



Class: 10th

Subject: Physics

Unit 11: SOUND

Exercise MCQs:

i. Which is an example of a longitudinal wave?

- (a) Sound wave
- (b) Light wave
- (c) Radio wave
- (d) Water wave


ii. How does sound travel from its source to your ear?

- (a) By changes in air pressure
- (b) By vibrations in wires or strings
- (c) By electromagnetic wave
- (d) By infrared waves



iii. Which form of energy is sound?

- (a) Electrical
- (b) Mechanical
- (c) Thermal
- (d) Chemical




iv. Astronauts in space need to communicate with each other by radio links because

- (a) Sound waves travel very slowly in space
- (b) Sound waves travel very fast in space
- (c) Sound waves cannot travel in space
- (d) Sound waves have low frequency in space

v. The loudness of a sound is most closely related to its

- (a) Frequency
- (b) Period
- (c) Wavelength
- (d) Amplitude


vi. For a normal person, audible frequency range





for sound wave lies between

- (a) 10 Hz and 10 kHz
- (b) 20 Hz and 20 kHz
- (c) 25 Hz and 25 kHz
- (d) 30 Hz and 30 kHz



vii. When the frequency of a sound wave is increased, which of the following will decrease?

Where:

i = wavelength

ii = period

iii = amplitude

- (a) i only
- (b) iii only
- (c) i and ii only
- (d) i and iii only



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Important MCQs:

1. How is sound produced?

- (a) By reflection of light
- (b) By electric current
- (c) By a vibrating body
- (d) By heat

2. In which form does sound travel from one place to another?

- (a) Transverse waves
- (b) Longitudinal waves
- (c) Compressional waves
- (d) Radiant waves

3. Which feature helps us distinguish between a loud and a faint sound?

- (a) Pitch
- (b) Quality
- (c) Intensity
- (d) Loudness



4. What is the SI unit of intensity level of sound?

- (a) Watt
- (b) Decibel
- (c) Joule
- (d) Hertz



5. On what factor does the pitch of sound depend?

- (a) Amplitude
- (b) Frequency
- (c) Intensity
- (d) Surface area

6. Which characteristic allows us to distinguish two sounds of same loudness and pitch?

- (a) Loudness
- (b) Frequency
- (c) Quality
- (d) Pitch

7. Sounds that produce an unpleasant effect on our ears are called:



(a) Music

(b) Echo

(c) Noise

(d) Tone

8. What causes noise pollution?



(a) Sunlight

(b) Silent rooms

(c) Noisy machinery and traffic

(d) Clean environment

9. What is the method of reducing unwanted sound called?

(a) Sound reflection

(b) Acoustic protection

(c) Light absorption

(d) Magnetic shielding

10. What is the audible frequency range for the human ear?

(a) 2 Hz to 2,000 Hz





(b) 10 Hz to 100,000 Hz

(c) 20 Hz to 20,000 Hz

(d) 0 Hz to 1,000 Hz

11. Sound is produced by:



(a) Stationary objects

(b) Vibrating bodies

(c) Magnetic fields

(d) Heat energy

12. In a guitar, sound is produced due to the vibrations of:

(a) Frame

(b) Strings

(c) Air holes

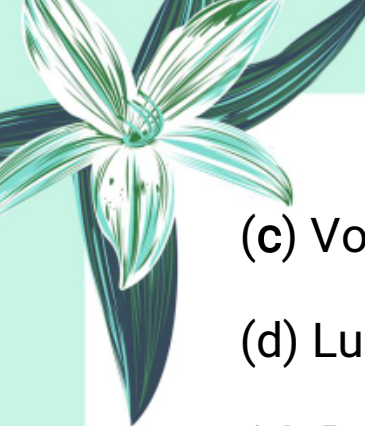
(d) Wooden base

13. The human voice is produced due to the vibrations of:

(a) Nose

(b) Tongue





(c) Vocal cords

(d) Lungs

14. Doctors use which instrument to hear heartbeat sounds?



(a) Thermometer

(b) Barometer

(c) Microphone

(d) Stethoscope

15. When a vibrating tuning fork is dipped in water:

(a) Water freezes

(b) Water starts boiling

(c) Splash occurs

(d) No change is observed

16. Sound requires _____ for its propagation.

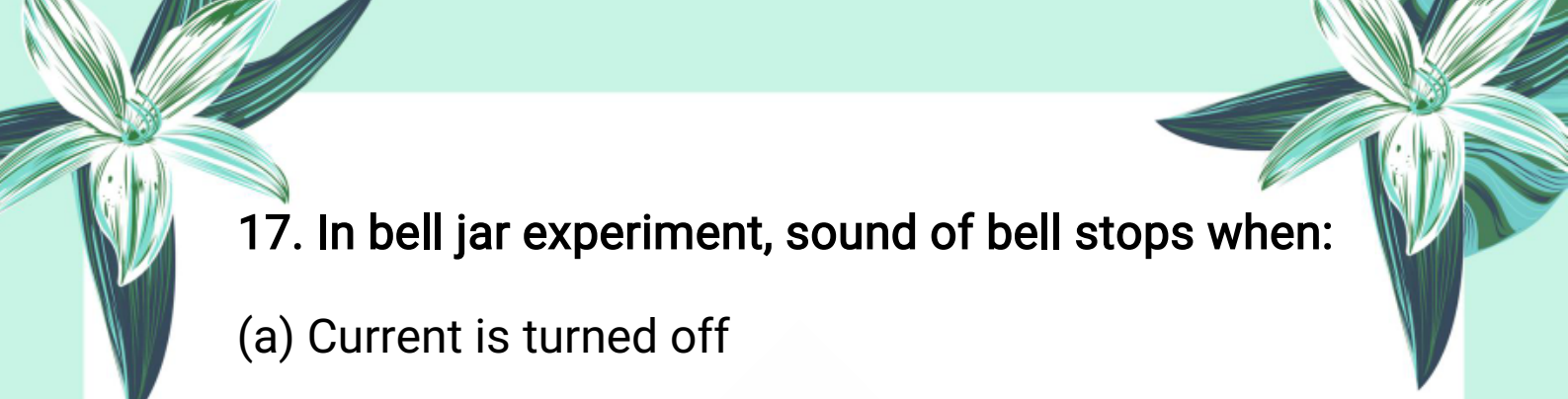
(a) Vacuum

(b) Light

(c) Material medium

(d) Electric field





17. In bell jar experiment, sound of bell stops when:

- (a) Current is turned off
- (b) Air is removed
- (c) Water is added
- (d) Light is switched off



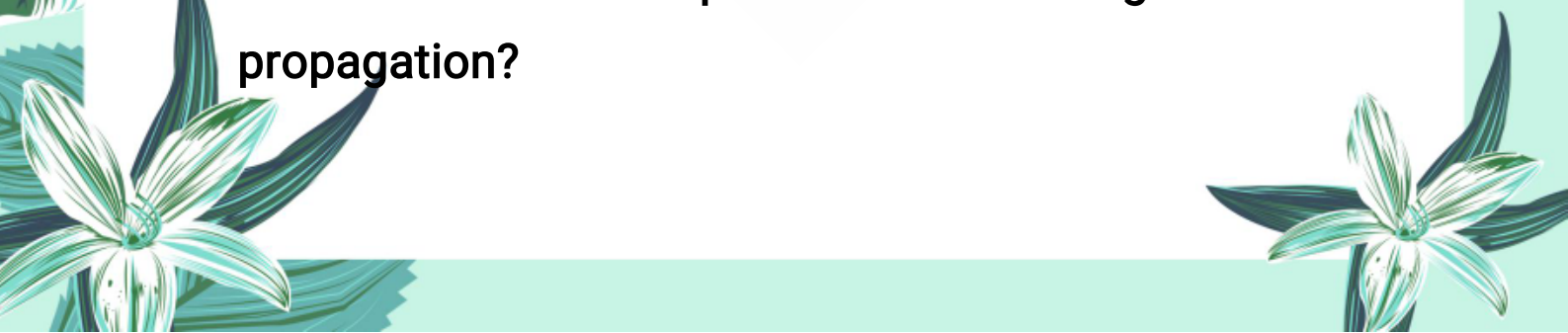
18. Sound waves are:

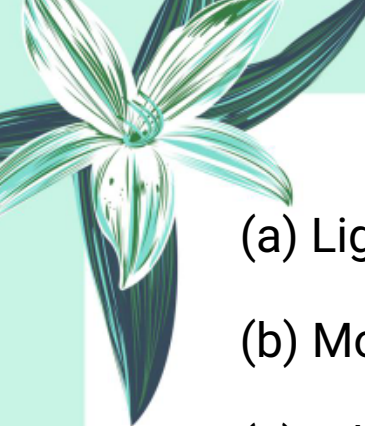

- (a) Longitudinal
- (b) Transverse
- (c) Circular
- (d) Electromagnetic


19. The distance between two consecutive compressions is called:

- (a) Frequency
- (b) Amplitude
- (c) Wavelength
- (d) Pitch

10. What causes compression in air during sound propagation?



- 
- 
- (a) Light rays
 - (b) Moving fan
 - (c) Vibrating tuning fork
 - (d) Heat energy





11. Which characteristic of sound allows us to distinguish between loud and faint sounds?

- (a) Pitch
- (b) Frequency
- (c) Loudness
- (d) Quality

12. Loudness of sound increases with:

- (a) Decrease in amplitude
- (b) Increase in amplitude
- (c) Constant frequency
- (d) Decrease in frequency

13. Which factor does pitch of sound depend on?

- (a) Amplitude
 - (b) Frequency
- 
- 



(c) Distance

(d) Quality

14. The difference between the sound of piano and flute (even if pitch and loudness are same) is due to:



(a) Frequency

(b) Wavelength

(c) Quality

(d) Amplitude

15. Which physical quantity is defined as the sound energy passing per second through unit area?

(a) Frequency

(b) Pitch

(c) Intensity

(d) Loudness

16. Echo is produced due to:

(a) Absorption of sound






(b) Refraction of sound

(c) Reflection of sound

(d) Diffraction of sound



17. The minimum distance required between the sound source and the reflecting surface to hear a clear echo is:



(a) 34 m

(b) 0.1 m

(c) 17 m

(d) 10 m

18. Sound cannot travel through:

(a) Solid

(b) Liquid

(c) Gas

(d) Vacuum

19. Speed of sound is fastest in:

(a) Gases

(b) Liquids



(c) Solids

(d) Vacuum

20. At room temperature (21°C), speed of sound in air is approximately:

(a) 150 m/s

(b) 273 m/s

(c) 343 m/s

(d) 500 m/s

21. The formula used to calculate the speed of sound is:

(a) $v = f + \lambda$

(b) $v = f / \lambda$

(c) $v = f \times \lambda$

(d) $v = \lambda / f$

22. In the echo method, the total distance traveled by sound is measured from:

(a) Source to ear only

(b) Wall to ear



(c) Source to wall and back

(d) Ear to ground

23. Sounds that are pleasant to ears are called:

(a) Noise

(b) Echo



(c) Musical sounds

(d) Sound pollution

24. Which of the following is a source of noise pollution?

(a) Violin

(b) Drum

(c) Loud vehicle horn

(d) Flute

25. Continuous exposure to high noise levels may lead to:

(a) Hearing loss

(b) Increase in appetite

(c) Improved sleep





(d) Better concentration

26. Safe level of noise for 8-hour workday is approximately:

(a) 20 dB

(b) 40 dB

(c) 85–90 dB

(d) 120 dB

27. Which of the following materials helps reduce noise pollution?

(a) Smooth glass

(b) Hard tiles

(c) Draperies and rugs

(d) Metal sheets

28. Excessive reflection of sound that causes garbled sound is called:

(a) Vibration

(b) Echo

(c) Reverberation






(d) Absorption

29. The frequency range audible to a normal human ear is:

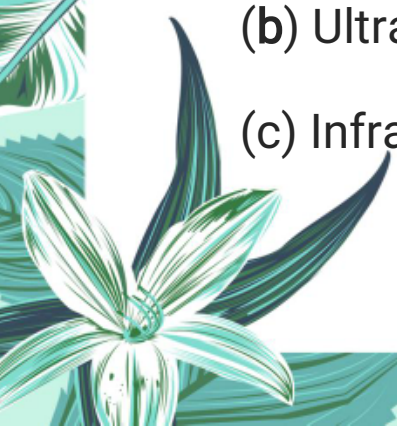
- (a) 0 to 10,000 Hz
- (b) 20 to 20,000 Hz
- (c) 200 to 2,000 Hz
- (d) 2,000 to 20,000 Hz



30. With increasing age, a person's ability to hear high-frequency sound:

- (a) Increases
- (b) Decreases
- (c) Remains same
- (d) Becomes perfect

31. Sound waves with frequency more than 20,000 Hz are called:

- (a) Echo waves
 - (b) Ultrasound
 - (c) Infra-sound
- 





(d) Sonic waves

32. The technique of using ultrasound to locate underwater objects is called:

(a) RADAR

(b) LASER

(c) SONAR

(d) SCUBA

Important Short Questions:

1. What is a sound wave and how is it produced?

Answer:

A sound wave is a type of mechanical wave produced by a vibrating body. These vibrations cause air particles to vibrate, forming compressions and rarefactions that travel to our ears.

