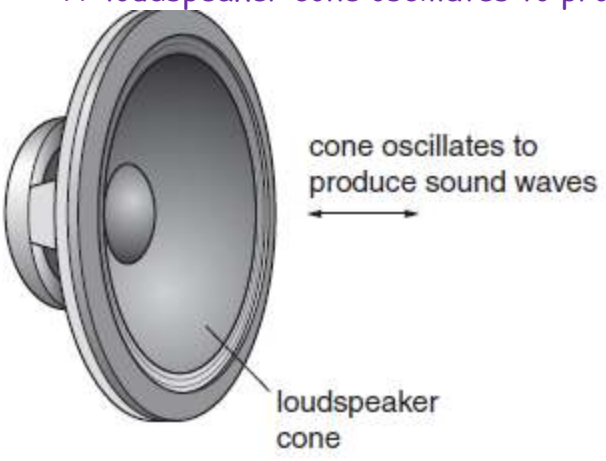
SOUND

PRODUCTION OF SOUND BY VIBRATI NG OBJECTS

- A loudspeaker cone oscillates to produce sound waves



When the loudspeaker cone vibrates, the cone moves forward (in the direction of travel of the waves). The cone thus pushes the particles together. This creates high pressure regions of air also called as compressions.
When the cone moves backwards(away from the direction of travel), it creates empty spaces in the air known as regions of rarefactions(regions of low pressure).As a result a series of compressions and rarefactions travel through the air. These are sound waves.

Speed of sound in air= 343m/s Speed of sound in water= 1450 to 1498m/s

Properties of sound waves:

- Sound waves are caused by vibrations.
- Sound waves are longitudinal waves.
- Sound waves require a material to travel.
- Sound waves can travel through solids, liquids and gases.

More about properties of sound waves:

Sound waves are caused by vibrations:

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As a result a series of compressions and rarefactions travel through the air. These are sound waves.

Sound waves are longitudinal waves:

Sound waves are longitudinal waves as the particles vibrate(oscillate) along the line of the waves(along the direction of the waves)

Sound waves need a medium to travel and cannot travel through vacuum:

A medium is required to pass on the oscillations.'

Sound can travel through solids, liquids and gases: it travels the furthest in gases and the fastest in solids

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Note:

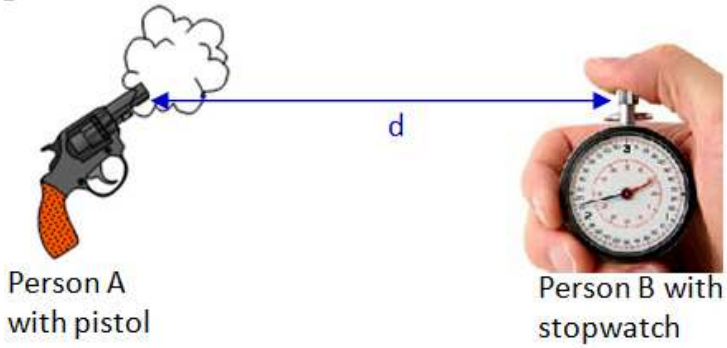
- Sound waves reach the observer after the light waves because the speed of light is much greater than the speed of sound.
- Speed of sound depends on the temperature of the air. Sound travels faster in warmer air than in cooler air.
- Speed of sound is different in different materials.
- Speed of sound does not depend upon the pressure of the air.
- **Ultrasound:**

Sound whose frequency is higher than the upper limit of the normal range of audible human frequency (20,000 hertz) is called ultrasound.

- **Infrasound: (NOT IN SYLLABUS)**

Sound at frequencies too low to be audible—about 20 hertz or lower—is called infrasound.)

Experiment to determine the speed of sound:



Apparatus needed: Source of sound(gun, stopwatch, meter tape) **Note the word" clock is rejected"**

Procedure.

A person A can fire a bullet in the air and produces a flash and the person B can start the stop watch when A presses the trigger and stop the stopwatch when the hears the bang.

