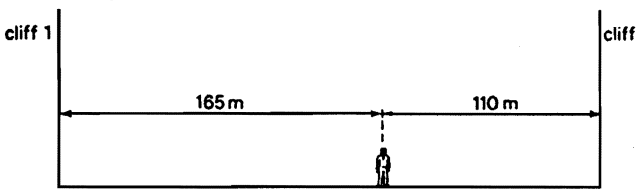
TOPIC 15 Sound

1 A tuning fork, a violin string, and a loudspeaker cone are producing sounds. This is because they are all in a state of

A compression
B rarefaction.
C rotation.
D tension.
E vibration.

J90/I/23

2 A man stands between two cliffs as shown in the diagram and claps his hands once.



Assuming that the velocity of sound in air is 330 m/s, what will be the time interval between the two loudest echoes?

A $^1/_6$ s
B $^1/_3$ s
C $^2/_3$ s
D $^5/_6$ s
E 1 s

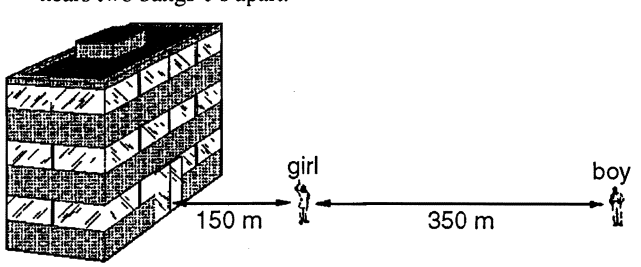
J90/I/24

3 What would a drummer do to make the sound of a drum give a note of lower pitch?

A hit the drum skin with a larger force
B hit the drum skin with a smaller force
C hit the drum skin nearer the edge
D loosen the drum skin
E tighten the drum skin.

N90/I/22

4 A girl, standing 150 m in front of a tall building, fires a shot with a starting pistol. A boy, standing 350 m behind her, hears two bangs 1 s apart.



From this information, what is the speed of sound in air?

A 150 m/s
B 300 m/s
C 350 m/s
D 500 m/s
E 650 m/s

N90/I/23; J98/I/40

5 Astronauts are in a space-ship orbiting the Moon. They see an explosion on the surface of the Moon.

Why can they **not** hear the explosion?

A Explosions cannot occur in space.
B Sound cannot travel through a vacuum.
C Sound is reflected from the space-ship.
D Sound travels too quickly through space to affect the ear drum.
E The space-ship would be moving too quickly for the sound to reach it.

J91/I/23

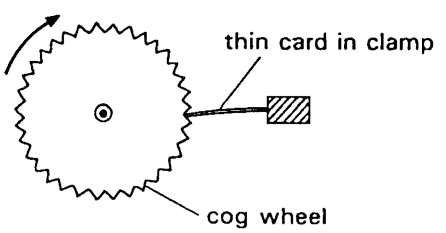
6 What is the approximate range of audible frequencies for a young person?

A 2 Hz to 2000 Hz
B 20 Hz to 2000 Hz
C 20 Hz to 20 000 Hz
D 200 Hz to 200 000 Hz
E 2 000 Hz to 200 000 Hz

J91/I/24

7 A piece of thin card was held against the teeth of a cog wheel.

When the wheel is turned at high speed a note is heard.



How may the pitch of this note be raised?

A using a thicker card
B using a thinner card
C pressing the card against the teeth with a greater force
D turning the wheel more slowly
E turning the wheel more quickly

N91/I/23; N99/I/22

8 Which of the following ranges of sound frequencies would a healthy human adult be most likely to hear?

A 0.2 Hz → 200 Hz
B 2 Hz → 2 000 Hz
C 20 Hz → 20 000 Hz
D 200 Hz → 200 000 Hz
E 2000 Hz → 2 000 000 Hz

J92/I/22

9 A sonic 'tape measure' is used to measure the length of a room. It measures a time interval of 0.06 s between transmitting a sound pulse and receiving the echo. The speed of sound in air is 330 m/s.

What is the length of the room?

A 3.3 m
B 6.0 m
C 9.0 m
D 9.9 m
E 19.8 m

J92/I/23

10 A marine survey ship sends a sound wave straight to the sea bed. It receives an echo 1.5 s later. The speed of sound in sea-water is 1500 m/s.

How deep is the sea at this position?

A 500 m **D** 2250 m
B 1000 m **E** 4500 m
C 1125 m N92/I/22

11 Which of the following correctly gives the properties of sound waves?

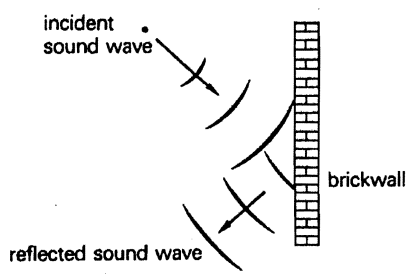
	nature	*can travel in*	*speed in air*
A	longitudinal	vacuum	3.4 m/s
B	longitudinal	vacuum	3×10^8 m/s
C	longitudinal	air	340 m/s
D	transverse	vacuum	340 m/s
E	transverse	air	3.4 m/s

N92/I/23

12 In which of the following situations could sound waves **not** travel?

A along a metal railway line
B between two spaceships in space
C from a surface ship to a submarine
D from inside a diving chamber to a microphone in water outside
E through a balloon filled with helium J93/I/21

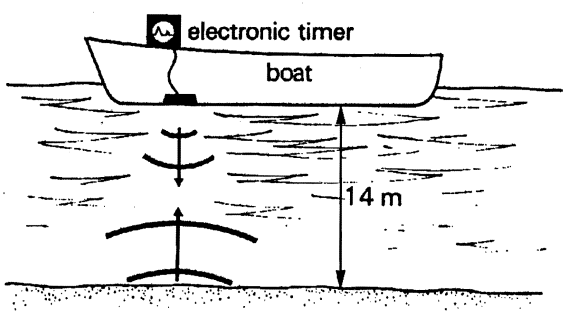
13 A sound wave is reflected from a brick wall.