2. How does sound travel through air?

Answer:

Sound travels through air in the form of longitudinal



waves by vibrating air particles that transfer energy from one to another.

3. Give two examples of vibrating bodies that produce sound.

Answer:

Examples:

(i) Vibrating strings of a guitar

(ii) Human vocal cords

4. What is the role of a stethoscope in hearing sound?


Answer:

Doctors use a stethoscope to detect internal body sounds like heartbeat and lung vibrations, which travel through the device to their ears.

5. Define loudness of sound.

Answer:


Loudness is the property of sound by which we can distinguish between loud and faint sounds. It depends on the amplitude of the vibrating body.





6. How does amplitude affect the loudness of a sound?


Answer:



The louder the sound, the greater the amplitude of vibration. A small amplitude produces a soft sound, while a large amplitude produces a loud sound.

7. How does the area of a vibrating body affect loudness?

Answer:



Larger vibrating areas produce louder sounds. For example, a large drum produces more sound than a small drum due to its greater surface area.

8. Define pitch and on what factor does it depend?

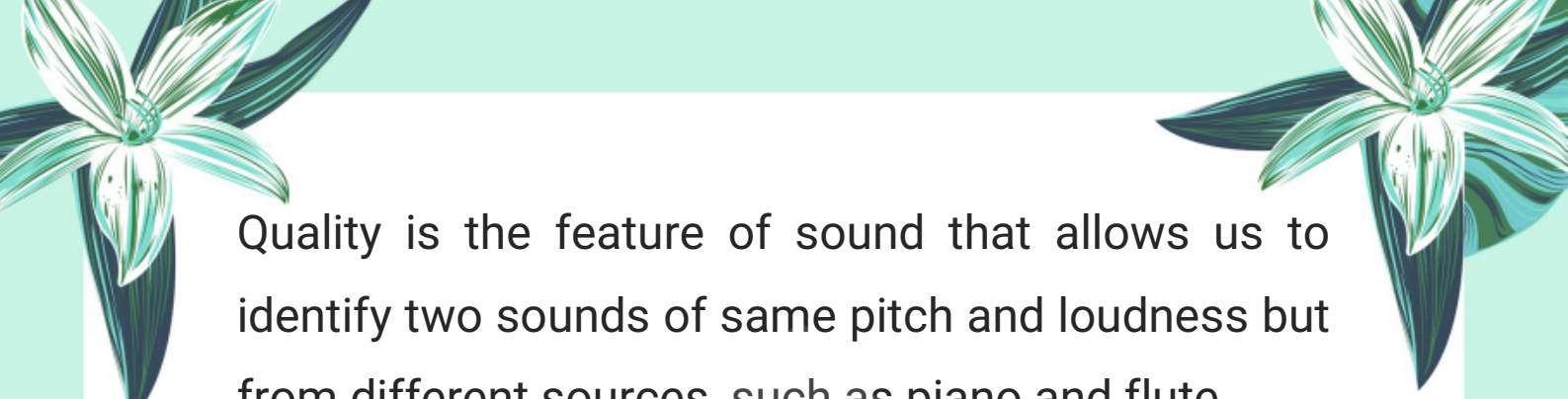
Answer:

Pitch is the characteristic of sound that helps distinguish between shrill and grave sounds. It depends on the frequency of the sound wave.

9. What is the quality of sound?

Answer:






Quality is the feature of sound that allows us to identify two sounds of same pitch and loudness but from different sources, such as piano and flute.

10. Define intensity of sound and write its SI unit.

Answer:



Intensity of sound is the sound energy passing per second through a unit area perpendicular to the wave direction. Its SI unit is Watt per square metre (W/m^2).

11. What is meant by reflection of sound?

Answer:

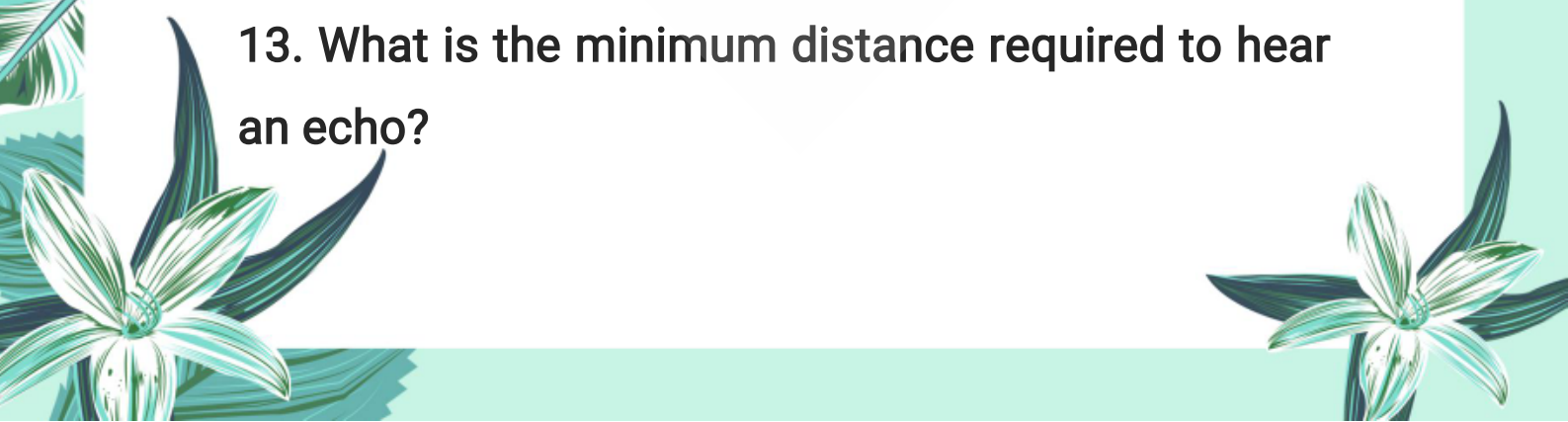
The bouncing back of sound from a surface is called reflection of sound.

12. Define echo.

Answer:

An echo is a reflected sound heard after a short delay.

13. What is the minimum distance required to hear an echo?





Answer:

At least 17 meters between the source and the obstacle.

14. How long does sound remain in the human brain?



Answer:

For about 0.1 seconds.

15. Write the formula to calculate speed of sound.

Answer:

$v = f \times \lambda$ (speed = frequency \times wavelength)

16. Compare the speed of sound in solids, liquids, and gases.

Answer:

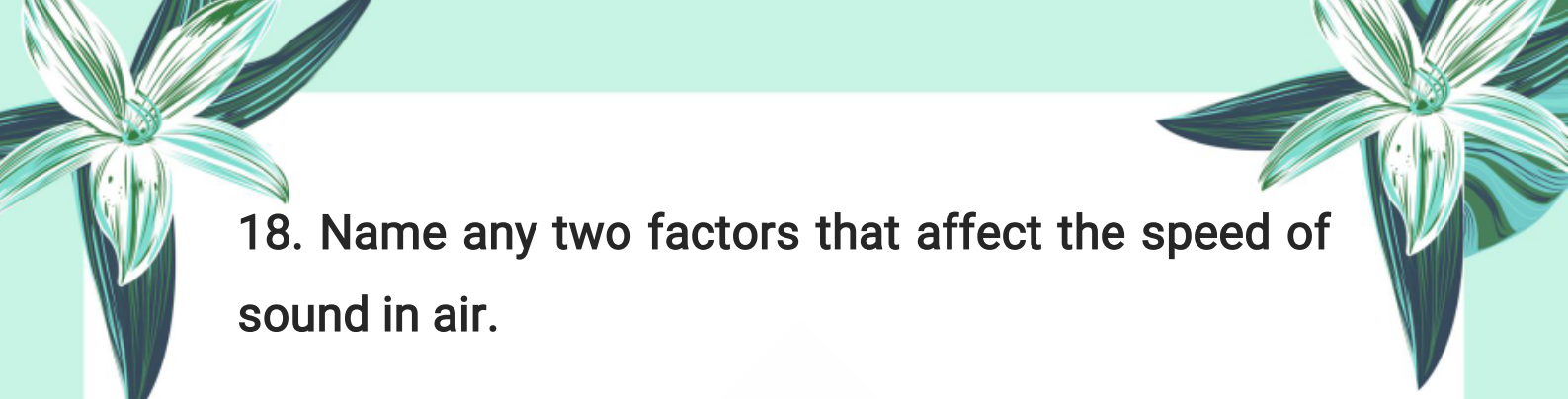
Solids > Liquids > Gases

17. What is the speed of sound in air at room temperature?

Answer:

343 m/s at 21°C.





18. Name any two factors that affect the speed of sound in air.

Answer:

Temperature and humidity



19. What is noise?

Answer:

Unpleasant and irregular sound is called noise.

20. Give two harmful effects of noise pollution.

Answer:

It can cause hearing loss and high stress.

21. What is meant by acoustic protection?

Answer:

The method of reducing unwanted sounds using soft and porous materials is called acoustic protection.

22. What is reverberation?

Answer:

The multiple reflections of sound causing the sound





to become garbled is called reverberation.

23. What is the audible frequency range of human ear?

Answer:

From 20 Hz to 20,000 Hz.



24. Define ultrasound.

Answer:

Sounds with frequencies higher than 20,000 Hz are called ultrasound.

25. Write any two uses of ultrasonic waves.

Answer:

- In medicine to detect internal organs and tumors.
- In SONAR to locate objects under the sea.

26. How is sound produced?

Answer:

Sound is produced by a vibrating body.

27. In which form does sound travel in a medium?





Answer:

Sound travels in the form of compressional (longitudinal) waves.

28. What is loudness of sound and what does it depend on?



Answer:

Loudness is the feature by which loud and faint sounds are distinguished. It depends on amplitude, surface area, and distance.

29. Define intensity of sound.

Answer:

Sound energy passing per second through a unit area perpendicular to the direction of sound is called intensity.

30. What is the unit of sound intensity level?

Answer:

Bel is the unit of sound intensity level.

(1 bel = 10 decibels)

31. What is pitch of sound and what does it





depend on?

Answer:

Pitch is the characteristic that distinguishes shrill and grave sounds. It depends on frequency.



32. What is the quality of sound?

Answer:

The quality is the characteristic that distinguishes two sounds of same loudness and pitch.

33. Differentiate between musical sound and noise.

Answer:

Musical sound is pleasant to hear; noise has a jarring and unpleasant effect.



