table shows the student's results for an angle of incidence of 40°.

Angle of refraction 1 (°)	Angle of refraction 2 (°)	Angle of refraction 3 (°)
22	23	67

Calculate the mean value for the angle of refraction.

(2)

mean angle = ... degrees

(iii) Describe how the student could improve their method to get a more accurate value for the refractive index.

(2)

.....

.....

.....

.....

(b) Diagram 1 shows a ray of light refracted by a transparent block of material.

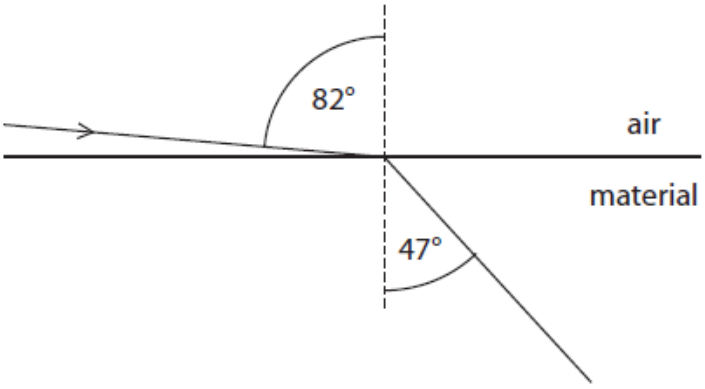


Diagram 1

(i) Calculate the refractive index of this material.

(2)

refractive index = ...

(ii) State the formula linking critical angle and refractive index.

(1)

(iii) The refractive index of a different material is 1.7

Calculate the critical angle of this material.

(2)

critical angle = ... degrees

(c) Diagram 2 shows a ray of light travelling through an optical fibre.

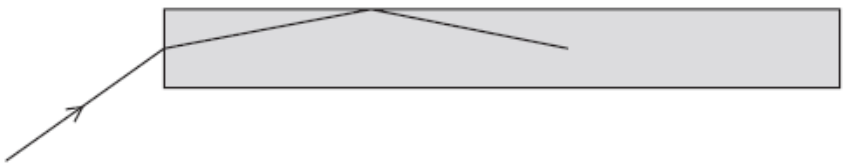


Diagram 2

The optical fibre is made of a material with a refractive index of 1.7

Explain the path of the ray in the optical fibre.

(2)

.....

.....

.....

.....

.....

.....

(Total for question = 12 marks)

Q10.

Sound waves with a frequency above the range of human hearing are known as ultrasound.

(a) State the frequency range for human hearing.

(2)

.....

(b) The frequency of ultrasound waves can be determined using an oscilloscope.

(i) Give the name of the piece of apparatus that could be connected to the oscilloscope to detect the ultrasound waves.

(1)

.....

(ii) The time period of the ultrasound waves must be measured to determine their frequency.

Describe how the oscilloscope is used to measure the time period of the ultrasound waves.

(3)

.....

.....

.....

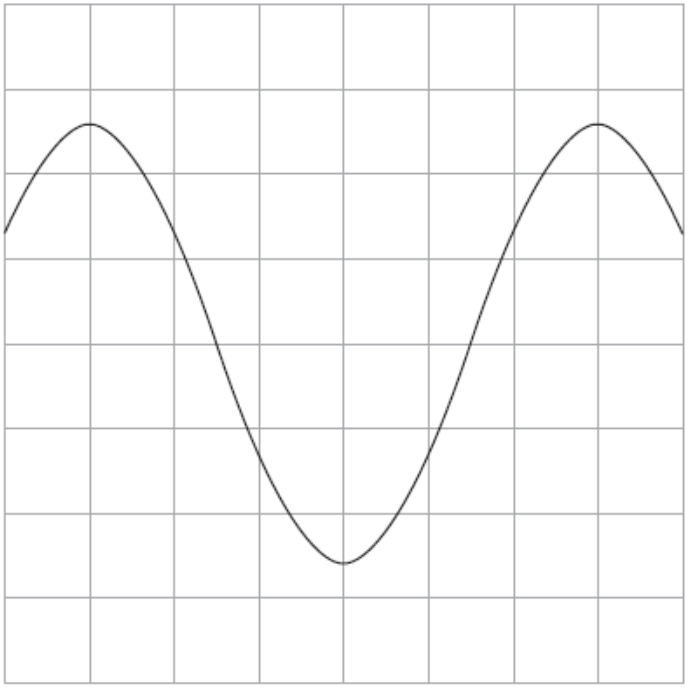
.....

