Waves and Sound
Task

Grade 11

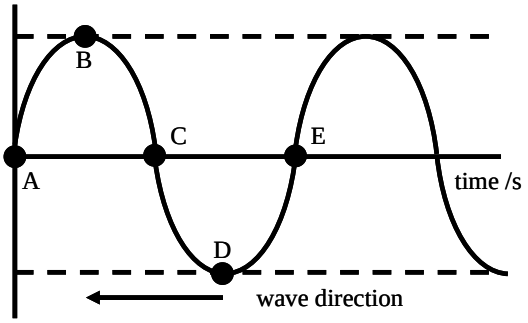
Waves and Sound

Exercise 8.1

1 1.1 Explain the difference between longitudinal and transverse waves and give an example of each.

1.2 It is possible to represent a longitudinal wave by drawing a graph having the wave-form of a transverse wave. Explain carefully what it is that you are plotting on the x and y axes.

1.3 The diagram shows the positions of some particles as a sound wave passes through the medium. Redraw the diagram.



1.3.1 Explain what is meant by compression, rarefaction, amplitude and period and mark these on your diagram.

1.3.2 Plot on your diagram the new positions of the particles when one quarter of a period has passed.

1.3.3 Which particles are moving in phase?

2 2.1 Explain what is meant by the terms a) frequency b) wavelength.

2.2 A wave has a wavelength of 6,6 m and a frequency of 50 Hz. What is the speed of the wave?

3 3.1 A tuning fork makes 1024 complete vibrations in 4 s. What is the frequency of the fork?

3.2 Find the wavelength of this sound in air if the speed of sound in air is 330 $m.s^{-1}$.

3.3 How will the wavelength of the sound change if it moves into water (speed = 1500$m.s^{-1}$)?

3.4 What effect does this have on the wave direction?

4 4.1 Why do you not hear an echo when you are close to the reflecting surface?

4.2 Explain why:

4.2.1 Sounds are louder in an empty room than in a furnished one.

4.2.2 The sound of a speaker in the school hall is much clearer if the hall is filled with people.

4.2.3 It is difficult to hear your teacher speaking out on the sports field. How does a megaphone help to increase the loudness of the teacher's voice?

5 5.1 When you are x meters from a cliff face you shout and 2,5 s later you hear the echo. If the speed of sound is 350m.s^{-1} on this day calculate the value of x.

5.2 What factors affect the speed of sound?

5.3 Astronauts on the moon carried out experiments in which they detonated explosive charges on the surface. Do you think that they would hear the explosion? Give reasons for your answer.

6 Two learners carry out an experiment to measure the speed of sound. Patrick fires a starting pistol and Simphiwe measures the interval between seeing the flash and hearing the sound. The boys are 495m apart and the time taken by the sound is 1,5s. When the boys change their positions the time interval measured is 1,4s. Calculate the value of speed of sound according to these results.

7 A time keeper at the finish line in a 200 m race starts his watch when he hears the sound of the pistol instead of when he sees the flash. If the speed of sound is 340 m.s^{-1} what is the error in the time he records?

8 An echo sounder was used to measure the depth of the ocean floor. The time between transmission of the pulse and detection of the sound was 4 s. If the speed of sound in water is 1500 m.s^{-1} what was the depth of the ocean floor at that point?

9 9.1 Explain why sound waves sometimes change direction when they travel through still air.

9.2 Use diagrams to explain the fact that it is easier to hear sounds at night than during the day.

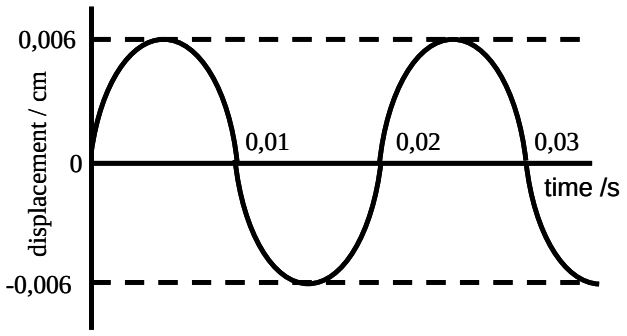
10 You put one ear against the railing of a steel fence. Your friend taps the fence some distance away. Explain why you will hear two taps. Which tap will you hear first?

11 Classify the following as true or false. If false correct the statement.

i. When sound is reflected the angle of incidence is greater than the angle of reflection.
ii. We hear the sound of a tuning fork because air particles move from the fork to our ears.
iii. Sound travels faster in gases and liquids than in solids.
iv. A wave undergoes refraction because the frequency changes when the medium changes.
v. Sounds at night are louder because the air near the ground is cooler than the air higher up.