34. What is acoustic protection?

Answer:

It is a technique of absorbing unwanted sound using soft and porous materials.

35. Define ultrasound and give one use.

Answer:



Ultrasound is sound with frequency above 20,000 Hz. It is used in medical diagnosis and SONAR.

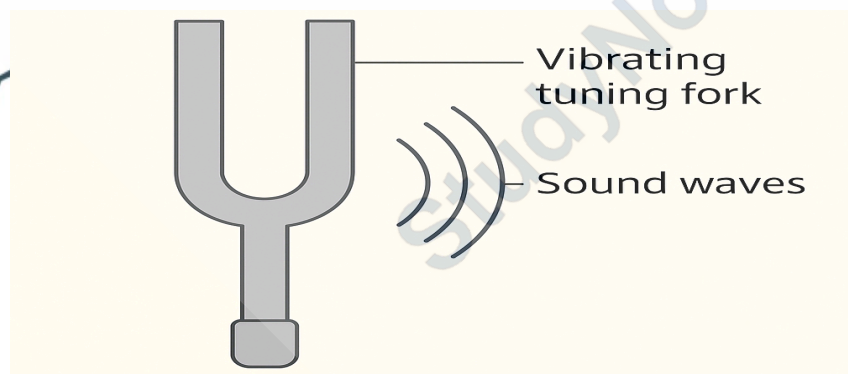
Exercise Long Questions:

REVIEW QUESTIONS:

☀ Q11.1: What is the necessary condition for the production of sound?


❖ Introduction:

Sound is a form of energy that travels through a medium in the form of waves. It helps us communicate and hear various sounds around us.



✓ Necessary Condition for Sound Production:

- ☞ The necessary condition for the production of sound is vibration.

- 
- The page is decorated with various illustrations: a white butterfly with black markings on its wings is on the left side. There are several green and white flowers with long, narrow leaves, some in the top corners and some at the bottom. The background is a light green color with a subtle pattern of leaves and flowers.
- Sound is always produced by a vibrating body.
 - When an object vibrates, it causes the surrounding medium (like air) to vibrate as well.
 - These vibrations travel in the form of compressional (longitudinal) waves, which reach our ears and are interpreted as sound.

Examples of Sound Produced by Vibrations:

◆ 1. Vibrating Strings (Guitar):

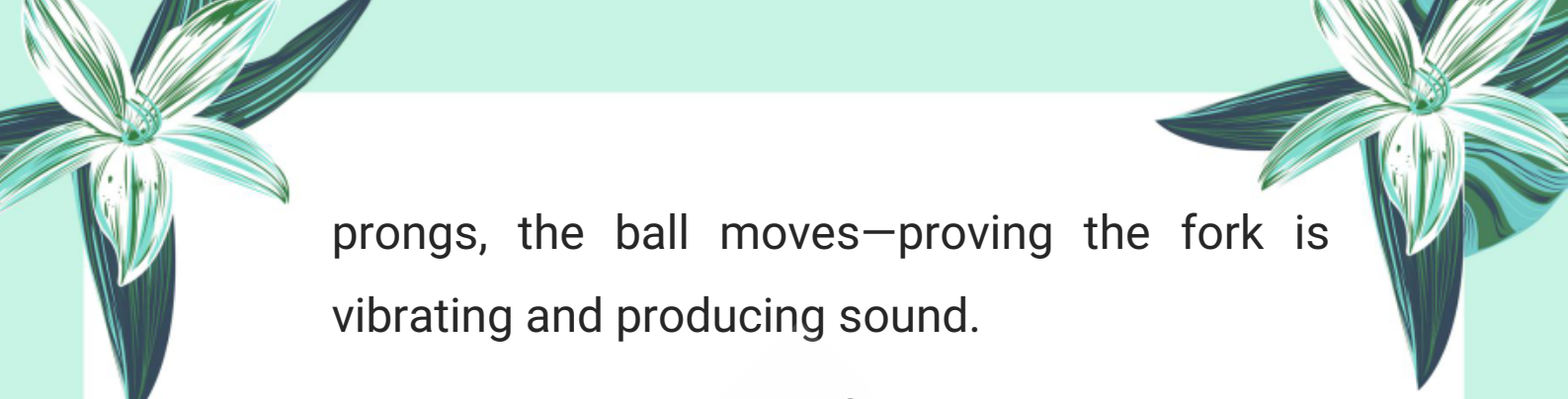
- When a guitar string is plucked, it vibrates.
- The vibrations travel through air and produce sound.

◆ 2. Vibrating Vocal Cords:

- In humans, vocal cords vibrate when we speak.
- These vibrations generate sound waves that travel through air.

◆ 3. Tuning Fork (Lab Activity):

- When a tuning fork is struck with a rubber hammer, its prongs vibrate.
- If we touch a suspended plastic ball to the



prongs, the ball moves—proving the fork is vibrating and producing sound.

- Dipping the vibrating fork in water creates splashing, showing the vibrations.



◆ **Scientific Explanation:**

- Vibrations cause compressions (high-pressure regions) and rarefactions (low-pressure regions) in air molecules.
- These alternating regions travel as longitudinal waves to reach our ears.



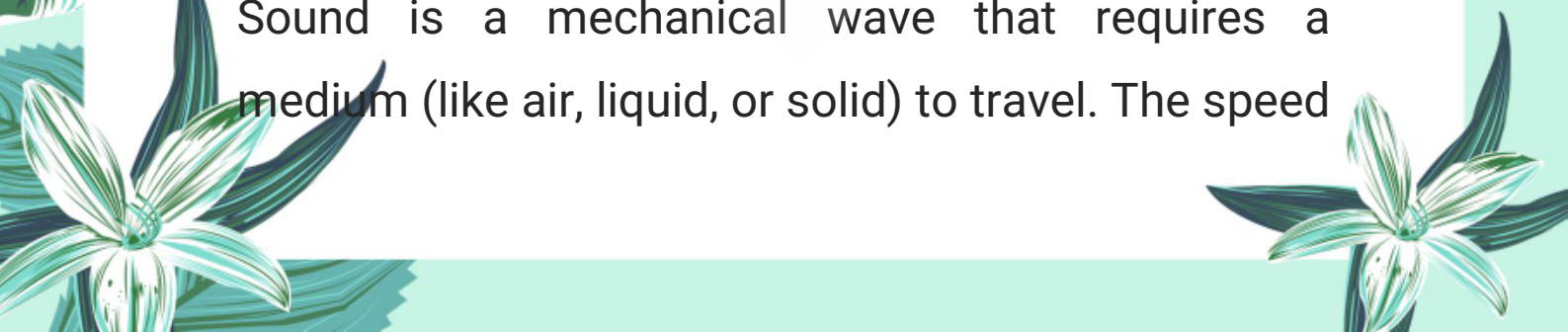
Summary:

Hence, the vibration of a body is the essential condition for the production of sound. Without vibration, no sound can be produced.

☀ **Q11.2:** What is the effect of the medium on the speed of sound? In which medium sound travels faster: air, solid or liquid? Justify your answer.

◆ **Introduction:**

Sound is a mechanical wave that requires a medium (like air, liquid, or solid) to travel. The speed



of sound depends on the type and properties of the medium.

✓ Effect of Medium on Speed of Sound:

The speed of sound varies in different mediums based on:

- Density
- Elasticity of particles
- Intermolecular forces

| Medium | Speed of Sound (approx.) |
|---------------|--------------------------|
| Air (at 20°C) | 343 m/s |
| Water | 1480 m/s |
| Steel (solid) | 5000 m/s |

◆ Which Medium is Fastest?

✓ Sound travels fastest in solids, slower in liquids, and slowest in gases.

◆ Reason / Justification:

- In solids, molecules are closely packed, so




vibrations pass quickly from particle to particle.

- In liquids, molecules are less tightly packed, so sound travels slower than solids.
- In gases (like air), molecules are far apart, so it takes longer for vibrations to transfer—hence, slowest.

 **Summary:**

The denser and more elastic the medium, the faster the sound travels. Therefore, sound travels fastest in solids, then in liquids, and slowest in gases like air.

 **Q11.3:** How can you prove the mechanical nature of sound by a simple experiment?

 **Answer:**

 **Introduction:**

Sound is a mechanical wave, meaning it needs a material medium to travel. It cannot travel in vacuum. This fact can be proved through a simple bell jar experiment.




Experiment to Prove Mechanical Nature of






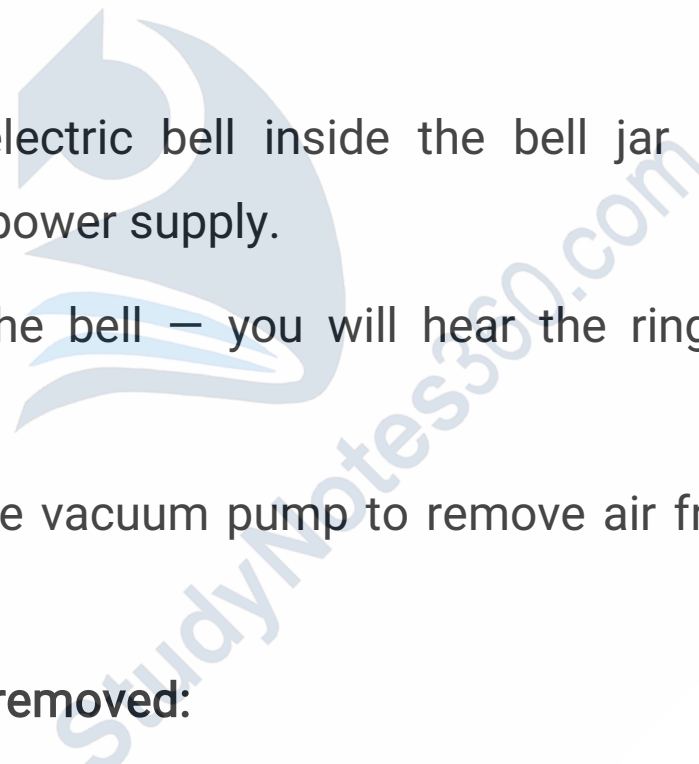
Sound:

Apparatus Needed:

- Bell jar with airtight lid
 - Electric bell
 - Vacuum pump
 - Power supply
- 



Procedure:



1. Place the electric bell inside the bell jar and connect it to a power supply.
 2. Switch on the bell – you will hear the ringing sound clearly.
 3. Now start the vacuum pump to remove air from the jar.
 4. As the air is removed:
 - The sound of the bell becomes fainter.
 - Eventually, no sound is heard, even though the bell is still vibrating (you may see its parts moving).
 5. Releasing the air back into the jar allows sound to
- 
- 
- 
- 


be heard again.


Observation:

- When there is no air (vacuum) inside the jar, sound cannot travel, even though the bell is ringing.
- When air is present again, sound becomes audible.

Summary:

-  This proves that sound cannot travel through vacuum, and hence, it is a mechanical wave.
-  Sound requires a material medium (solid, liquid, or gas) to propagate.

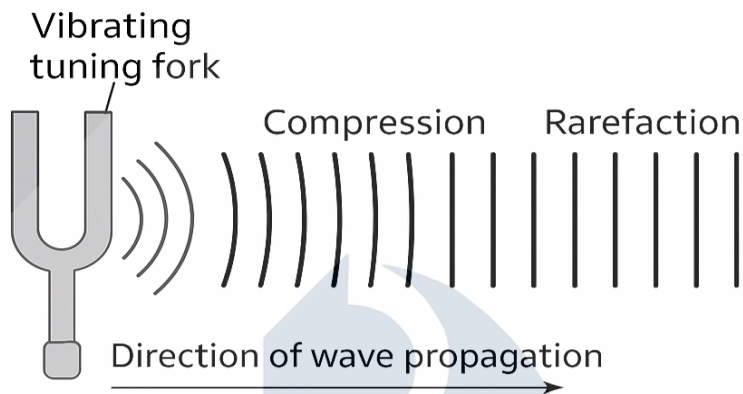
 **Extra Tip for Exams:** Always mention that light can travel in vacuum but sound cannot, because light is electromagnetic but sound is mechanical.