Speed of sound $= \frac{Distance\ between\ the\ flash\ produced\ and\ the\ bang\ heard}{Time\ taken\ between\ the\ flash\ and\ the\ bang}$

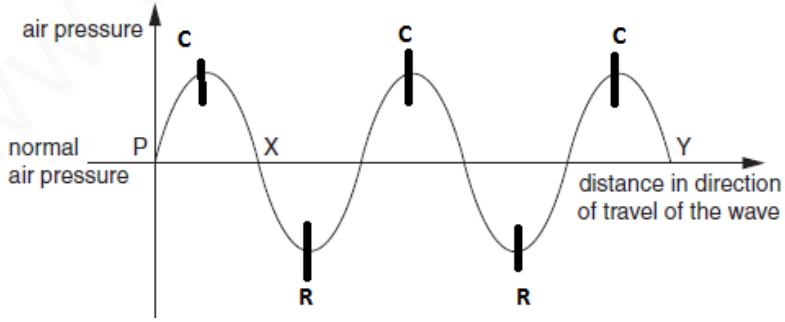
The accuracy of the experiment can be improved by:

- **Increasing the distance between the flash and the bang**
- **Repeating the experiment.**
- **Using a more accurate timer.**

Sound wave:

- **The sound wave consists of alternate regions of compressions and rarefactions.**
- **Compressions: Compressions are regions of above normal air pressure or high air pressure regions or regions where the particles are close together**
- **Rarefactions: Rarefactions are regions of below normal air pressure or low air pressure regions or regions where the particles are far apart.**

Diagram of sound waves:



Use of ultrasound:

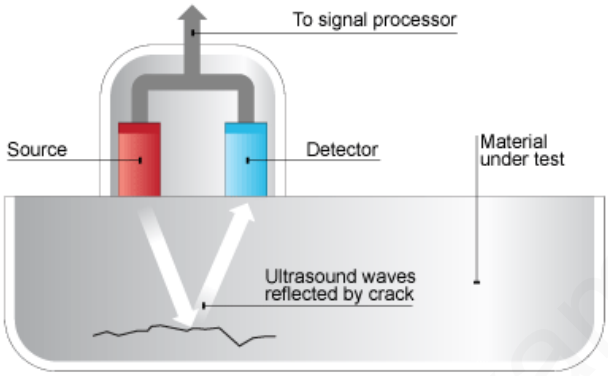
Medical:

3-D ultrasound scan of a human foetus

Computers are able to create detailed images by combining many ultrasound reflection readings. This is used in medicine for pre-natal scanning (checking unborn babies).

Industry:

Ultrasound can be used in industry for quality control procedures to check manufactured objects, such as railway tracks and oil pipelines, for damage or defects. The diagram shows how a piece of metal may be tested for cracks or other flaws using ultrasound.



Sonar is used on ships and submarines to detect fish or the sea bed. A pulse of ultrasound is sent out from the ship. It bounces off the seabed or shoal of fish and the echo is detected. The time taken for the wave to travel indicates the depth of the seabed or shoal of fish.

Speed of sound-Depends upon the material of the substance and the temperature of the substance

Material	Density(g/cm)	Speed(m/s)
Copper	8.90	6420
Steel	7.86	5940
Beryllium	1.93	12890
Aluminium	2.58	6420
Water	1.00	1496
Ethanol	0.79	1207
Air	0.00139	331.45
Helium	0.000178	965
Fat	0.95	1450
Muscle	1.07	1580
Skull bone	1.91	4080

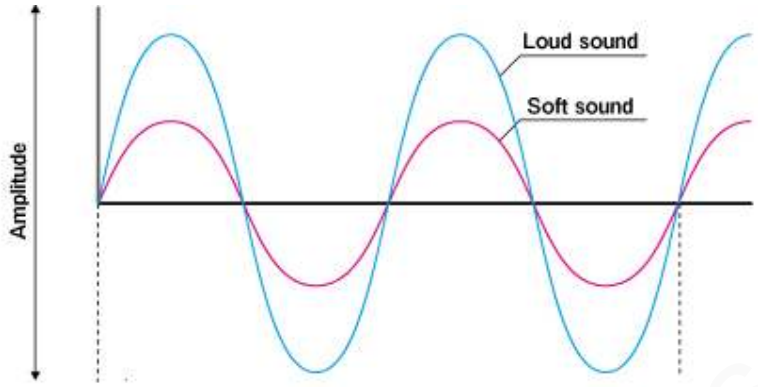
You are not expected to learn by heart these values. You need to have an idea of the relative speeds of sound in the different media.