Exercise 8.2

The graph shows the displacement of an air particle with time as a sound wave moves past. Use this for questions l and 2



1 What is the frequency of these waves?

A 0,01 B 0,02 C 50 D 100

2 If the speed of these waves is 2 $cm.s^{-1}$ which one of the following pairs of figures for wavelength and amplitude must be correct?

A. wavelength 0,006 cm; amplitude 0,02 cm
B. wavelength 0,02 cm; amplitude 0,006 cm
C. wavelength 0,012 cm; amplitude 0,04 cm
D. wavelength 0,04 cm; amplitude 0,006 cm

3 Sound waves are described as longitudinal because

A. they travel away from the source.
B. they carry energy.
C. they move at right angles to the direction of motion of the particles.
D. they move in the same direction as the direction of motion the particles.

4 The wavelength of a longitudinal wave is the distance between

A. a compression and a rarefaction
B. any two compressions or rarefactions
C. two successive compressions or rarefactions.
D. two points which are moving out of phase.

5 We can see a bell ringing in an evacuated jar but we cannot hear it. This shows that:

A. sound waves can travel through a vacuum, but not light waves.
B. light waves can travel through a vacuum, but not sound waves.
C. both sound and light waves can travel through a vacuum.
D. neither sound nor light waves can travel through a vacuum.

Which of the following properties shows that:

6 sound is a wave motion?

7 sound travels by longitudinal waves?

A. Sound waves can be reflected.
B. Sound waves can be refracted.
C. Sound waves cannot travel in a vacuum.
D. Sound waves can undergo interference

8 Two identical sound waves move past point A. A compression from one wave reaches A at the same time as a rarefaction from the other wave. At point A:

A. the sound will be louder because of destructive interference.
B. the sound will be softer because of destructive interference.
C. the sound will be louder because of constructive interference.
D. the sound will be softer because of constructive interference.

9 A sound wave travelling at 330 $m.s^{-1}$ with a wavelength of 50 cm has a frequency?

A 660 Hz B 115 Hz C 6,6 Hz D 16500 Hz

10 If the speed of sound in air is 330$m.s^{-1}$ a person who fires a pistol at a distance of 165 m from a cliff will hear

A. No echo at all.
B. An echo after 1 second
C. An echo after 0,5 s
D. Two echoes in 1 second

Exercise 9.1

1 Write down the function for each of the given parts of the ear. Hammer, anvil and stirrup; Cochlea; Auditory canal; Semi circular canals; Ear drum; Auditory nerve

2 2.1 What happens at the eardrum when a sound wave reaches it?

2.2 Where does the actual hearing of sound take place?

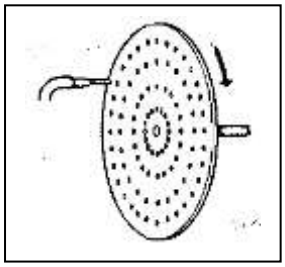
2.3 Is the signal received by the brain a sound wave?

2.4 Why do you go deaf when you have been in an aeroplane?

2.5 The composer Beethoven was deaf for most of his life but he could "hear" music by using a hearing horn placed between the bone behind his ear and the piano. Why did this help?

2.6 Why can we not hear the squeaks emitted by a bat or the sound of its wings in flight?

3 The diagram shows a siren. Slowing air on the wheel as it rotates produces the note of the siren.



3.1 What will happen to the pitch of the note as the speed of rotation increases?

3.2 Suggest a way in which the note may be made louder.

4 A stiff piece of card is held on a toothed wheel having 40 teeth and rotating at 2,5 revolutions per second.

4.1 What is the frequency of the sound emitted by this device?

4.2 What is the wavelength of this sound in air? (Use the speed of sound as 330$m.s^{-1}$).

5 5.1 Why does the buzzing of a bee differ from the hum of a mosquito?

5.2 How does a violin player produce sounds of different pitch?

5.3 How does a piano produce sounds of different pitch?

5.4 What is the difference between a musical note and a noise?

6 Compare the sounds from two sources A and B given that:

6.1 they have the same amplitude and waveform but A has twice the frequency of B.

6.2 they have the same frequency but wave-form A has twice the amplitude of B.

6.3 they have the same initial amplitude and the waveform of A is regular and repetitive while that of B is not.