 **Q11.4:** What do you understand by the longitudinal wave? Describe the longitudinal nature of sound waves.

 **Answer:**

❖ Definition of Longitudinal Wave:

A longitudinal wave is a type of wave in which the particles of the medium vibrate parallel to the direction of wave propagation.



Longitudinal sound wave

Example:

Sound waves in air are a perfect example of longitudinal waves.

Explanation of Longitudinal Nature of Sound:

- When a tuning fork vibrates, it causes compressions (high-pressure regions) and rarefactions (low-pressure regions) in the air.
- These compressions and rarefactions move in the direction of wave travel, and air particles vibrate back and forth in the same direction.






◆ Activity (Tuning Fork Experiment):

- Strike a tuning fork and place it near your ear or in water.
- You will hear the sound or see water splash.
- This shows that air molecules oscillate parallel to wave motion, creating longitudinal sound waves.



Summary:

-  In longitudinal waves like sound, the vibrations of particles are parallel to the direction of wave travel.
-  This proves the longitudinal nature of sound waves.

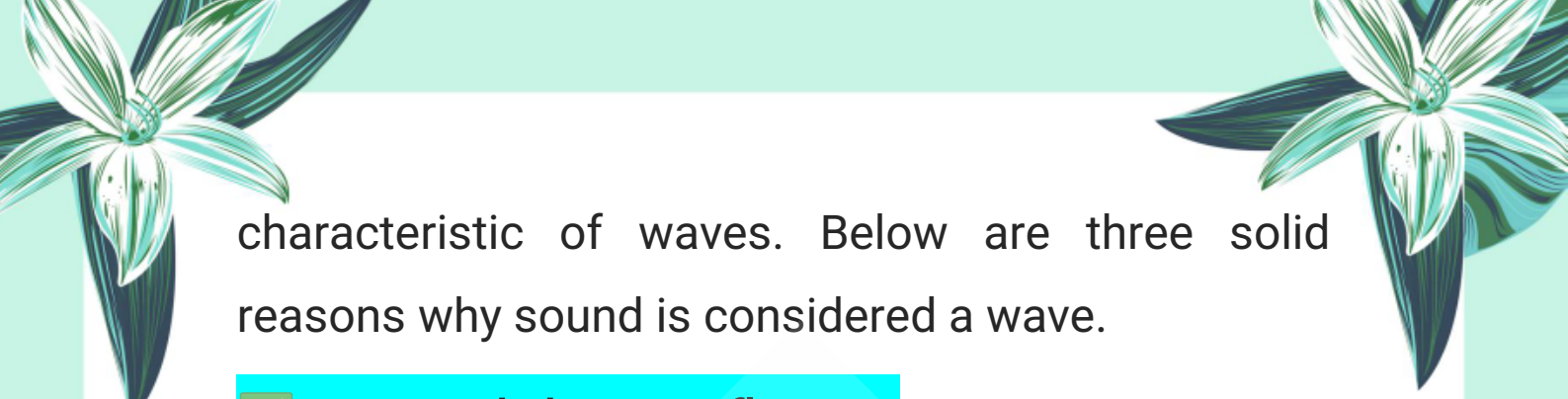
 Q11.5: Sound is a form of wave. List at least three reasons to support the idea that sound is a wave.

 Answer:

◆ Introduction:

Sound shows many properties that are





characteristic of waves. Below are three solid reasons why sound is considered a wave.



✓ 1. Sound shows Reflection:

- Like all waves, sound can bounce back from surfaces.
- **Example:** Echo is the reflection of sound from walls or mountains.

✓ 2. Sound shows Interference:

- When two sound waves of the same frequency meet, they can combine to produce louder or softer sounds.
- This is called constructive or destructive interference, just like other waves.

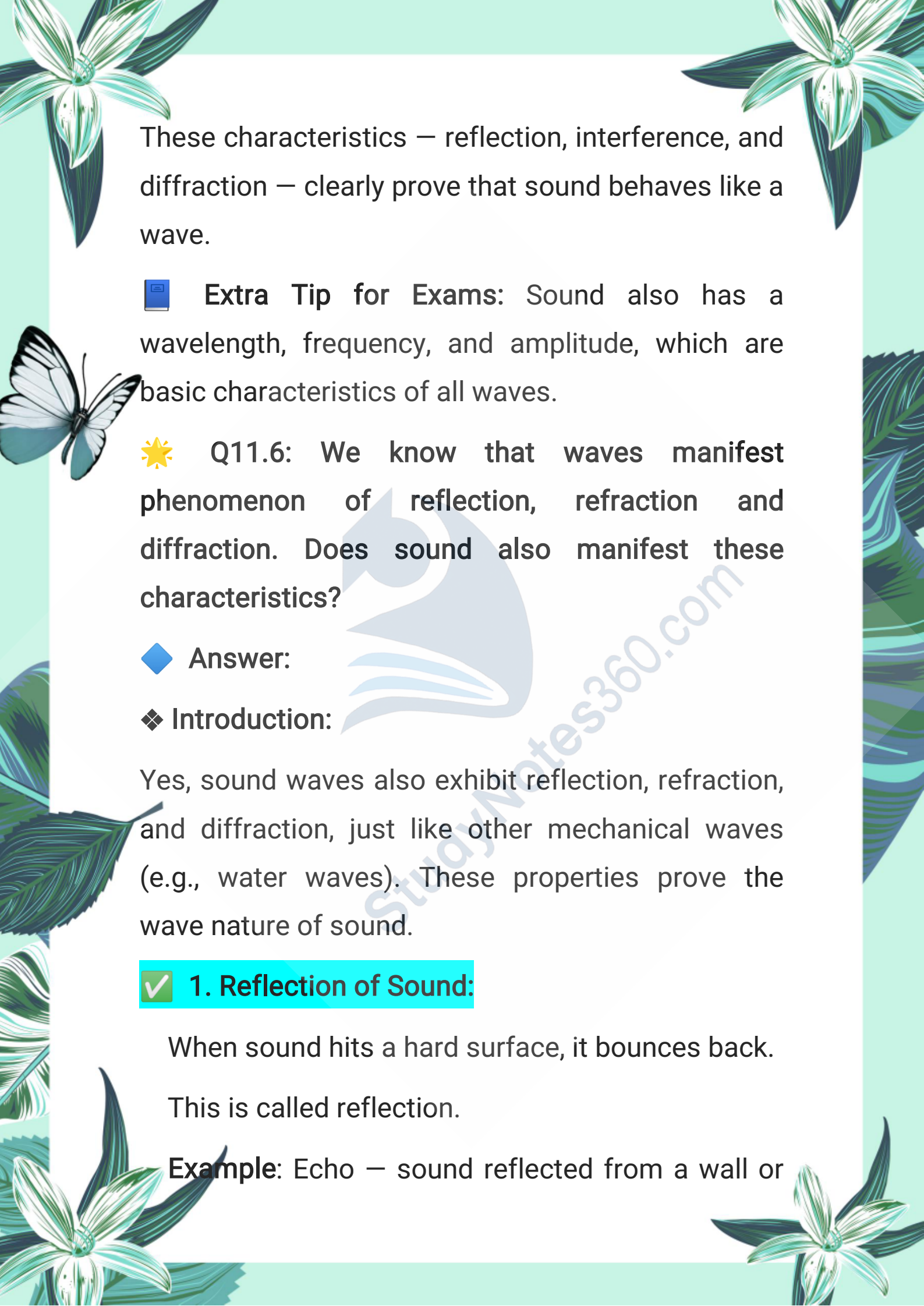
✓ 3. Sound shows Diffraction:

- Sound can bend around corners or obstacles and spread out.
- This property is called diffraction, a common wave behavior.





Summary:





These characteristics – reflection, interference, and diffraction – clearly prove that sound behaves like a wave.

 **Extra Tip for Exams:** Sound also has a wavelength, frequency, and amplitude, which are basic characteristics of all waves.

 **Q11.6:** We know that waves manifest phenomenon of reflection, refraction and diffraction. Does sound also manifest these characteristics?

 **Answer:**

 **Introduction:**

Yes, sound waves also exhibit reflection, refraction, and diffraction, just like other mechanical waves (e.g., water waves). These properties prove the wave nature of sound.

1. Reflection of Sound:

When sound hits a hard surface, it bounces back.

This is called reflection.

Example: Echo – sound reflected from a wall or



mountain.

✓ 2. Refraction of Sound:

When **sound** travels from one medium to another (like warm air to cold air), its speed changes, causing it to bend.

This bending is called **refraction**.

Example: Sound heard more clearly over water at night due to refraction in cool air.

✓ 3. Diffraction of Sound:

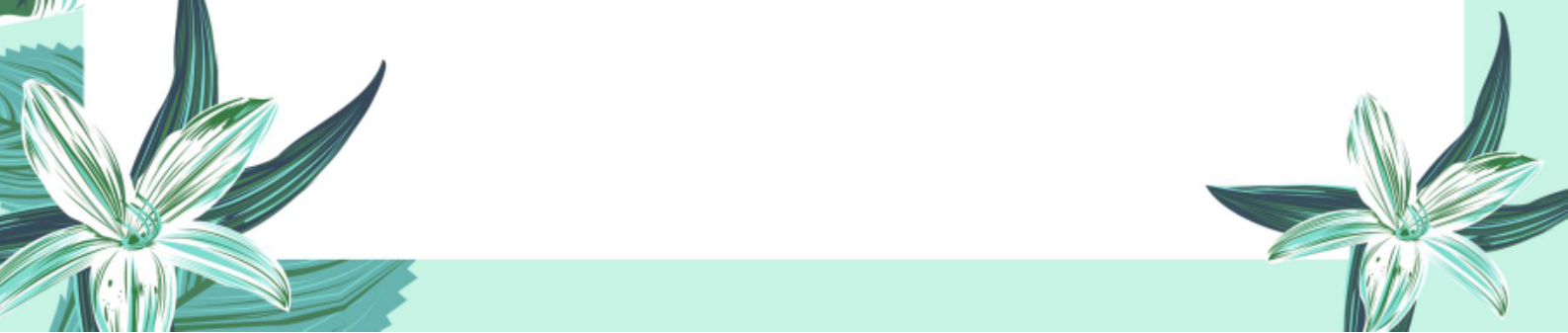
Sound waves can bend around obstacles and spread out after passing through small openings.

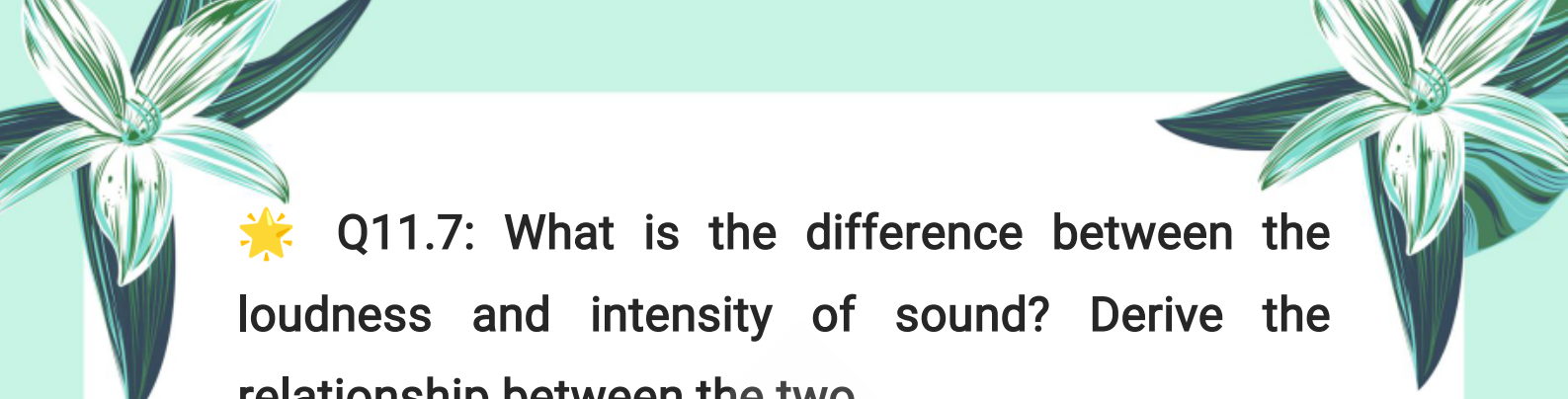
This is called **diffraction**.

