

Unit 7

SOUND

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7.1 DEFINITION, PRODUCTION AND TRANSMISSION OF SOUND

Definition:

Sound is a form of energy. It is generated by a vibrating object.

When a teacher teaches in a classroom, students sit in front line can hear more easily than students in rear sit. Why?

Because the teacher's sound energy generated by his vocal cord is decreased as it travels.

How to Produce Sound?

When you hit a drum with stick, the stretched plastic vibrates back and forth. Then sound is generated. This sound travels in every direction.

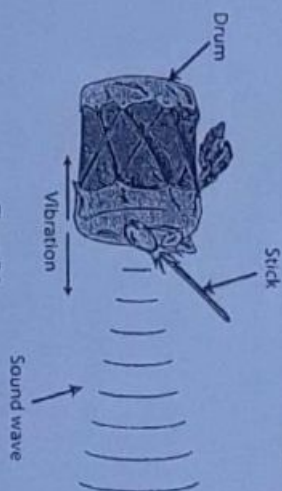


Figure 7.1

In some musical instruments, sound is produced by the vibration of air. For example, flute and saxophone.



Figure 7.2

Once sound is produced it needs a material medium to reach listener's end. And materials (i.e., solid, liquid and air (gas)) can transmit sound.

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Note:

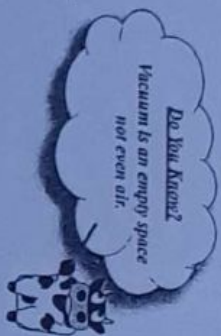
- ▶ Solid is better transmitter of sound than liquid and gas.
- ▶ Liquid is better transmitter of sound than gas.

Sound cannot be transmitted through vacuum.

Note:

To produce sound, there must be:

- ▶ a vibrating source,
- ▶ medium of transmission and
- ▶ a receiver.

**Example**

1. How can sound produced by the "Kirita"?
2. Why does sound decrease as it goes a long distance?

How to solve it!

1. When the player hits the stretched strings of a "Kirita", the string starts to vibrate, the sound is produced.
2. Sound is a form of energy. When it goes a (long) distance, it loses its energy. So, it decreases.

Let's Exercise

1. What happens to the transmission of sound in different material? (Solids, liquids, and gases). Explain it!
2. Why is it possible to hear round corners?

Let's Go Further

Sound cannot travel in vacuum. Why?

7.2 SPEED OF SOUND IN DIFFERENT MEDIA

Sound needs material medium for its transmission. This means there is no sound in vacuum. Speed of sound depends on the nature of the material through which it travels. The speed of sound is maximum in solid and minimum in gas, whereas in liquid it is relatively moderate.

Example

Substances	Speed (m/s) at 0 °C
Air	331
Sea water	1450
Copper	4998

On rough estimation, the speed of sound:

- ▶ in solid is about four times that of in liquid.
- ▶ in liquid is about four times that of in gas.

The speed of sound in air at any temperature (v_t) can be calculated:

$$v_t = v_0 + \frac{0.6}{1^\circ\text{C}} \times T \quad \text{where } v_0 \text{ is the speed of sound at } 0^\circ\text{C and } T \text{ is temperature in degree Celsius.}$$

Example

A thunder was heard 4 s after the lightning was seen. If the distance of the lightning is 1396 m away from the observer, what is the speed of sound at that temperature?

How to solve it!

Given:

$$t = 4 \text{ s}, s = 1396 \text{ m}$$

Required:

$$v = ?$$

$$s = vt$$

$$\Rightarrow v = \frac{s}{t} = \frac{1396 \text{ m}}{4 \text{ s}} = 349 \text{ m/s}$$

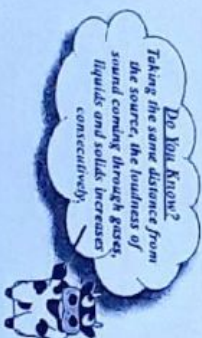
Let's Exercise

1. The speed of sound in air at 0 °C is _____ m/s.
2. When temperature increases 1 °C, the speed of sound in air increases by _____ m/s.
3. The speed of sound in air at any temperature (t_a) can be calculated by

$$v_T = \text{_____}$$
4. What is the nature of the sound?
5. Among solid, liquid and gas, in which medium sound travels the fastest?
6. Can sound be transmitted in vacuum? If not why?
7. A thunder was heard 2 sec later after the lightning is seen. If the distance of lightning is 698 m away from the observer, what is the speed of sound at that temperature?