Order of magnitude of the speed of sound:

Solids> *Liquids* > *Gases*

Loud and quiet sound and high and low pitched sound

- Loud sounds (High volume)are sound waves with bigger amplitude.
- Quiet sounds(Low volume sounds) are sound with smaller amplitude
- Loud sounds are high energy waves and quiet sounds are low energy waves



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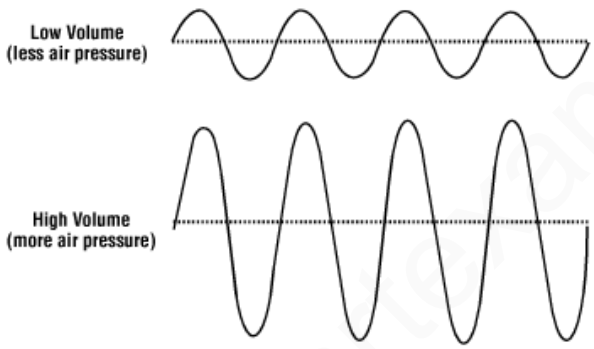
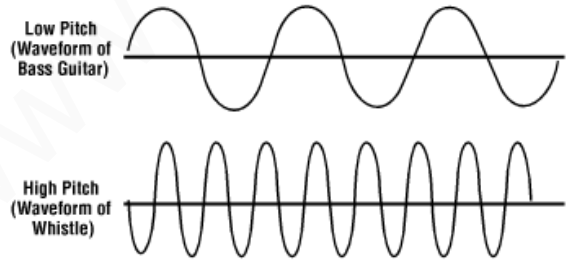


High pitch and low pitch sound:

- High pitch sound is a sound with high frequency and small wavelength
- Low pitch sound is a sound with low frequency and large wavelength



Echoes:

- Sound waves can reflect off surfaces. We hear sound reflections as echoes.
- Hard, smooth surfaces are particularly good at reflecting sound. This is why empty rooms produce lots of echoes.
- Soft, rough surfaces are good at absorbing sound. This is why rooms with carpets and curtains do not usually produce lots of echoes.

Reflection of sound produces an echo

- An echo is a reflection of sound.
- Echoes can be heard in a large hall or a gallery which has with smooth walls.
- Sound waves are created which reflect off a smooth surface and reach you.
- The further you are from the reflecting surface, the longer the sound waves will take to reach the reflecting surface and then back to you, So there will be a longer delay between the original sound and the echo.

Unwanted echoes can be eliminated by:

- Covering the walls in soft fabric . This will absorb sound waves instead of reflecting them. So no echoes will be heard.
- Make the surface of walls uneven. This will scatter the reflected sound. Hence echoes will not be formed.

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25 A ship sends a pulse of sound vertically downwards to the sea bed. An echo is heard 0.4 seconds later.

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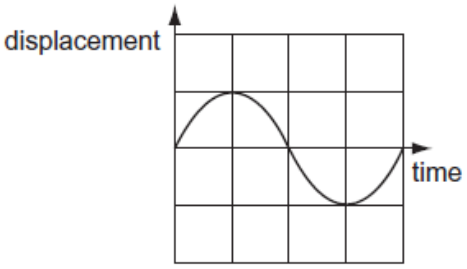
If the speed of sound in the water is 1200 m/s, how deep is the water below the ship?

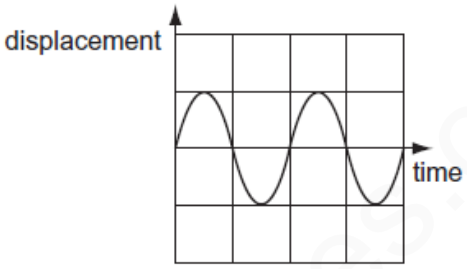
A 240 m **B** 480 m **C** 1500 m **D** 3000 m

Application based questions:

24 The diagrams represent two sound waves. The scales in the two diagrams are the same.



sound wave 1



sound wave 2

Which statement describes the waves?

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A The waves have different loudness and different pitch.

B The waves have different loudness but the same pitch.

C The waves have the same loudness and the same pitch.

D The waves have the same loudness but different pitch.

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21 The diagram represents a wave.