Compared with the incident wave, the reflected wave has

A a shorter wavelength. **D** a greater amplitude.
B the same speed. **E** a greater frequency.
C the same velocity. J93/I/23; J99/I/39

14 An underwater transmitter sends out a pulse of sound from the bottom of a boat. An electronic timer measures the time between the pulse being emitted and the echo being received.



When the water beneath the boat is 14 m deep, the timer records a time of 0.02 s. Which of the following gives the speed of sound in water?

A 14×0.02 m/s
B $2 \times 14 \times 0.02$ m/s **D** $\frac{2 \times 14}{0.02}$ m/s
C $\frac{14}{0.02}$ m/s **E** $\frac{14}{2 \times 0.02}$ m/s N93/I/23

15 The amplitude and frequency of a sound wave are both increased. How are the loudness and pitch of the sound affected?

	loudness	*pitch*
A	increased	raised
B	increased	unchanged
C	increased	lowered
D	decreased	raised
E	decreased	lowered

N93/I/24

16 Which of the following travels as longitudinal waves?

A infra-red radiation in space
B radio waves in air
C ripples on a water surface
D sound waves in a solid J94/I/19

17 The sound wave from a violin had a larger amplitude than that from a flute. The sound wave from the flute had a higher frequency than that from the violin.

Which instrument produced the louder sound and which the higher pitch?

	louder sound	higher pitch
A	flute	flute
B	flute	violin
C	violin	flute
D	violin	violin

J94/I/23

18 The table shows how the speed of sound varies with substances of different densities.

substance	*speed of sound in substance* m/s	*density of substance* kg/m^3
air (gas)	330	1.29
oxygen (gas)	320	1.43
aluminium (metal)	5100	2710
iron (metal)	5000	7870
lead (metal)	1200	11300

What conclusion about the speed of sound can be drawn from this information?

A The speed increases as the density of the substance increases.
B The speed is greater in less dense substances.
C The speed is greater in metals than in gases.
D The speed is greatest in the densest metal.

J94/I/24

19 Which set of information about sound waves is correct?

	nature of wave	*speed in air, in* m/s	*speed in glass in* m/s
A	longitudinal	300	5 000
B	longitudinal	300 000 000	200 000 000
C	transverse	300	5 000
D	transverse	300 000 000	200 000 000

N94/I/23

20 Two notes are played on a guitar. The second is louder and has a higher pitch.

The second note is

A higher in amplitude and lower in frequency.
B higher in both amplitude and frequency.
C lower in amplitude and higher in frequency.
D lower in both amplitude and frequency.

N94/I/24

21 What is the approximate range of audible frequencies for a young person?

A 1 Hz – 20 Hz
B 20 Hz – 20 kHz
C 20 kHz – 200 kHz
D 1000 kHz – 20 000 kHz J95/I/21

22 What would a drummer do to make the sound of a drum give a note of lower pitch?

A hit the drum skin with a larger force
B hit the drum skin with a smaller force
C loosen the drum skin
D tighten the drum skin J95/I/22

23 The echo sounder of a ship transmits a pulse of sound which is reflected back to the ship by a shoal of fish directly below the transmitter. The time between the transmission and reception of the pulse by the ship is 0.1 s. The speed of sound in sea water is 1200m/s.

At what depth are the fish?

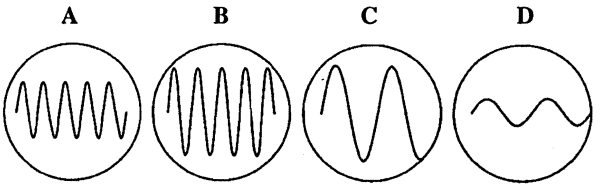
A 60 m
B 120 m
C 6000 m
D 12 000 m J95/I/23

24 Which line in the table correctly gives the speed of sound in air, water and steel?

	air	*water*	*steel*
A	330 m/s	6000 m/s	1500 m/s
B	330 m/s	1500 m/s	6000 m/s
C	6000 m/s	330 m/s	1500 m/s
D	6000 m/s	1500 m/s	330 m/s

N95/I/23

25 The diagrams show the oscilloscope traces produced by different sounds.



Which diagram corresponds to the loudest sound of lowest pitch? N95/I/24

26 In space there is no sound because there is no

A air.
B gravity.
C light.
D magnetic field. J96/I/23

27 A sonic 'tape measure' is used to measure the length of a room. It measures a time interval of 0.06 s between transmitting a sound pulse and receiving the echo. The speed of sound in air is 330 m/s.

How far is the reflecting wall from the 'tape measure'?