.....

.....

(c) The diagram shows the oscilloscope screen when an ultrasound wave is detected.

The oscilloscope settings are also shown.



oscilloscope settings:

y direction: 1 square = 2V

x direction: 1 square = 5×10^{-6} s

(i) Determine the time period of the ultrasound waves.

(2)

time period = ... s

(ii) Calculate the frequency of the ultrasound waves.

(2)

frequency = ... Hz

(Total for question = 10 marks)

Q11.

A student investigates the speed of sound in air.

(a) The student sets up two microphones, A and B, as shown in Diagram 1.



Diagram 1

The microphones are connected to a datalogger.

A sound is made to the left of microphone A.

The datalogger records the time when the sound wave reaches each microphone.

The student uses the data to calculate the time taken for the sound wave to travel from microphone A to microphone B.

(i) Describe how the student could determine the speed of sound in air using his calculated value of time taken.

(3)

.....

.....

.....

.....

.....

.....

(ii) Suggest why the student does not use a stop clock in this investigation.

(1)

.....

.....

.....

(b) The student investigates how the speed of sound in air varies with temperature.

He places several Bunsen burners in the space between the microphones, as shown in diagram 2.

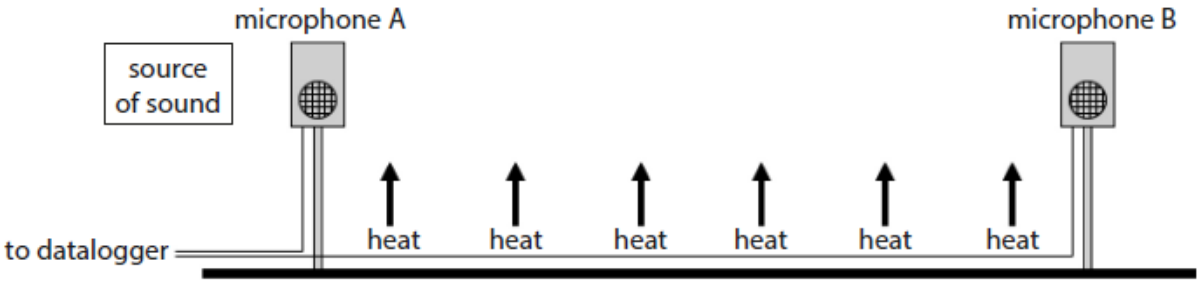


Diagram 2

He uses this method

- light all the Bunsen burners on a low heating flame
- measure the air temperature in three places between the microphones using three temperature sensors
- use the datalogger to record the time taken for a sound wave to travel from microphone A to microphone B
- determine the speed of sound

The student repeats this method as the air temperature increases.

(i) Suggest why it is important for all the Bunsen burners to burn the same amount of gas each second.

(1)

.....

.....

.....

(ii) The table shows the student's results.

Temperature in °C				Time in ms	Speed in m/s
sensor 1	sensor 2	sensor 3	mean		
20.3	20.2	19.9	20.1	4.37	344
29.9	31.3	30.0	30.4	4.29	350
39.7	41.0	39.0	39.9	4.22	358
51.0	50.2	49.3	50.2	4.15	362
59.8	61.5	58.6		4.08	368

Calculate the mean temperature for the last row in the table.