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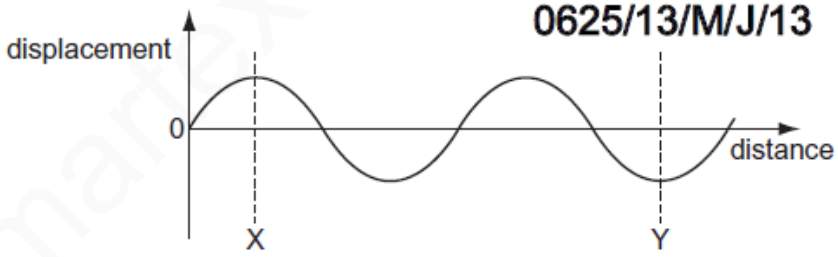
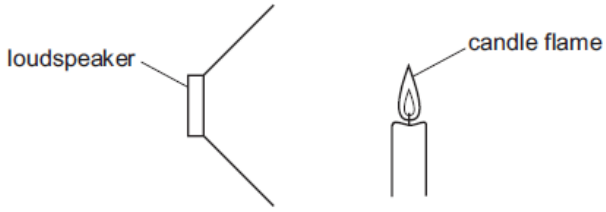


How many wavelengths are there between X and Y?

A $\frac{2}{3}$ **B** 1 **C** $1\frac{1}{2}$ **D** 3

19 A lighted candle is placed in front of a loudspeaker that is making a loud, steady note. The candle flame vibrates because of the sound wave.



Which type of waves are sound waves and in which direction does the flame vibrate?

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	type of wave	direction of vibration
A	longitudinal	↕
B	transverse	↕
C	longitudinal	↔
D	transverse	↔

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18 A boy blows a whistle that has a frequency of 10 000 Hz. The boy's friend cannot hear the sound from the whistle. The friend has normal hearing.

0625/13/M/J/14

What could be a reason why he cannot hear the sound?

A The amplitude is too large.

B The amplitude is too small.

C The frequency is too high.

D The frequency is too low.

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23 A student wishes to measure the speed of sound in air. She plans to measure the time betwe making a sound and hearing the echo from a cliff.

0625/11/O/N/11

She will use the equation: speed = $\frac{\text{distance}}{\text{time}}$.

Which type of sound should she make and which distance should she use in her calculation?

	type of sound	distance to use
A	continuous sound	$\frac{\text{distance to cliff}}{2}$
B	continuous sound	distance to cliff × 2
C	short, sharp sound	$\frac{\text{distance to cliff}}{2}$
D	short, sharp sound	distance to cliff × 2

APPLICATION BASED QUESTIONS-EXTENDED THEORY:

8 Fig. 8.1 shows a loudspeaker cone oscillating to produce sound waves. 292

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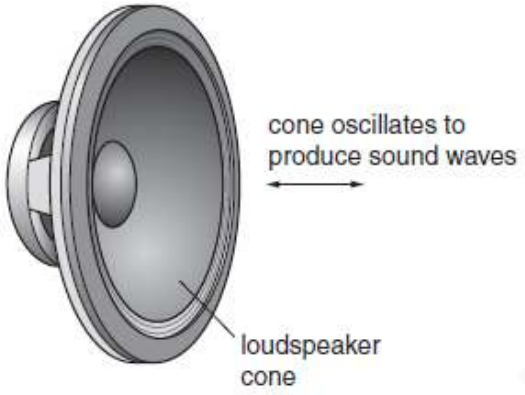

Fig. 8.1

(a) As the sound wave passes a point, it produces regions of higher and lower pressure. State the names of these regions.

higher pressure .....

lower pressure ..... [2]

(b) Describe how the movement of the loudspeaker cone produces these regions of different pressure.

higher pressure .....

.....

lower pressure .....

..... [2]

(c) State the effect on the loudness and pitch of the sound from the loudspeaker when

(i) the amplitude increases but the frequency of the sound stays the same,

loudness .....

pitch .....

(ii) the amplitude stays the same but the frequency increases.

loudness .....

pitch .....

[2]

6 (a) Draw a straight line from each wave to the most appropriate speed on the right.