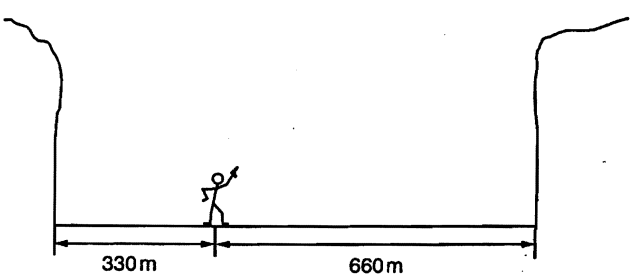
A 5.5 m
B 9.9 m
C 11.0 m
D 19.8 m J96/I/24 ; N2000/I/21

28 A guitar string is made to vibrate.

What would make the pitch of the note rise?

A a decrease in the amplitude of vibration
B an increase in the amplitude of vibration
C a decrease in the frequency of vibration
D an increase in the frequency of vibration N96/I/22

29 A student stands 330 m from a tall cliff which is 990 m from another tall cliff.



The student fires a starting pistol and hears some echoes.

If the speed of sound between the cliffs is 330 m/s, what is the interval between the first echo and the second echo?

A 1.0 s
B 2.0 s
C 3.0 s
D 6.0 s N96/I/23

30 On what do the pitch and the loudness of a sound wave depend?

	pitch	*loudness*
A	amplitude	frequency
B	frequency	amplitude
C	frequency	speed
D	speed	amplitude

J97/I/22

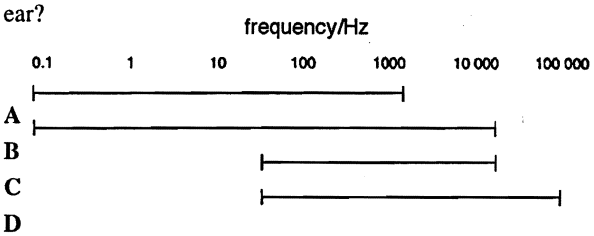
31 A healthy teenager has a hearing test.

Which range of frequencies is the teenager likely to be able to hear?

A 2 Hz to 20 Hz
B 2 Hz to 200 Hz
C 20 Hz to 20 kHz
D 20 Hz to 200 kHz

N97/I/24

32 Which line on the diagram best represents the range of frequencies of sound that can be heard by a healthy human ear?



J98/I/21

33 The sounds produced by two musical instruments are directed towards a microphone connected to an oscilloscope. The waveforms produced on the oscilloscope screen are shown.

The waveforms show that the sounds produced have a different property.

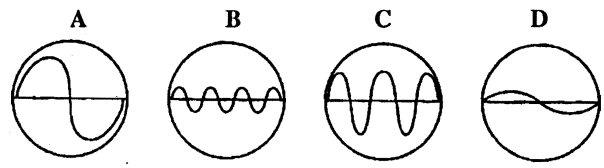
What is the property?

A frequency
B speed
C timbre (quality)
D wavelength

J98/I/22

34 The diagrams represent sound waves displayed on an oscilloscope.

Assuming the controls of the oscilloscope remain the same for each sound, which diagram represents the quietest sound with the highest frequency?



N98/I/22

35 The speeds of sound in air, in steel and in water are different.

Which of the following gives the speeds in increasing order?

	slowest ⟶		fastest
A	air	water	steel
B	steel	water	air
C	water	air	steel
D	water	steel	air

J99/I/21

36 A sound wave from a violin has a larger amplitude than that from a flute. The sound wave from the flute has a higher frequency than that from the violin.

Which instrument produces the louder sound and which produces the sound of higher pitch?

	louder sound	higher pitch
A	flute	flute
B	flute	violin
C	violin	flute
D	violin	violin

J99/I/22

37 A microphone is connected to an oscilloscope. The diagram shows the trace on the screen when the microphone receives a pure note.

Which trace can be obtained when a musical instrument produces a note of the same pitch but of a different quality?

A


B


C


D


N99/I/21

38 On what does the quality (timbre) of a sound wave depend?

A the loudness of the sound
B the pitch of the sound
C the shape of the wave
D the speed of the wave J2000/I/21

39 Four different whistles, when blown, emit pure notes with the frequencies shown.

0.1 kHz **1 kHz** **10 kHz** **100 kHz**

How many of the frequencies are above the normal audible range for humans?

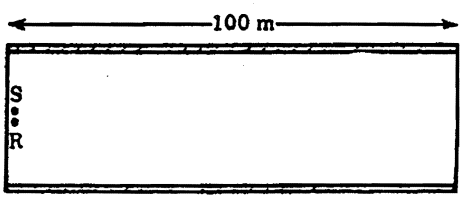
A 1
B 2
C 3
D 4 J2000/I/22

40 What is the correct order for the speed of sound in air, steel and water?

	slowest ⟶ fastest		
A	air	steel	water
B	air	water	steel
C	water	air	steel
D	water	steel	air

N2000/I/20

41 The diagram shows the plan of a very large hall, 100 m long, which has sound-absorbent side walls and a smooth hard wall at each end.



A source of sound at S emits a short single blast.

(a) Why are *several* echoes of *decreasing* loudness heard by an observer at R?

(b) Calculate the approximate time interval between the second and third echoes heard at R, given that the speed of sound in air is 340 m/s.

J79/I/9

42 Sound waves are *longitudinal* waves; when they travel through air they are associated with *compressions* and *rarefactions* in the air. Explain the meanings of the terms in italics.