Let's Go Further

1. Why is the speed of sound in solid greater than that of liquid and gas? Explain based on the arrangement of particles in the three states of matter.
2. In an electric bell jar, as the air in the jar is out, the sound decreases and finally stops. Why?
3. What are the three requirements of sound?
4. Birhanu is chopping a log with an axe. His friend Challa is seeing at 2 km away from him. Challa has observed that the sound is heard after the axe is raised off the log. Why is that Challa do not hear the sound immediately while the axe hitting the log?



7.3 REFLECTION OF SOUND

- ☒ When you shout in empty hall the sound bounces back from the wall and comes towards you.
- ☒ When a sound meets a boundary or an obstacle some portions of a sound are absorbed and the remaining are reflected. This reflection of sound is called an *Echo*.
- ☒ Hard substance such as wall, hall, metal, Wood, building, ... etc are good reflectors. But such as cloth, wool, ... etc, absorb sound energy a lot.
- ☒ If the reflected sound reaches you more than 0.1 second later, we can hear reflected sound as echo.

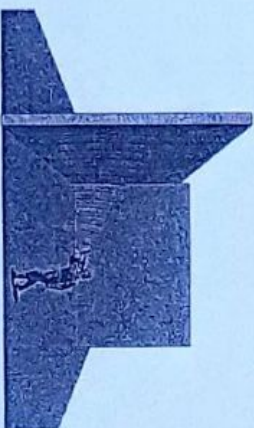


Figure 7.3

APPLICATIONS OF ECHO SOUNDING

Since the distance travelled by the sound is the sum of the distance from the source to the reflector and back from the reflector to the source.

$$2s = vt \quad v = \frac{2s}{t}$$

Hence, the minimum distance from the source to produce an echo is 17 m, if the speed of sound at that temperature is 340 m/s.

Example

What is the speed of sounds at a given temperature if an echo is heard 3 s later from a mountain which is 519 m away?

How to solve it!

Given:

$$t = 3 \text{ s}, x = 519 \text{ m}$$

Required:

$$v = ?$$

$$v = \frac{2x}{t} = \frac{2 \times 519 \text{ m}}{3 \text{ s}} = 346 \text{ m/s}$$

Let's Exercise

- The reflection of sound from hard surface to the source is called _____.
- The minimum time require to hear an echo is _____ sec.
- The minimum distance from an echo to be heard is _____ m.

Let's Go Further

- Classify the following materials as reflectors of sound and as absorbers of sound.

a) Hills	e) Walls
b) Buildings	f) Cloth
c) Wood	g) Wool
d) Metals	
- Observers: _____
- The echo produced by 850 m away cliff is heard after 5 s. What is the speed of sounds from this information?
- What is the distance of sound at a given temperature if an echo is heard 3 s later from a mountain with the speed of 344 m/s.
- The time taken to hear an echo from a mountain at a speed of 344 m/s and distance of 860 m away is _____.

7.4 UNIT SUMMARY

I Choose the Correct Answer.

- Which one of the following is true about the sensation of hearing sound?
 - All sounds when hear are produced by vibrating.
 - The produced sound do NOT travel in all direction.
 - Sound is NOT a form of energy.
 - If sound travels in long distance it gains more energy.
 - If an alarm clock is placed in a vacuum and then activated, how is the sound of alarm?
 - Sound is heard.
 - No sound is heard.
 - Sound is amplified.
 - Sound is absorbed.
 - An echo is produced when sound wave is _____.
 - reflected from a surface.
 - refracted from hard surface.
 - refracted from soft surface.
 - absorbed into soft surface.
 - Different media transmit sound at different speed. Which one of the following shows the correct arrangement of media in increasing order of their property to transmit sound?
 - Gas - liquid - solid.
 - Liquid - solid - gas.
 - Liquid - gas - solid.
 - Solid - gas - liquid.
- II Give Short Answer.
- Sound is produced by _____ of a body.
 - Among air, steel and water in which sound travel the fastest at 0°C? _____
 - Why do we hear sound after it collides with a hard material? _____
 - Two boys are located in front of hill as shown in Figure 7.4. The time taken to hear the echo of their own whistles are 0.8 s for the first boy and 1.2 s for the second boy. What is the distance between the two boys, if the speed of sound at that temperature is 332 m/s?

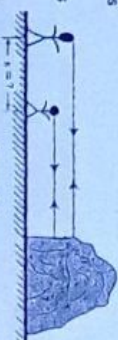


Figure 7.4