O/N/13P32

wave	speed
light in air	15 m/s (1.5 × 10 m/s)
sound in air	300 m/s (3×10^2 m/s)
sound in water	1500 m/s (1.5×10^3 m/s)
	1 500 000 m/s (1.5×10^6 m/s)
	300 000 000 m/s (3×10^8 m/s)
	1 500 000 000 m/s (1.5×10^9 m/s)

[3

(b) Fig. 6.1 shows a railway-line testing-team checking a continuous rail of length 120 m. The diagram is not to scale.

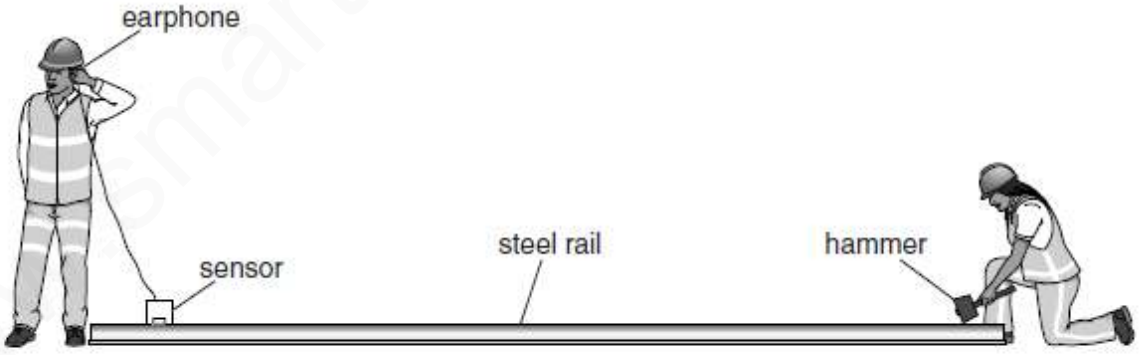

Fig. 6.1 (not to scale)

One tester strikes one end of the rail with a hammer. The other tester hears the sound transmitted through the air and transmitted through the rail. He hears the two sounds at different times.

The speed of sound in steel is 5000 m/s.

Calculate the time difference, using your value from **(a)** for the speed of sound in air.

time difference = ...[4]

[Total: 7]

5 **(a)** Fig. 5.1 shows the air pressure variation along a sound wave.

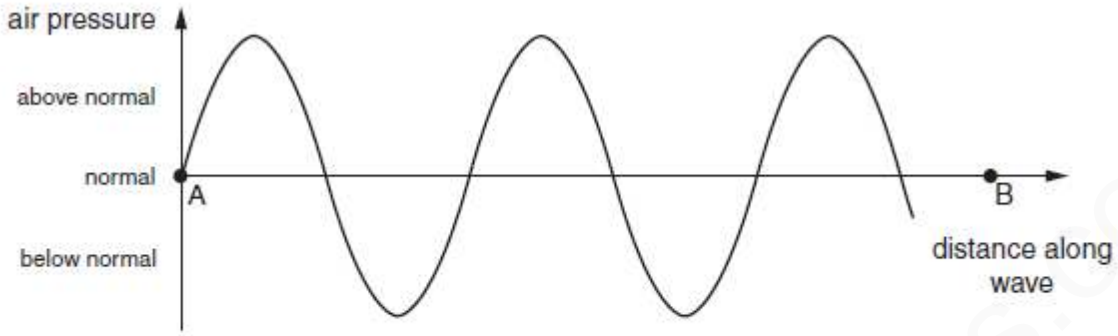

Fig. 5.1

(i) On AB in Fig. 5.1, mark one point of compression with a dot and the letter C and the next point of rarefaction with a dot and the letter R.

(ii) In terms of the wavelength, what is the distance along the wave between a compression and the next rarefaction?

.....

[3]

(b) A sound wave travels through air at a speed of 340 m/s. Calculate the frequency of a sound wave of wavelength 1.3 m.

frequency = ... [2]

6 Observations of a distant thunderstorm are made. M/J/02-P3 304

(a) During a lightning flash, the average wavelength of the light emitted is 5×10^{-7} m. This light travels at 3×10^{8} m/s.

Calculate the average frequency of this light.

frequency = ... [2]

(b) The interval between the lightning flash being seen and the thunder being heard is 3.6 s. The speed of sound in air is 340 m/s.