Give your answer to a suitable number of decimal places.

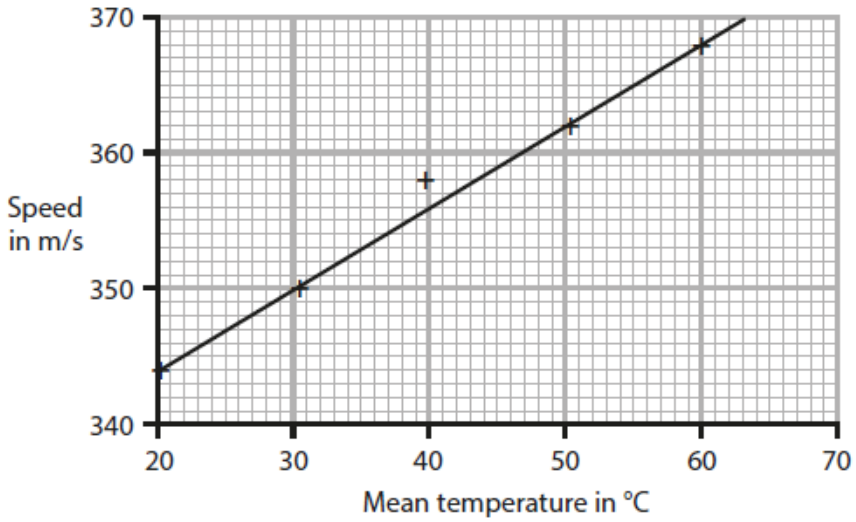
(2)

mean temperature = ... °C

(iii) The student plots his results and draws the line of best fit.

Draw a circle around the anomalous result.

(1)



(iv) State how the student should deal with the anomalous result.

(1)

.....

.....

(v) Explain why a line graph is the correct type of graph to display these results.

(2)

.....

.....

.....

.....

(vi) Describe the relationship between the speed of sound in air and temperature.

(2)

.....

.....

.....

.....

(Total for question = 13 marks)

Q12.

(a) Describe an investigation to determine the speed of sound.

You may draw a diagram to help your answer.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

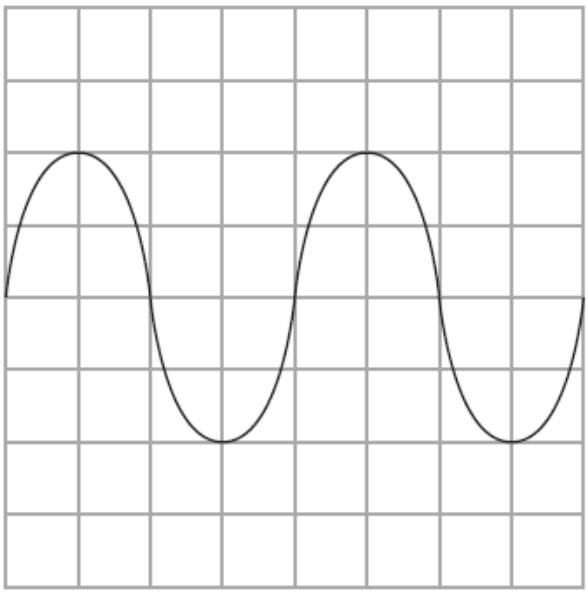
.....

.....

(b) A microphone is connected to an oscilloscope.

A sound is detected by the microphone.

The diagram shows the oscilloscope trace.



Oscilloscope settings

y direction: 1 square = 0.1 V

x direction: 1 square = 5.0 ms

(i) Determine the period of the sound wave.

(3)

period = ... s

(ii) Calculate the frequency of the sound wave.

(2)

frequency = ... Hz

(Total for question = 10 marks)

Q13.

The photograph shows a security camera.

The camera detects light waves and sound waves.



(a) State two differences between light waves and sound waves.

(2)

1 .....

.....

2 .....