Example: We can hear someone speaking from behind a wall.

 **Summary:**

✓ Yes, sound exhibits reflection, refraction, and diffraction, proving that sound is a wave and behaves like other waveforms.






☀️ Q11.7: What is the difference between the loudness and intensity of sound? Derive the relationship between the two.

◆ Answer:

❖ Introduction:



Sound is a form of energy that travels in the form of waves. When sound reaches our ears, we perceive it as loud or faint, depending on various factors. Scientifically, we use the terms loudness and intensity to describe and understand sound, but they are not the same.

 **Loudness:**

Loudness is the sensation or perception of sound by the human ear. It tells us how strong or weak a sound feels. It is a subjective quantity, which means it varies from person to person and depends on factors like:

- The amplitude of the sound wave (higher amplitude = louder sound),
- The distance from the source,



- The sensitivity of the ear, And the frequency of sound.
- Loudness does not have an SI unit, but it is often expressed in phons for comparison.

Intensity of Sound:

Intensity is a physical and measurable quantity. It is defined as the sound energy passing per second through a unit area, placed perpendicular to the direction of wave motion.

It depends only on:

- The amplitude of the wave,
- The medium through which sound is traveling,
- And the distance from the sound source.
- It is measured in watts per square meter (W/m^2).

Mathematical Relationship Between Loudness and Intensity:

According to the Weber-Fechner law, the loudness (L) of sound is directly proportional to the logarithm

of its intensity (I).

$$\text{Loudness (L)} \propto \log_{10}(\text{Intensity})$$

Or in formula form:

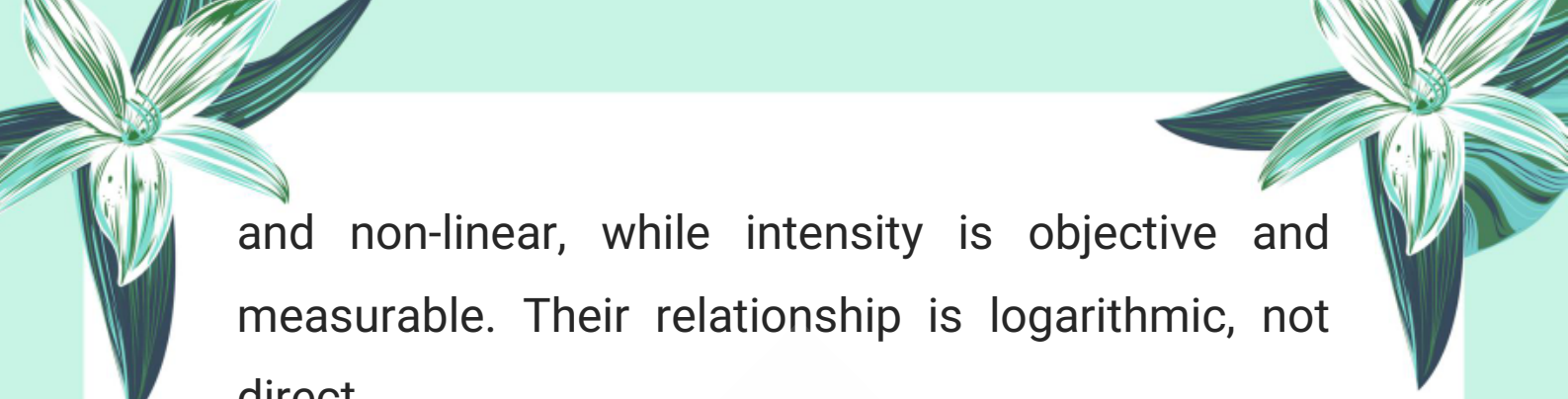
$$L = k \log_{10} \left(\frac{I}{I_0} \right)$$

Where:


- L = Loudness
- I = Intensity of the sound
- I_0 = Reference intensity (threshold of hearing, usually 10^{-12} , W/m^2)
- k = Constant of proportionality

Summary:

In short, loudness is how we feel the sound, and intensity is how we measure it scientifically. Though both are related to amplitude, loudness is subjective



and non-linear, while intensity is objective and measurable. Their relationship is logarithmic, not direct.



☀️ Q11.8: On what factors does the loudness of sound depend?

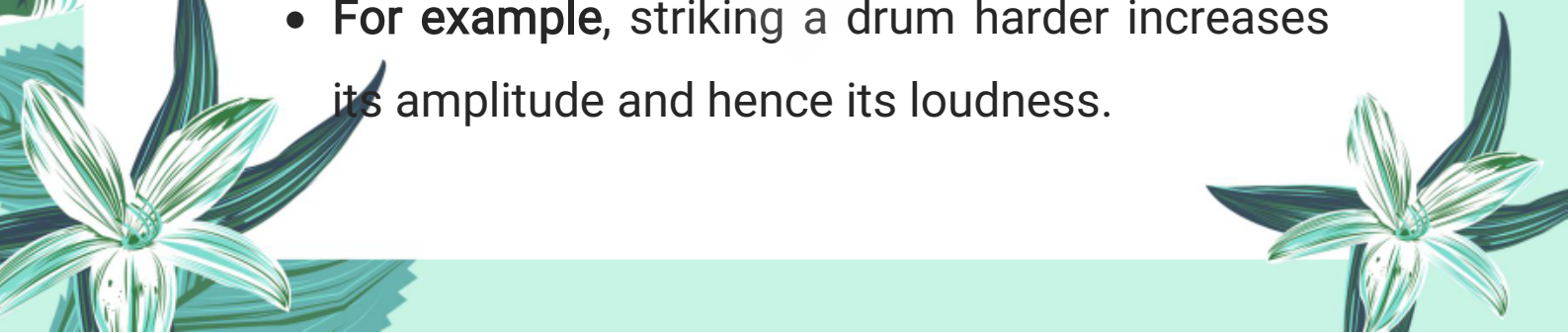
◆ Answer:

❖ Introduction:

Loudness is the perceived strength or volume of a sound as experienced by the human ear. It tells us whether a sound is loud or soft. Although it depends on the physical intensity of the sound wave, it is subjective, meaning it can vary from person to person.

🔍 Factors Affecting the Loudness of Sound:

1. Amplitude of Sound Wave:

- The greater the amplitude, the louder the sound.
 - Loudness is directly proportional to the square of amplitude.
 - **For example**, striking a drum harder increases its amplitude and hence its loudness.
- 



2. Distance from the Source:

- Loudness decreases with increasing distance from the source.
- Sound energy spreads in all directions; as distance increases, less energy reaches the ear.





3. Sensitivity of the Listener's Ear:

- Loudness depends on how sensitive a person's ear is.
- Some people (especially younger ones) can hear faint sounds better than others.

4. Frequency of the Sound:

- Human ears are more sensitive to certain frequencies, especially between 1000–4000 Hz.
- Sounds within this range appear louder even if their intensity is the same as others.


5. Environmental Conditions:

- Temperature, humidity, and pressure of air affect the transmission of sound.
 - Sound travels faster in warm and humid air,
- 
- 

increasing its apparent loudness.

Summary:

Thus, loudness depends on multiple factors like amplitude, distance, frequency, ear sensitivity, and environmental conditions. It is not a fixed value and differs from intensity, which is purely physical.

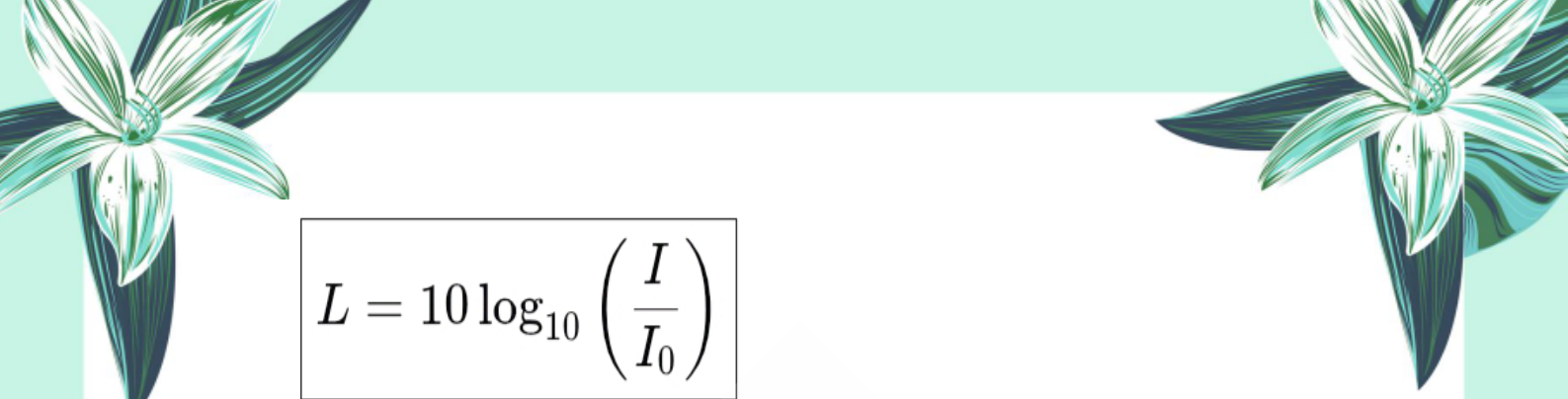
 Q11.9: What do you mean by the term intensity level of the sound? Name and define the unit of intensity level of sound.

Answer:


Definition of Intensity Level:

- The intensity level (also called sound level) is a logarithmic measure of the intensity of sound relative to a reference intensity. It tells us how loud or soft a sound is, quantitatively.
- It is measured relative to the threshold of hearing, which is the lowest intensity that a healthy human ear can detect.

Mathematical Formula:


$$L = 10 \log_{10} \left(\frac{I}{I_0} \right)$$

Where:

- 
- L = Intensity level in decibels (dB)
 - I = Measured intensity of sound (in W/m^2)
 - I_0 = Reference intensity = $10^{-12}, W/m^2$



Unit of Intensity Level:

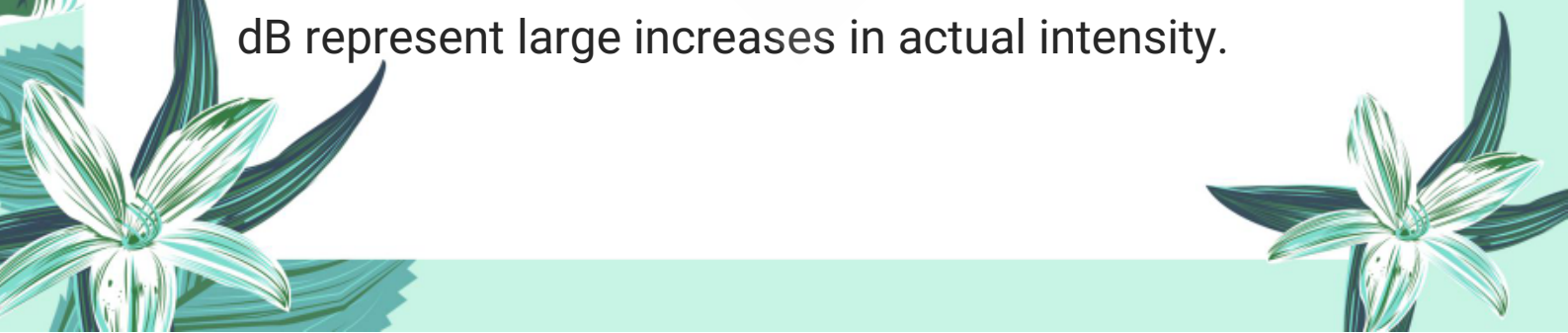
The unit of sound intensity level is the decibel (dB).