The waves from a sound source of frequency 510 Hz travel through air at 340 m/s. Calculate the wavelength of the waves and deduce the distance from a compression to the nearest rarefaction.

A different source of sound has a frequency of 1020 Hz. How is its pitch related to that of the source of frequency 510 Hz?

Describe in detail an experiment by which the speed of sound waves in air could be determined. State the precautions you would take to reduce the errors in your experiment. J80/II/10

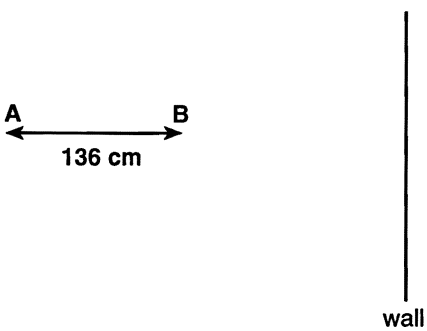
43 In an experiment to determine the speed of sound in air the experimenter tries to find a value using the reflection of sound waves by a wall.

(a) Suggest a suitable source of sound waves and describe any features of the wall which would make it suitable for this experiment.

(b) How would you determine the time taken by the sound waves to travel to the wall and return to the source?

(c) State one reason which could account for error in this timing.

Suggest one way of improving the accuracy of the time obtained.



(d) An experimenter at A found that the time taken by the sound waves to travel to the wall and return to A was 4.3 s. On walking 136 m to B and repeating the test the experimenter found the corresponding time reduced to 3.5 s.

Find the speed of sound in air from these observations.

(e) What would be the difficulty in attempting to use the same method to find the speed of light waves?

J81/II/3

44 What determines the following characteristics of a musical note?

(a) pitch

(b) loudness

(c) quality N81/I/8

45 *(a)* In a simple experiment to determine the speed of sound, an observer with a stopwatch stands on a flat stretch of sand and an assistant standing at a measured distance of 800 m fires a pistol. The observer starts his stopwatch when he sees the flash of the pistol and stops it when he hears the sound of the shot. The time intervals obtained for three experiments are: 2.2, 2.3 and 2.1 s.

Calculate a value for the speed of sound in air.

(b) On another occasion, by a similar experiment, the speed of sound was found to be 310 m/s compared with the expected value of 330 m/s. State, giving a reason in each case, whether the variation between these two values could be due to

(i) the fact that there is a strong wind blowing directly from the assistant to the observer.

(ii) the tact that the stopwatch is running fast (i.e. the pointer is going round too quickly).

(c) This experiment is sometimes carried out with the observer and assistant standing together in front of a cliff; the observer then measures the time interval between the firing of the pistol and the arrival of the echo of the shot.

Why does this method reduce the effect of wind on the result obtained for the speed of sound?

(d) What conclusion can be drawn from the fast that in such an experiment the average time interval between the sound and the arrival of the echo is the same whatever the pitch of the sound? N81/II/4

46 A sound wave, of wavelength 600 mm and frequency of vibration 550 Hz, produces moving compressions and rarefactions in the air. What do you understand by

(a) compressions. *(b)* rarefactions?

What is the distance from the middle of a compression to the middle of the nearest rarefaction in this wave at any instant?

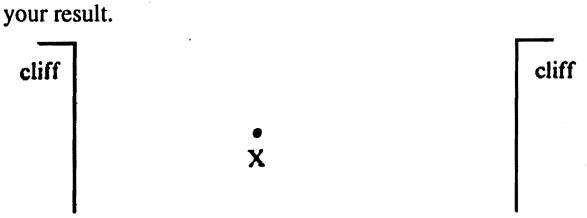
How many compressions pass a point in one second? N82/I/10

47 The frequency of vibration of a tuning fork is 512 Hz. Calculate the wavelength of the sound waves emitted by the fork when vibrating in air in which the speed of sound is 330 m/s.

Find the wavelength and frequency of the waves produced by the fork when it is vibrating in a gas in which the speed of sound is 300 m/s. J83/I/8

48 Someone standing between two parallel cliffs fires a gun. The first two echoes are heard after 1.1 s and 3.3 s, respectively. Taking the speed of sound as 330 m/s, calculate the distance between the cliffs. J83/II/10 (part)

49 A gun is fired at point X between two vertical cliffs – see diagram. The first echo heard at X occurs 1.5 s after firing, and a second echo after a further 1.0 s. Calculate how far the cliffs are apart, showing clearly how you have arrived at your result.



[Take the speed of sound waves in air as 340 m/s.] N83/I/14

50 A loudspeaker emits very short pulses of sound at a rate of 2 per second. An experimenter holds the loudspeaker very close to, and facing, a cliff and then moves it away from the cliff until he can hear no interval between the pulses from the loudspeaker and the reflection of the pulses from the cliff face.

(a) How far from the cliff face has the experimenter moved the loudspeaker?

[Take the speed of sound in air as 340 m/s.]

(b) The frequency of the note emitted by the loudspeaker is 850 Hz. Calculate the wavelength of the note.

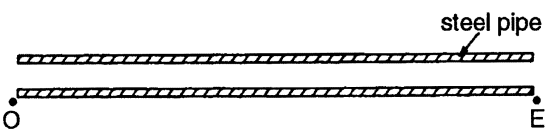
(c) Describe carefully the movement of an air particle as a sound wave passes.