(i) Calculate the distance between the thunderstorm and the observer.

distance = ...

(ii) Explain why the speed of light is not taken into account in this calculation.

.....

.....

MCQ:

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10 The diagram shows a microphone being used in an interview. 0625/12/O/N/09

Which energy change takes place in the microphone?

	input energy	output energy
A	chemical	electrical
B	electrical	chemical
C	electrical	sound
D	sound	electrical

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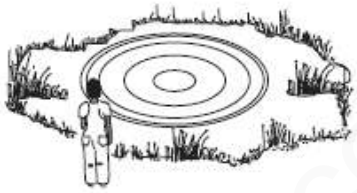
20 Which waves are longitudinal?

0625/11/M/J/10

A	B	C	D
			
light waves from a lamp	microwaves in an oven	sound waves from a trumpet	water waves on a pond

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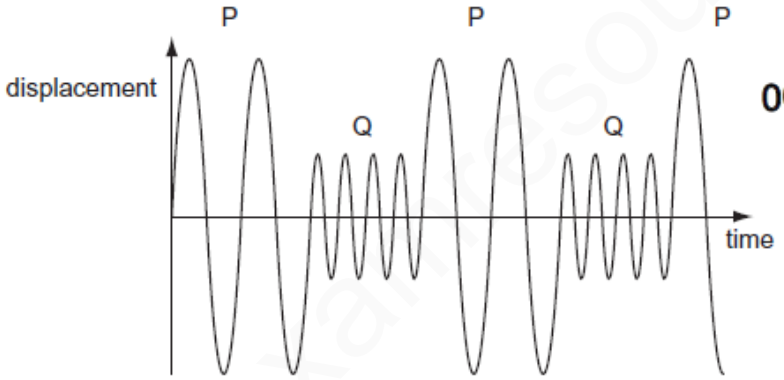
25 A police car siren emits two different sounds P and Q. These are produced alternately. The diagram represents the sounds emitted.



0625/11/M/J/10

Which sound is the louder and which has the lower pitch?

	louder	lower pitch
A	P	P
B	P	Q
C	Q	P
D	Q	Q

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22 What is the approximate value of the highest frequency that can be heard by a young person?

A 20 Hz **B** 200 Hz **C** 2000 Hz **D** 20 000 Hz

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23 Sound travels by wave motion.

0625/11/M/J/11

Which property of waves causes echoes?

A diffraction

B dispersion

C reflection

D refraction

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25 A student claps once when standing 100 m away from a large wall.

The speed of sound in air is 330 m/s.

0625/11/M/J/13

How long after clapping does the student hear an echo?

A 0.30 s **B** 0.61 s **C** 1.7 s **D** 3.3 s

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26 In a test, a car horn is found to be too loud and the pitch of the note is too high.

What information does this give about the amplitude and the frequency of the sound wave produced?

0625/11/O/N/12

	amplitude	frequency
A	too large	too large
B	too large	too small
C	too small	too large
D	too small	too small

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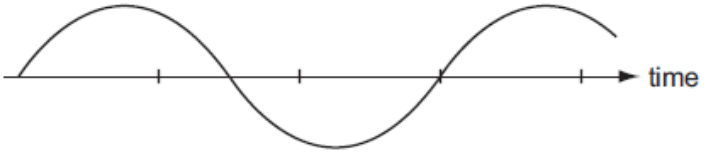
20 The diagrams represent the waves produced by four sources of sound. The scales are the same for all the diagrams.

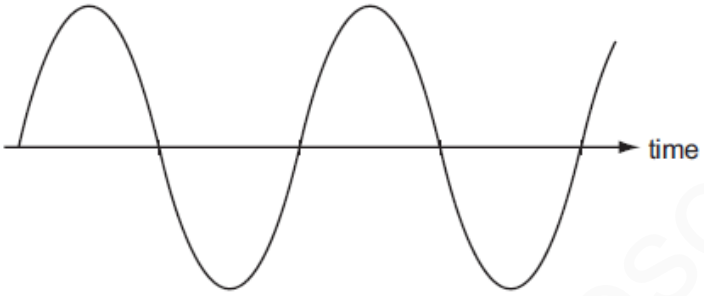
Which sound has the highest frequency?

0625/13/M/J/12

A



B



C

D