Definition of Decibel (dB):

One decibel is the intensity level when the intensity of a sound is ten times greater than the reference intensity.

➤ $1 \text{ dB} = 10 \times \log_{10}(I / I_0)$

It is a logarithmic unit, so even small increases in dB represent large increases in actual intensity.



 **Example:**

If a sound has intensity 10^{-10} , W/m^2 ,
then:

$$L = 10 \log_{10} \left(\frac{10^{-10}}{10^{-12}} \right) = 10 \log_{10}(100) = 10 \times 2 = 20 \text{ dB}$$

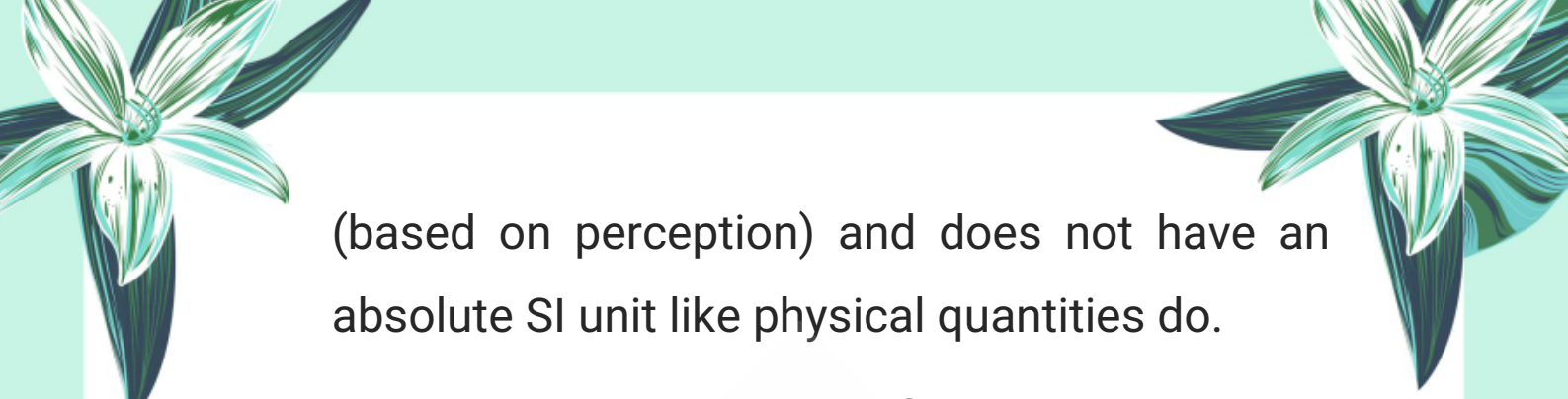
 **Summary:**

The intensity level of sound gives us a practical way to compare different sounds. It is measured in decibels, which help describe sounds as quiet, normal, or loud. It also helps engineers and scientists control noise pollution and measure sound in various environments.

☀️ Q11.10: What are the units of loudness? Why do we use logarithmic scale to describe the range of the sound intensities we hear?


 **Answer:** **Units of Loudness:**


- Technically, loudness is a subjective quantity



(based on perception) and does not have an absolute SI unit like physical quantities do.

- However, in practice, it is often measured using the same unit as intensity level, which is the decibel (dB).



 **Note:** While intensity is a physical quantity measured in watts per square meter (W/m^2), loudness is perceived by the human ear and measured using phons or more commonly decibels (dB) based on intensity level.

◆ Why Use a Logarithmic Scale for Sound Intensity?

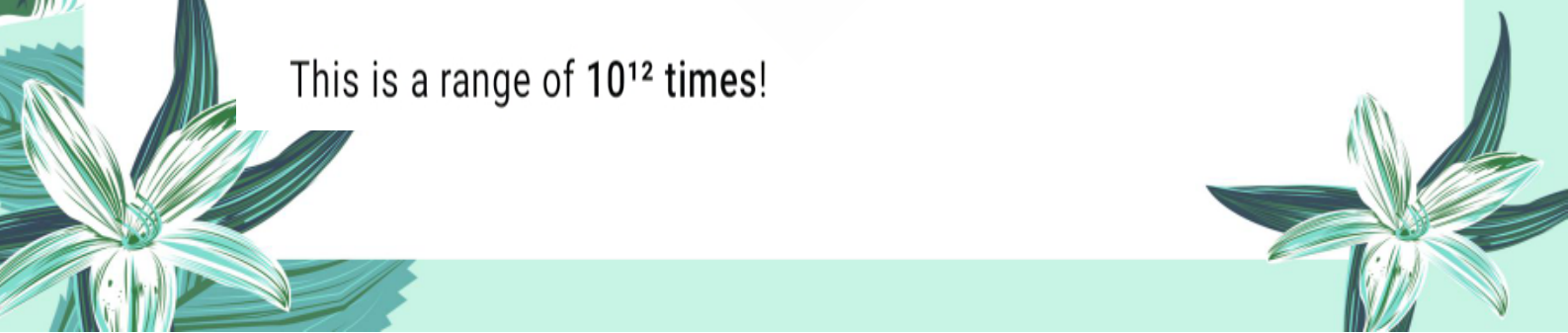
The human ear is extremely sensitive. It can detect sound intensities from as low as:

$$10^{-12} \text{ W}/\text{m}^2 \quad (\text{threshold of hearing})$$

to as high as:

$$1 \text{ W}/\text{m}^2 \quad (\text{threshold of pain})$$

This is a range of 10^{12} times!



1
2
3
4

Reasons for Using Logarithmic Scale:

1. Wide Range Handling:

- The range of intensities we can hear is enormous.
- A logarithmic scale compresses this vast range into manageable values (e.g., 0 dB to 120 dB).

2. Closer to Human Perception:

- Human ears perceive sound logarithmically, not linearly.
- A sound 10 times more intense does not feel 10 times louder – it feels just a little louder.
- The logarithmic scale matches our psychological perception of sound.

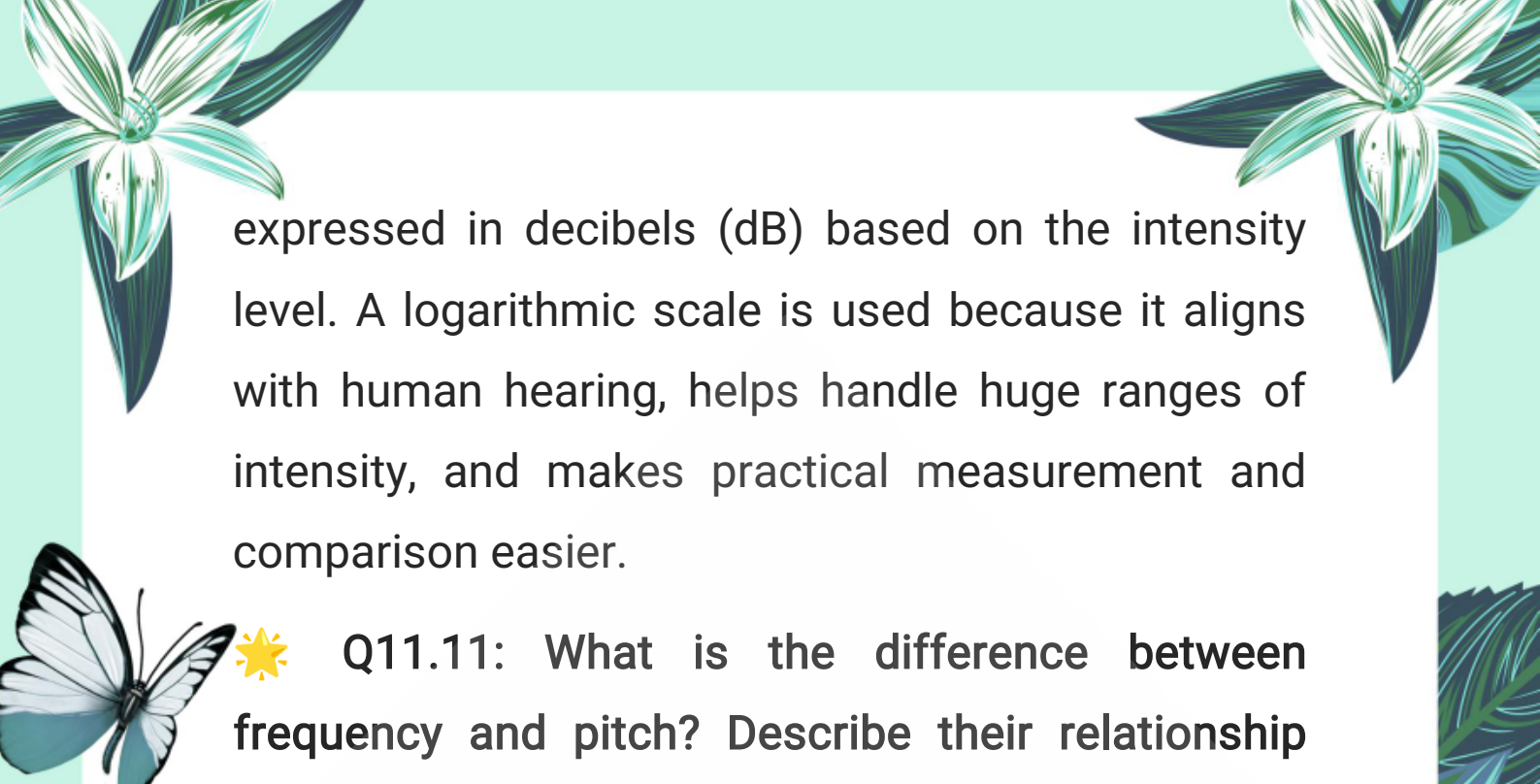
3. Easier Comparison:

- Decibels make it easy to compare sound levels.
- A 10 dB increase means the sound is 10 times more intense.



Summary:

Though loudness has no strict SI unit, it is usually



expressed in decibels (dB) based on the intensity level. A logarithmic scale is used because it aligns with human hearing, helps handle huge ranges of intensity, and makes practical measurement and comparison easier.

☀️ Q11.11: What is the difference between frequency and pitch? Describe their relationship graphically.

◆ 1. Frequency of Sound

❖ Definition:

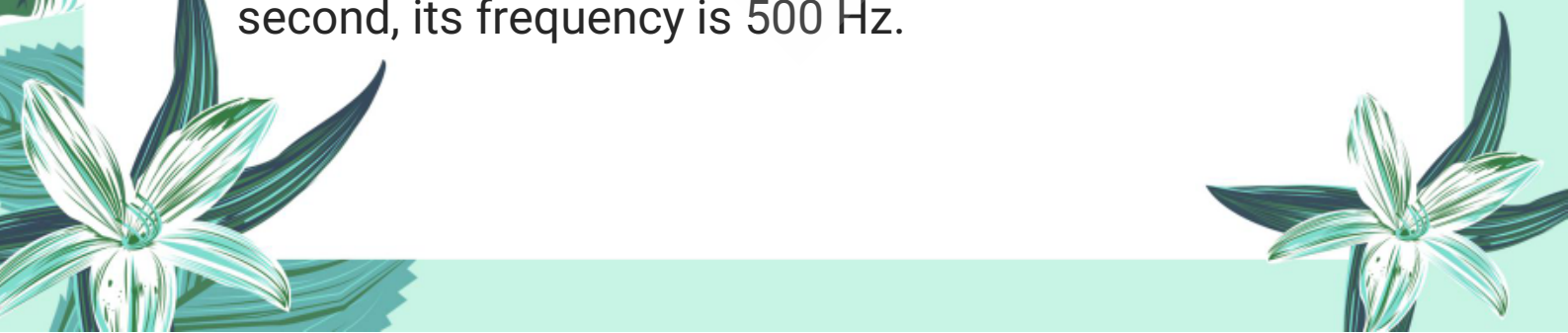
Frequency refers to the number of vibrations or cycles a sound wave completes in one second. It is a physical quantity.