(d) Explain the occurrence of compressions and rarefactions as the sound wave travels through the air. N84/II/3

51 A vibrator of fixed frequency 500 Hz produces sound waves in air which have a wavelength 0.68 m. Calculate the speed at which sound waves travel in air.

The same vibrator is now submerged in water and set vibrating. The sound waves produced travel at 1500 m/s. Calculate the wavelength of these waves. N85/I/8

52 The diagram shows a large diameter steel pipe 80 m long (not drawn to scale). An experimenter at E bangs the pipe and his assistant at O listens for the sound reaching him.



(a) Explain why the assistant will hear two sounds, one arriving before the other.

(b) In an experiment to measure the time needed for the sound to travel through the air from E to O, five values were recorded;

0.20 s, 0.28 s, 0.25 s, 0.27 s, 0.23 s.

Hence find

(i) the mean time,

(ii) the mean speed of sound in air.

(c) Suggest how you would attempt to find the time needed for the sound to travel from E to O through the air.

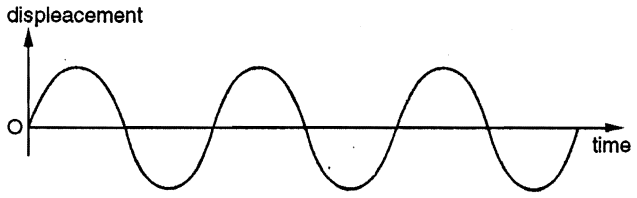
(d) Further experiments were performed by;

(i) striking the pipe harder thereby producing a *much louder* sound,

(ii) using a different pipe which gave a sound of *considerably increased pitch.*

What would you expect to be the effect on the value obtained for the speed of sound in air in each case? N85/II/6

53 The diagram represents the displacement of a particle as a sound wave passes. Draw, on the same diagram and starting at O, a line which represents the displacement of the particle when a wave of twice the frequency and half the amplitude of the original passes.



How is the sound heard affected by

(i) the frequency of the source

(ii) the amplitude of the sound wave? J86/I/6

54 *(a)* The sound wave from a source of frequency 400 Hz travels in air at a speed of 340 m/s. Calculate the wavelength of this sound wave.

(b) At any instant there are *compressions* and *rarefactions* along the path of the sound wave.

(i) Explain briefly the meaning of the words in italics.

(ii) What is the distance from the centre of a compression to the centre of *the nearest* rarefaction in the wave described in part *(a)*?
N86/I/8

55 *(a)* In an experiment to determine the speed of sound, a gun was fired and an observer 1.3 km away measured the time interval between seeing the flash of the gun and hearing the shot. The result obtained was 3.9 s. Using this information calculate a value for the speed of sound in air.

(b) The person with the gun and the observer changed places and repeated the experiment. The results of the two experiments were averaged. State **two** reasons why the average might be more accurate than either separate result. J87/II/6

56 *(a)* In an experiment to measure the speed of sound in air a person with a starting pistol stands at one end of a field and a second person with a stopwatch stands at the other end of the field. When fired, the gun emits a puff of smoke. On seeing this smoke the second person starts the stopwatch and on hearing the sound of the gun he stops the watch. The time recorded by the watch is 1.10 s and the distance travelled by the sound is 375 m. Calculate the speed of sound from these readings. [2]

State the assumption made about the speed of light in this calculation. [1]

Explain how the result of this experiment would be changed, if at all, when

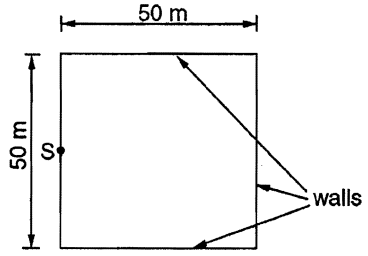
(i) the sound of the gun was louder,

(ii) a wind blew directly from the gun to the stopwatch,

(iii) sound waves were reflected from several nearby buildings. [3]

Suggest one way of making this determination of the speed of sound more accurate. [1]

(b) A sound source is set at S in the centre of one wall of a quadrangle, as shown in the diagram.



(i) Draw the path of the sound wave returning to S after striking each of the other three walls in turn.

(ii) State with **two** reasons why the loudness of the sound returning to S is less than that of the sound leaving S. [3]
N87/II/4

57 *(a)* Fig. 1.1 illustrates an apparatus which can be used to demonstrate that the transmission of sound requires a material medium.

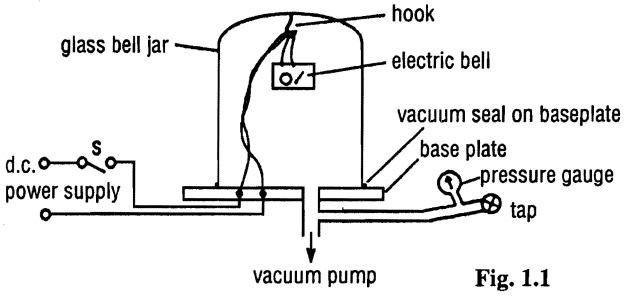


Fig. 1.1

The stages in the demonstration are set out below. Initially, the air inside the bell jar is at atmospheric pressure. State what is seen and heard at each of the following stages and what deductions can be made.

State 1. The bell circuit is completed by closing switch S.

Seen and heard .....

Deduction .....

Stage 2. The tap is closed and the vacuum pump is switched on.

Seen and heard .....

Deduction .....

State 3. The vacuum pump is switched off and the tap opened.