.....

(b) The camera detects infrared waves, which allow the camera to record videos in the dark.

(i) Which of these electromagnetic waves has a longer wavelength than infrared waves?

(1)

☒ **A** gamma rays

☒ **B** microwaves

☒ **C** ultraviolet rays

☒ **D** visible light waves

(ii) Which of these is another use for infrared waves?

(1)

☒ **A** fluorescent lamps

☒ **B** heating lamps

☒ **C** satellite transmissions

☒ **D** sterilising medical equipment

(iii) Which of these is a harmful effect of infrared waves?

(1)

☒ **A** blindness

☒ **B** cancer

☒ **C** internal heating of body tissue

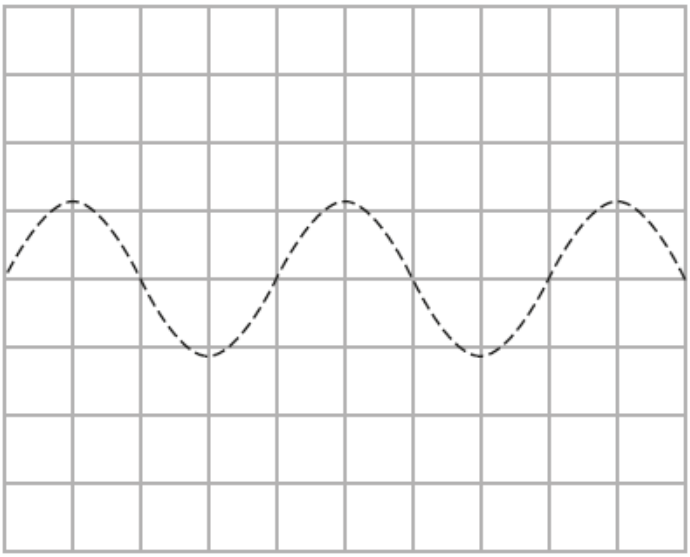
☒ **D** skin burns

(c) The grid shows the oscilloscope trace for a quiet, low-pitch sound wave.

The security camera has an alarm that produces a loud, high-pitch sound.

On the grid, draw a trace to represent the sound wave produced by the alarm.

(2)

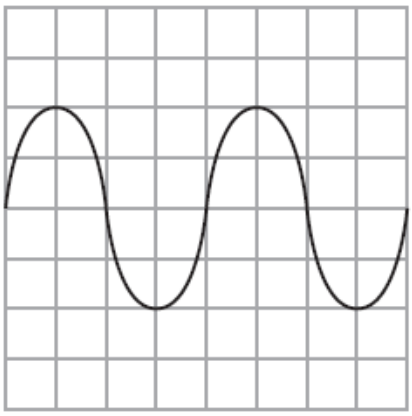


(Total for question = 7 marks)

Q14.

(a) A student uses an oscilloscope to determine the speed of sound.

The diagram shows the oscilloscope trace produced by the sound wave.



Oscilloscope settings
y direction: 1 square = 1 mV
x direction: 1 square = 1 ms

The student uses two microphones and a ruler to determine the wavelength of the sound wave.

He finds that the wavelength is 1.4 m.

(i) State the formula linking the speed, frequency and wavelength of a wave.

(1)

(ii) Use the oscilloscope trace to calculate the speed of the wave.

(5)

speed = ... m/s

(b) Another student uses this method to determine the speed of sound.

Step 1 The student stands 50 m away from her teacher, measuring the distance with a metre ruler.

Step 2 The teacher makes a loud sound and flashes a light at the same time.

Step 3 The student starts the stopwatch when she sees the flash of light.

Step 4 She stops the stopwatch when she hears the loud sound.

The speed of sound is calculated using the formula

$$\text{speed of sound} = \frac{\text{distance}}{\text{time taken}}$$

Evaluate whether this method could produce an accurate value for the speed of sound in air.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 11 marks)