◆ Symbol:

- SI Unit: Hertz (Hz)
- 1 Hz = 1 vibration per second

🔊 Example:


If a sound wave completes 500 vibrations in one second, its frequency is 500 Hz.





◆ 2. Pitch of Sound

Definition:

- 
- Pitch is the perception or sensation of frequency by the human ear. It tells us whether a sound is high or low.
 - **High Pitch:** Produced by high-frequency sounds (e.g., whistle, mosquito).
 - **Low Pitch:** Produced by low-frequency sounds (e.g., drum, lion's roar).



Important Note:

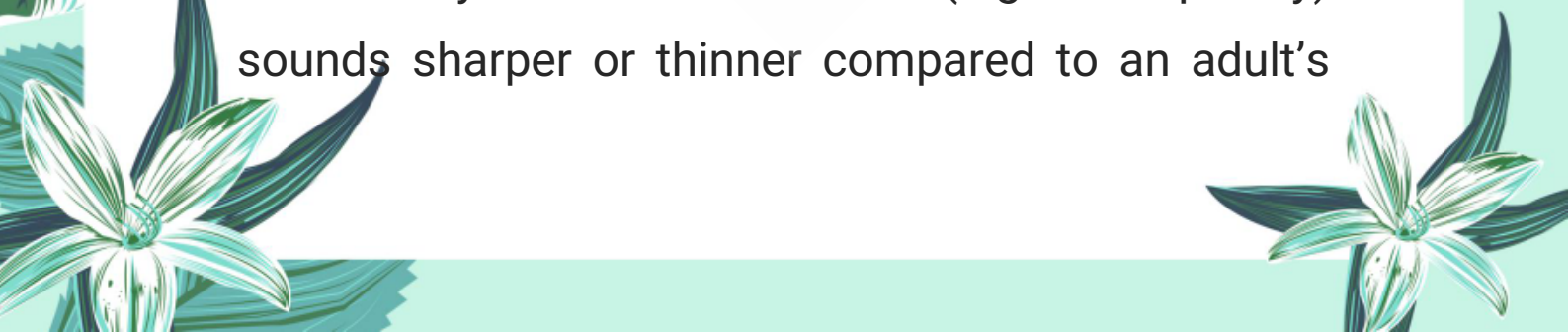
Pitch is a subjective (mental) response, while frequency is an objective (measurable) property.

◆ 3. Relationship Between Frequency and Pitch

Direct Relationship: As the frequency increases, the pitch also increases.

- Lower Frequency \Rightarrow Lower Pitch
- Higher Frequency \Rightarrow Higher Pitch

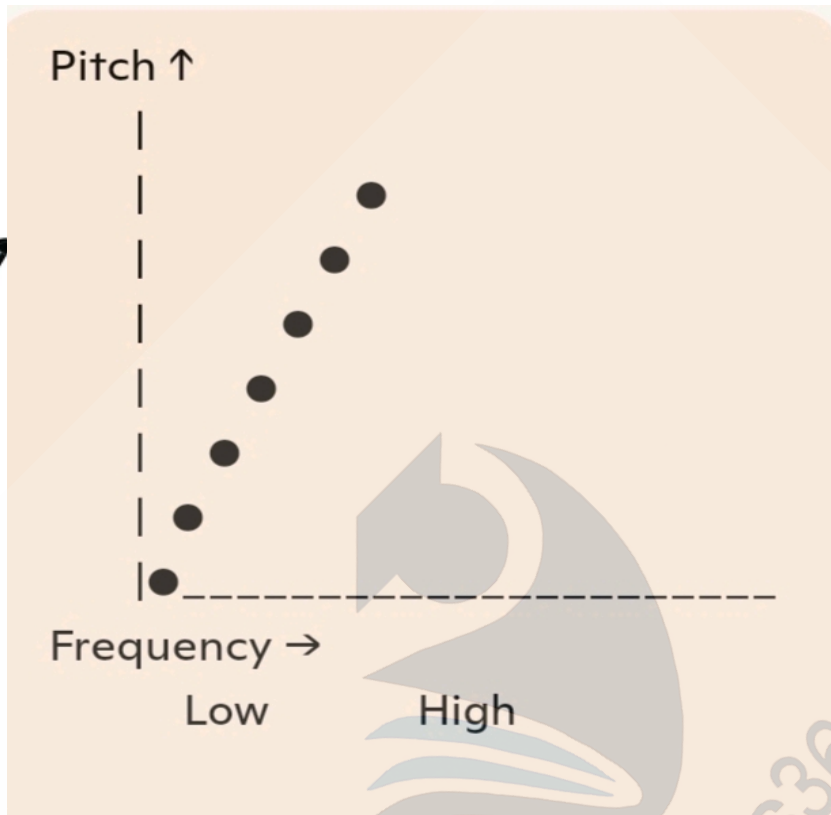
This is why a small child's voice (higher frequency) sounds sharper or thinner compared to an adult's



voice (lower frequency).



Graphical Representation:



◆ The graph shows that pitch increases with frequency.

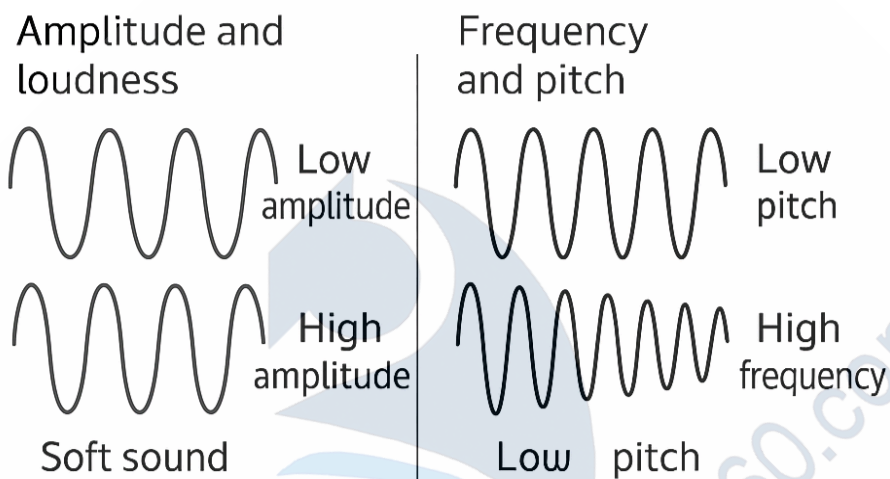
🔍 Summary:

- Frequency is a measurable quantity that defines how fast a sound vibrates.
- Pitch is how we hear that frequency.
- More frequency = Higher pitch
- Less frequency = Lower pitch

- They are related, but not the same.

☀ Q11.12: Describe the effect of change in amplitude on loudness and the effect of change in frequency on pitch of sound.

❖ Answer:



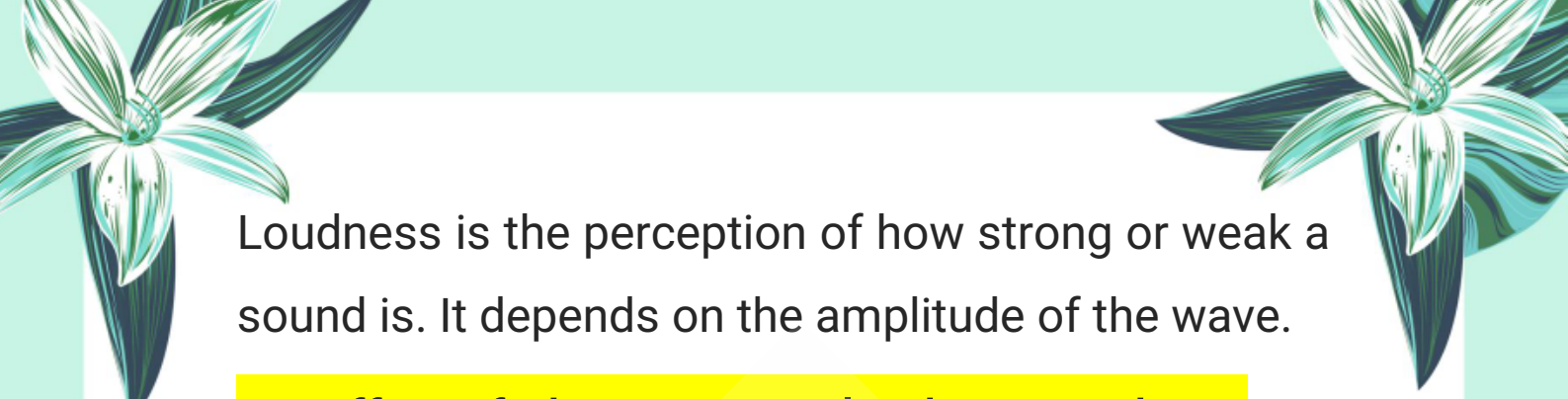
Effect of change in amplitude and frequency

◆ 1. Amplitude and Loudness

👉 Amplitude:

Amplitude is the maximum displacement of air particles from their rest position during the vibration of a sound wave. It represents the energy carried by the wave.


👉 Loudness:



Loudness is the perception of how strong or weak a sound is. It depends on the amplitude of the wave.

◆ Effect of Change in Amplitude on Loudness

- When the amplitude increases, the loudness of sound increases.
- When the amplitude decreases, the loudness of sound decreases.



High amplitude = Loud sound



Low amplitude = Soft sound

➤ Example:

If you strike a drum gently, it vibrates with low amplitude, producing a soft sound. If you strike it hard, it vibrates with high amplitude, producing a loud sound.

🧠 Important Concept:

- Loudness \propto (Amplitude)²
- This means if amplitude is doubled, loudness increases four times.

◆ 2. Frequency and Pitch



 **Frequency:**

Frequency is the number of vibrations per second. It is measured in Hertz (Hz).

 **Pitch:**

Pitch is the sensation or perception of frequency by the ear. It tells us whether a sound is high or low.