Seen and heard .....

Deduction .....

Why is the demonstration more conclusive if the bell is suspended, as in Fig. 1.1, rather than supported on a metal stand as in Fig. 1.2?

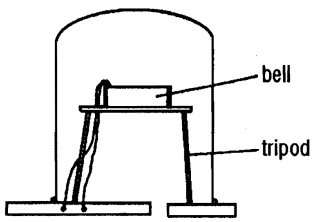


Fig. 1.2

[6]

(b) In a determination of c, the speed of sound in air on a windless day, one person P fired a stating pistol whilst another person Q started a digital stopwatch when he saw the flash and stopped it when he heard the sound. P and Q then exchanged positions and repeated the procedure.

The results obtained were:

Experiment 1, 1.36 s; Experiment 2, 1.29 s.

Given that the distance between P and Q was 450 m in both experiments, calculate a value of c.

Why is it better, in such a determination, to use a distance between P and Q of 450 m rather than 100 m? [4]

J88/II/4

58 A microphone is arranged to pick up sound waves from two different sources. The output from the microphone is fed into an oscilloscope. Without any adjustments being made to the oscilloscope, the traces shown in Fig. (i) and Fig. (ii) are obtained on the screen when each source in turn is placed at the same point in front of the microphone.

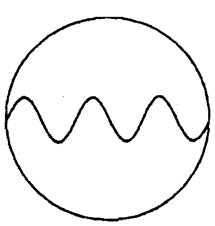


Fig. (i)

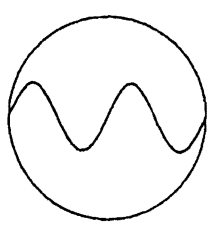


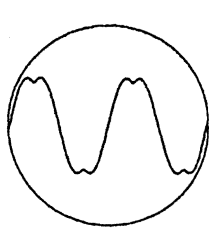
Fig. (ii)

(a) State, with a reason, which diagram represents

(i) a sound of lower pitch,

(ii) a louder sound. [2]

(b) When a third sound source is used, the trace below is obtained.



In what respects does this source differ from the source which produced Fig. (ii)? [2] N88/I/10

59 *(a)* Describe an experiment which shows that sound waves need a material medium for their transmission. State clearly how the observations made in the experiment demonstrate the need for a medium. [7]

(b) Explain how observation of the sound produced by a source and the echoes from a nearby wall can be used to determine the speed of sound in air. [3]

(c) A sound wave produces *compressions* and *rarefactions* in the air in which it travels.

(i) Explain the meanings of the terms *compression* and *rarefaction*.

(ii) Assuming that the wavelength of the wave is 1.5 m, calculate the distance between a compression and the nearest rarefactions. [3]

(d) Describe how the vibration of a source of sound must change if the sound heard at a given point is to change in each of the following ways.

(i) The sound becomes louder without changing the pitch.

(ii) The pitch of the note is increased by 1 octave without changing the amplitude of vibration. [4]

N89/II/10

60 In an experiment to determine the speed of sound in air, a student bangs two blocks of wood together when standing 125 m away from a high wall. The student hears the echo from the wall within one second of banging the blocks together. When he bangs the blocks repeatedly at a certain regular rate, he can no longer hear the echoes.

(a) Explain why he cannot hear the echoes when he bangs the blocks at a particular rate. [2]

(b) The lowest rate of banging for which the echoes cannot be heard is 81 bangs per minute. Calculate a value for the speed of sound in air. [3]

J90/II/5

61 *(a)* A loudspeaker and a microphone are set up facing each other several metres apart. Explain how the vibrations of the cone of the loudspeaker produce sound waves in the air and how these waves are transmitted through the air to the microphone. [5]

(b) The separation of the loudspeaker and the microphone in *(a)* is 6.8 m. When the cone of the loudspeaker vibrates at a frequency of 200 Hz there are exactly 4 complete waves in the air between the loudspeaker and microphone.

(i) Calculate the speed of sound as it travels in the air between the loudspeaker and microphone.

(ii) Estimate the number of waves between the loudspeaker and microphone when the frequency is 2.00 kHz.

(iii) State the effect on the sound heard by a normal healthy ear of changing the frequency from 200 Hz to 2.00 kHz. [5]

(c) Imagine that you have been asked to carry out an experiment to determine the speed of sound in air.

(i) Make a list of the apparatus you would use.

(ii) With the aid of a diagram, give a brief description of the experiment you would carry out.

(iii) State one precaution you would take to ensure that your value for the velocity of sound is as accurate as possible. [5]

N90/II/10

62 Fig. 2 shows a speaker diaphragm **SD** a distance d from a microphone diaphragm **MD**. The speaker is emitting a pure note with a wavelength in air of $d/2$.

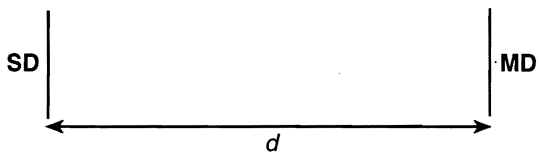


Fig. 2

(a) On Fig. 2 draw lines representing layers of air to show the compressions and rarefactions between **SD** and **MD** when there is a compression just to the right of **SD**. [3]

(b) Calculate a value for the speed of sound in air, given that the wavelength is 1.65 m when the frequency of vibration of **SD** is 200 Hz. [2]

J92/II/2

63 A student sits in the middle of a large rectangular hall which is 17m wide, as shown in **Fig. 3**. When the student bangs a drum, two echoes are heard, 50 ms and 80 ms, respectively, after the bang.