7 A man sings a note of frequency 294 Hz while a woman sings a note an octave higher

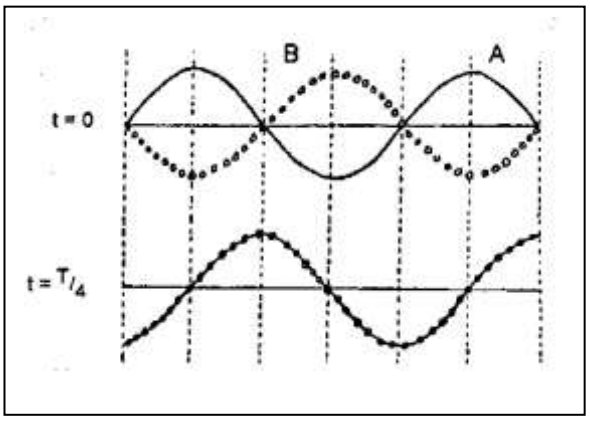
7.1 What is the frequency of the note that she sings?

7.2 Calculate the wavelength of each sound in air. (Speed of sound = 330m.s^{-1})

8 8.1 Name three characteristics of a musical note that will make it sound different from other notes.

8.2 Draw diagrams to show how two notes may differ in i) frequency ii) amplitude.

9 Two identical transverse waves A and B travel through the same medium. The diagram shows the positions of the two waves at t = 0 and t = T/4 where T is the period of either wave.



9.1 In what direction is

9.1.1 wave A travelling?

9.1.2 wave B travelling?

9.2 What is the speed of the waves if the distance between the vertical lines in the diagram is 2 cm and the period of the waves is 0,1 s?

9.3 Name the type of interference that the waves undergo at

9.3.1 t = 0

9.3.2 t = T/4.

9.4 Draw diagrams to show the resultant wave at t = 0 and t = T1/4

9.5 Indicate one node and one anti-node on either of your diagrams.

9.6 What is the distance in terms of wavelength between successive nodes?

9.7 What is the resultant wave called?

9.8 What conditions are necessary for this type of wave to form?

10 A fork of frequency 324 Hz gives the first position of resonance with a closed tube 25 cm long. Use this information to calculate the velocity of sound.

11 After dinner the singer Caruso would entertain his guests by singing a note that would make a wine glass break.

11.1 What is the name of this phenomenon?

11.2 Why did it require a particular note to make the glass break?

11.3 What caused the glass to break?

12 12.1 Compare the fundamental vibration in a closed pipe and an open pipe with reference to (i) the wavelength (ii) the frequency.

12.2 Which pipe can produce odd and even harmonics?

13 13.1 Draw the first and second overtones for an open pipe.

13.2 Explain why these notes are also known as the second and third harmonics.

14 A closed pipe sounds its fundamental note when the length of the pipe is 16cm. What is the frequency of this note? Take the speed of sound as 320 $m.s^{-1}$.

Exercise 9.2

1 The part of the ear which converts vibrations into electrical signals is

A. The auditory nerve
B. The cochlea
C. The hammer, stirrup and anvil
D. The semi-circular canals.

2 If the amplitude of a vibration increases there will be

A. An increase in loudness but not in pitch
B. An increase in pitch but not in loudness
C. An increase in frequency but not in pitch
D. An increase in wavelength but not in frequency

3 A reduction in the frequency of a vibration will

A. Only raise the pitch
B. Only lower the pitch
C. Raise the pitch but decrease the amplitude
D. Lower the pitch but increase the amplitude

4 The note from a flute and a piano must be different in

A. frequency B. quality C. loudness D. pitch

5 A standing wave is produced by two waves if they have

A. The same frequency and different amplitudes and move in the same direction
B. The same frequency and the same amplitude and move in opposite directions
C. The same frequency and amplitude and move in the same direction
D. Different frequencies and amplitudes and move in opposite directions

6 When a closed tube produces its fundamental note the length of the tube will be the same as:

A. The distance between a node and an anti-node
B. The distance between two nodes
C. The wavelength of the standing wave
D. The amplitude of the standing wave.

7 The phenomenon whereby one vibrating object will cause another to start vibrating is known as

A. Constructive interference
B. Destructive interference
C. Vibration
D. Resonance

8 A guitar string is held down at the middle while it is vibrating. The note heard will have
   A. the same frequency and wavelength and pitch
   B. half the frequency, twice the wavelength and a lower pitch
   C. double the frequency, half the wavelength and a higher pitch
   D. double the frequency , double the wavelength and a higher pitch

9 The third harmonic of a note has
   A. One-third the wavelength of the fundamental
   B. Three times the wavelength of the fundamental
   C. One-third the frequency of the fundamental
   D. Three times the amplitude of the fundamental