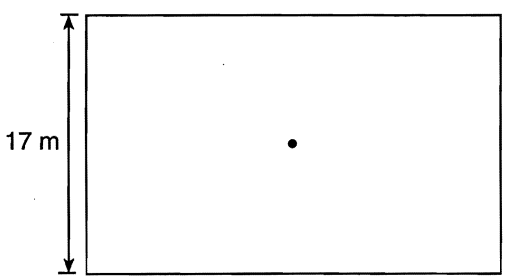


Fig. 3

Assuming that there is no echo from the ceiling, calculate

(a) the speed of sound in air,

Speed of sound = ...

(b) the length of the hall.

Length of the hall = ... [5]

J93/II/3

64 The speed of light in air is 3.00×10^8 m/s. The speed of sound in air is 0.340 km/s. An observer is 5.00 km away from a lightning discharge.

(a) Calculate the travel time, to the observer, of

(i) light from the lightning flash,

(ii) sound from the thunder. [4]

(b) What is the time interval between the observer seeing the lightning and hearing the thunder? [2]

N94/II/3

65 (a) (i) Describe the motion of the molecules of a gas.

(ii) What type of motion does a sound wave give to the molecules of air?

(iii) What effect does a sound wave have on the pressure of air as the wave moves through it? [4]

(b) A bicycle pump of volume 72 cm^3 is filled with air at a pressure of 0.100 MPa. The volume is reduced to 30 cm^3. No air leaks from the pump and the temperature stays constant. Calculate the pressure of the compressed air. [2]

N95/II/2

66 When a sound passes through the air, it affects the pressure of the air and the motions of the molecules of the air.

Describe briefly how each is affected.

(a) *the pressure* [2]

(b) *the motions of the molecules* [2]

J96/II/6

67 The lines in Fig. 4.1 represent the positions of equally spaced 'rows' of molecules of air before a sound wave passes through the air. The lines in Fig. 4.2 represent the positions of the same 'rows' at one particular instant as the sound wave passes. The wave is moving from left to right.

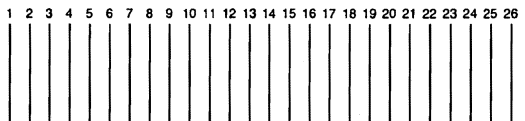


Fig. 4.1

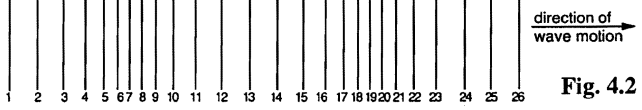


Fig. 4.2

(a) State the numbers of three 'rows' in Fig. 4.2 which, as well as being next to one another, are

(i) in a region of compression,

(ii) in a region of rarefaction. [2]

(b) Figs. 4.1 and 4.2 are drawn to full scale. Estimate the wavelength of the wave. [1]

(c) The speed of sound in air is 340 m/s. Estimate the frequency of the wave. [3]

N96/II/6

68 *(a)* Fig. 5 shows a metal rod, 2.4 m long, being struck a sharp blow at one end using a light hammer. The time interval between the impact of the hammer and the arrival of the sound wave at the other end of the rod is measured electronically.

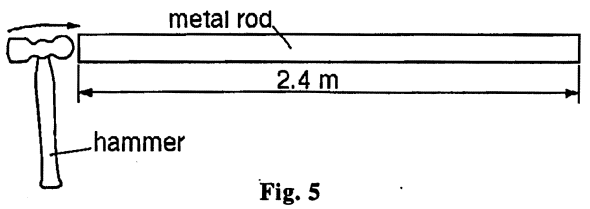


Fig. 5

Four measurements of the time interval are 0.44 ms, 0.50 ms, 0.52 ms and 0.47 ms.

(i) Determine the average value of the four measurements.

average = ...

(ii) Hence calculate a value for the speed of sound in the rod.

speed of sound in the rod = ...[4]

(b) State approximate values for the speed of sound in

(i) air,

(ii) a liquid.

speed of sound in air = ...

speed of sound in liquid =.....[2]

J97/II/5

69 Fig. 6 shows a cathode-ray oscilloscope trace for a sound wave produced by a loudspeaker.

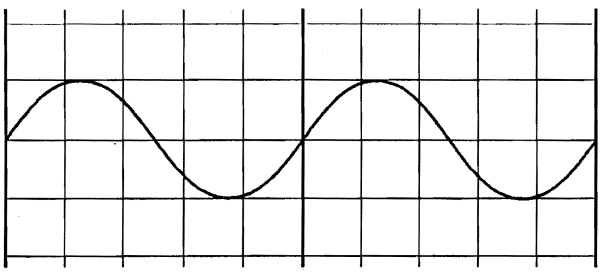


Fig. 6

(a) On Fig. 6, draw the trace for a louder sound of the same pitch. [2]

(b) It takes $\frac{1}{50}$ th of a second (0.02 s) for the whole trace to be produced.

(i) Show that the frequency of the sound produced by the loudspeaker is 100 Hz.

(ii) Determine the wavelength in air of the sound produced by the loudspeaker. (The speed of sound in air is 330 m/s.)

wavelength =..... [3]

J98/II/8

70 Ultrasound and X-rays are both used to provide information about structures inside the human body. Ultrasound is sound having a frequency above the highest audible frequency that humans can hear. X-rays are a region of the electromagnetic spectrum with a higher frequency than visible light.

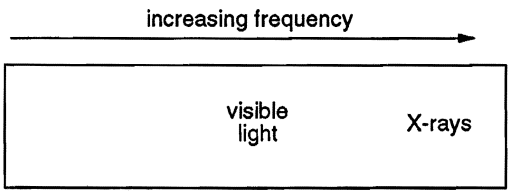


Fig. 7.1

(a) (i) Name three regions of the electromagnetic spectrum other than X-rays and visible light.

(ii) Copy Fig. 7.1 and on it show the position of the three regions of the electromagnetic spectrum that you have chosen in (i).

(iii) Write one or two sentences about each region of the spectrum that you have chosen, describing how the electromagnetic waves are used or how they affect people.

(iv) State one property that all parts of the electromagnetic spectrum have in common. [8]

(b) Fig. 7.2 shows ultrasound being used to study an unborn baby.

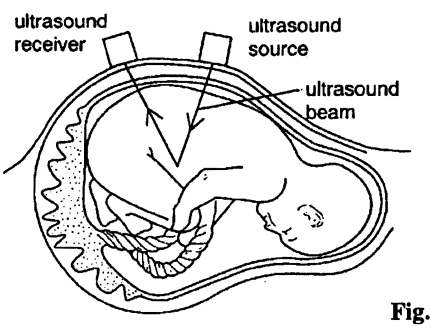


Fig. 7.2

(i) Explain how the vibrations of the source produce waves of ultrasound and suggest how these waves are transmitted through the body tissue to the receiver.

(ii) Ultrasound used in medicine has a frequency which is about 100 times higher than the maximum frequency that can be heard by humans.

Estimate the frequency that might be used for ultrasound in medicine, and calculate its wavelength in the human body. The speed of ultrasound in the human body is 1500 m/s. [7]

N99/II/11

71 *(a)* Sound is a longitudinal wave. Explain, with the aid of a diagram, what is meant by this statement. [4]

(c) (i) Fig. 8 shows the waveform produced on an oscilloscope screen by a sound.

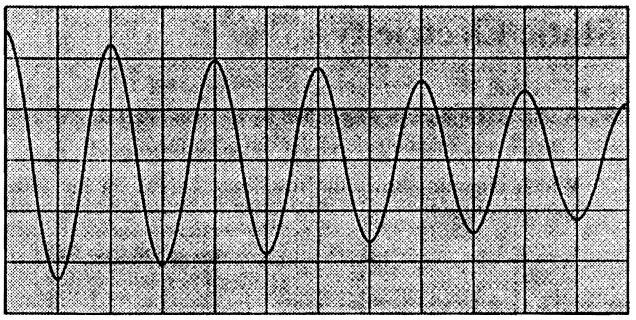


Fig. 8

State how you can tell from the waveform that

1. the loudness of the sound is decreasing,
2. the frequency of the sound is constant.

(ii) The separate waveforms of two whistles of different frequencies are obtained on the oscilloscope screen at the same time. Draw the two waveforms you would expect to see. Label the waveform that has the higher frequency. [4]

N2000/II/10*(a, c)*

ANSWERS

1. **E**	2. **B**	3. **D**	4. **B**	5. **B**
6. **C**	7. **E**	8. **C**	9. **D**	10. **C**
11. **C**	12. **B**	13. **B**	14. **D**	15. **A**
16. **D**	17. **C**	18. **C**	19. **A**	20. **B**
21. **B**	22. **C**	23. **A**	24. **B**	25. **C**
26. **A**	27. **B**	28. **D**	29. **B**	30. **B**
31. **C**	32. **C**	33. **C**	34. **B**	35. **A**
36. **C**	37. **B**	38. **B**	39. **A**	40. **B**

41. 0.6 s
42. 0.67 m ; 0.34 m
43. *(d)* 340 m/s
45. *(a)* 364 m/s
46. 300 mm ; 550
47. 0.64 m ; 0.59m , 512 Hz
48. 726 m
49. 680 m
50. *(a)* 85 m; *(b)* $\lambda = \frac{340}{850}$ m
51. 340 m/s ; 30 m
52. *(b)* (i) 0.25 s (ii) 320 m/s
54. *(a)* 0.85 m *(b)* 0.425 m
55. *(a)* 333.3 m/s
56. *(a)* 341 m/s
57. *(b)* 339.6 m/s
59. *(c)* (ii) 0.75 m
60. *(b)* 337.5 m/s
61. *(b)* (i) 340 m/s (ii) 40
62. *(b)* 330 m/s
63. *(a)* 340 m/s *(b)* 27.2 m
64. *(a)* (i) 1.66×10^{-5} s; (ii) 14.7 s
    (b) 14.7 s
67. *(a)* (i) 6 , 7 , 8 (ii) 12 , 13 , 14
    (b) 6 cm *(c)* 5670 Hz
68. *(a)* (i) $\frac{0.48}{1000}$ s (ii) 5000 m/s
    (b) (i) 340 m/s (ii) 1500 m/s
69. *(b)* (i) 100 Hz (ii) 3.3 m
70. *(a)* (i) Radio waves, infra-red & gamma rays
    (b) (ii) 7.5×10^{-4} m