 **Effect of Change in Frequency on Pitch**

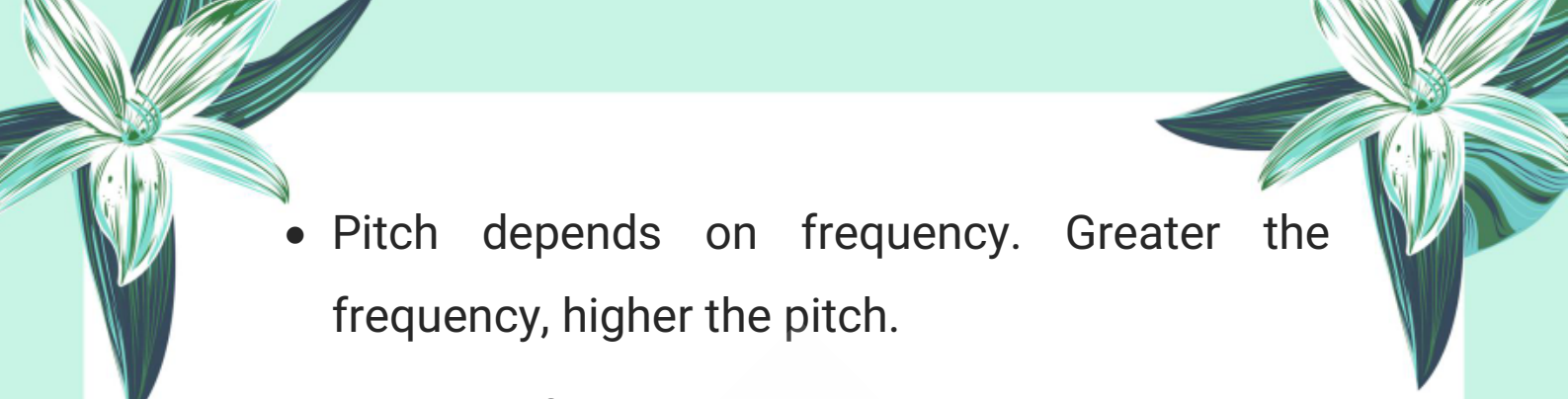
- Increase in frequency results in a higher pitch (sharp/thin sound).
- Decrease in frequency results in a lower pitch (deep/heavy sound).

 **Examples:**


- A mosquito produces high-pitched sound due to high frequency.
- A lion's roar has a low pitch because of low frequency.

 **Summary:**

- Loudness depends on amplitude. Greater the amplitude, louder the sound.

- 
- Pitch depends on frequency. Greater the frequency, higher the pitch.

These two factors help us understand and differentiate various sounds around us.



☀️ Q11.13: If the pitch of sound is increased, what are the changes in the following?

❖ Answer:

◆ a. Frequency

👉 Pitch is directly related to frequency.

- When pitch increases, it means the frequency increases.

Answer:

- Frequency increases.

➤ Example:

A high-pitched sound like a whistle has a high frequency.

◆ b. Wavelength

👉 The relationship between wave speed, frequency, and wavelength is:


$$v = f \times \lambda$$

Where:

- v = velocity of sound (constant in a given medium)
- f = frequency
- λ = wavelength

If the frequency increases and the speed of sound remains constant, the wavelength must decrease.

✓ **Answer:**

- Wavelength decreases.


◆ c. Wave Velocity

👉 Wave velocity depends on the medium, not on frequency or pitch.

So, even if pitch or frequency increases, wave speed remains the same in the same medium.

✓ **Answer:**

- Wave velocity remains constant.



Note: Sound travels at different speeds in air, water, and solids—but for a given medium, the speed is fixed.

◆ d. Amplitude of the Wave



Amplitude is not related to pitch.

It is associated with loudness, not frequency or pitch. So, an increase in pitch does not affect the amplitude.





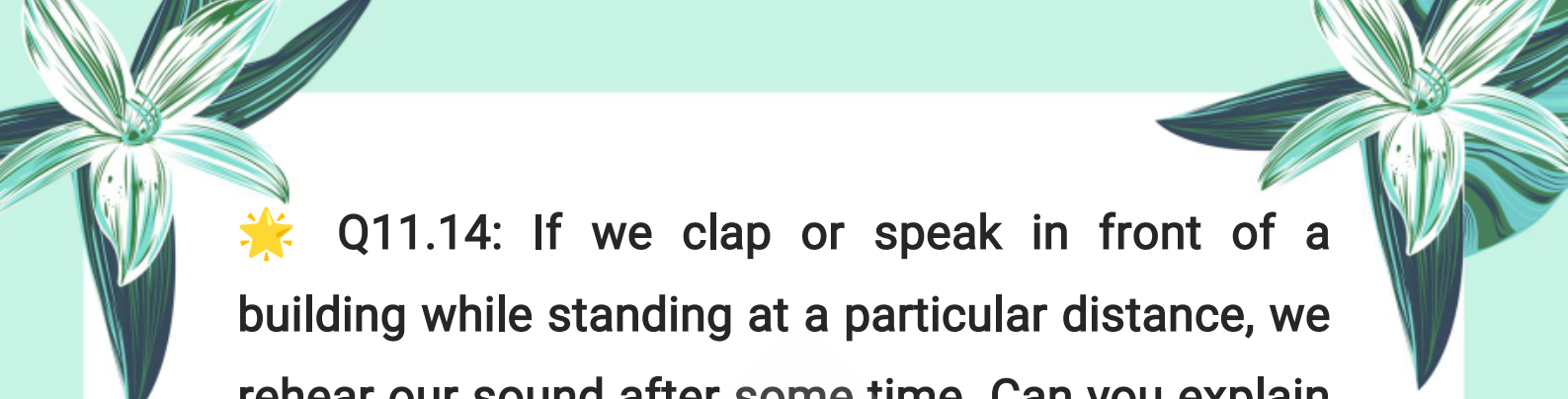
Answer:

Amplitude remains unchanged.



Final Summary:

| Change | Effect When Pitch Increases |
|------------------|---|
| a. Frequency |  Increases |
| b. Wavelength |  Decreases |
| c. Wave Velocity | No Change |
| d. Amplitude | No Change |



☀️ Q11.14: If we clap or speak in front of a building while standing at a particular distance, we rehear our sound after some time. Can you explain how this happens?

❖ Answer:

This phenomenon is known as Echo.

🔍 Explanation:

When we clap or speak, the sound travels through the air in the form of longitudinal sound waves. If there is a large building, wall, or mountain at some distance, the sound waves hit that surface and bounce back toward us. This reflected sound reaches our ears after a short time delay, and we hear it again. This repeated sound is called an echo.

◆ **Conditions for Hearing an Echo:**

To hear a clear echo:

1. Minimum distance between the sound source and reflecting surface must be at least 17 meters.
2. The time delay between the original sound and the echo must be at least 0.1 seconds, which is the



minimum time gap our ears can distinguish.

3. The surface must be hard and smooth to reflect the sound effectively.



 **Scientific Reason:**

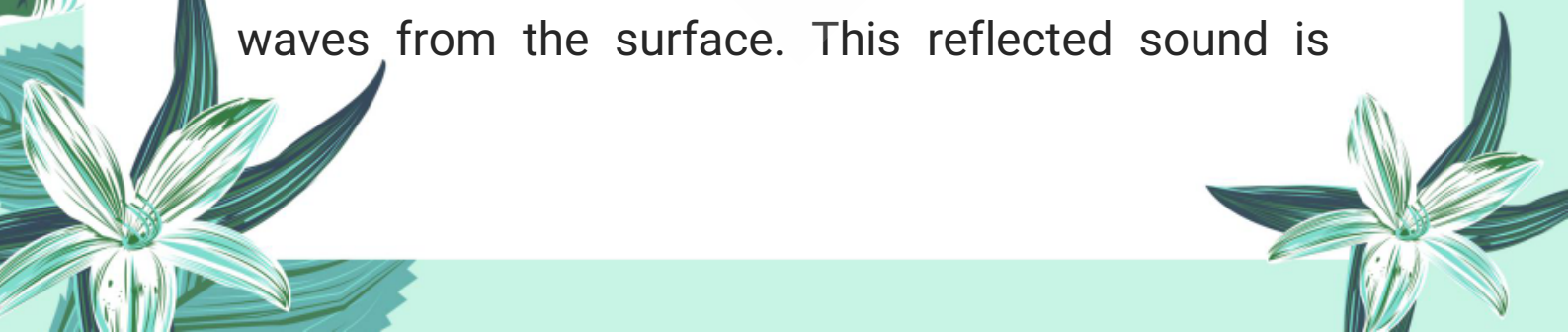
- Speed of sound in air ≈ 343 m/s (at room temperature).
- In 0.1 seconds, sound travels ≈ 34.3 meters.
- This means it travels 17 meters forward and 17 meters back.
- So, a minimum of 17 meters is needed for the echo to be heard.

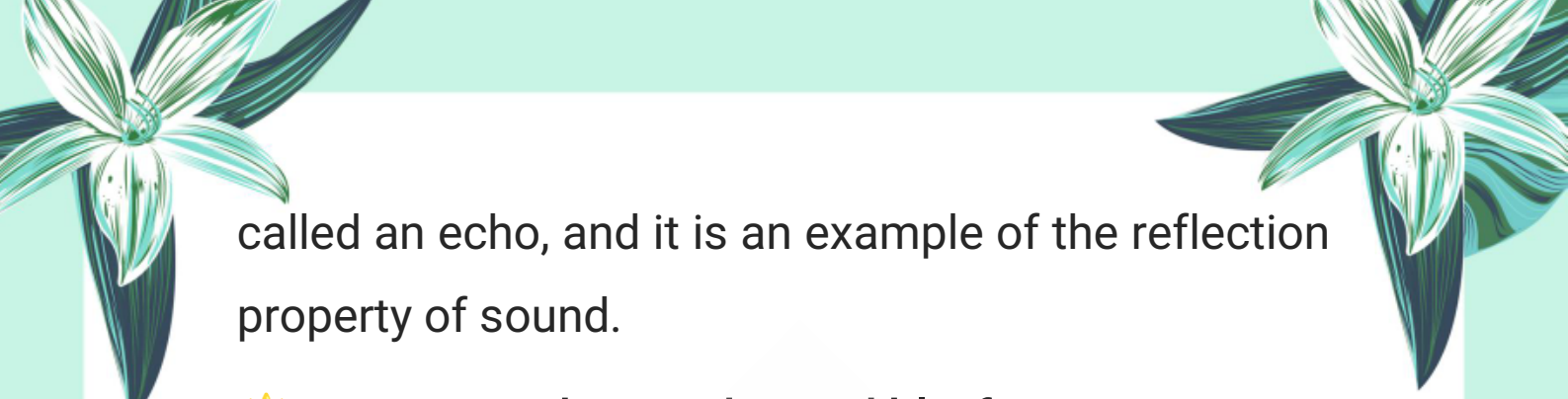
 **Real-life Example:**

Shouting near a valley, tall wall, or empty hallway often results in hearing your voice again – this is an echo.

 **Summary:**

We hear our sound again after clapping or speaking near a building because of the reflection of sound waves from the surface. This reflected sound is





called an echo, and it is an example of the reflection property of sound.

☀️ Q11.15: What is the audible frequency range for human ear? Does this range vary with the age of people? Explain.

❖ Answer:

The audible frequency range for the human ear is:

> 20 Hz to 20,000 Hz (20 kHz)

This means a normal human ear can hear sound waves whose frequencies lie between 20 vibrations per second (low pitch) and 20,000 vibrations per second (high pitch).

🔍 Explanation:

- Frequency is the number of vibrations or sound waves produced per second and is measured in Hertz (Hz).
- 20 Hz is the lowest frequency most humans can hear.
- 20,000 Hz (20 kHz) is the highest frequency that can be heard, mainly by young children and

teenagers.



Effect of Age on Audible Range:

- Yes, the audible range varies with age.
- As people grow older, their ability to hear high-frequency sounds decreases.
- This condition is called presbycusis, which is the age-related hearing loss.
- Older adults may only hear up to 15,000 Hz or even lower.

Additional Facts:

- **Below 20 Hz:** These are called infrasonic sounds. Humans can't hear them, but animals like elephants can detect them.
- **Above 20,000 Hz:** These are called ultrasonic sounds. Humans can't hear them, but animals like bats and dolphins can detect them.



Real-life Examples:

- Dog whistles use ultrasonic sounds that are heard by dogs but not by humans.

- Young children may hear high-pitched sounds from electronic devices that adults can't detect.

Summary:

The human ear can normally detect sounds between 20 Hz and 20,000 Hz, but this range shrinks with age, especially on the higher frequency side. Thus, age plays a significant role in altering our ability to hear the full range of sounds.

 Q11.16: Explain that noise is a nuisance.

 Answer:

Noise is defined as unpleasant, unwanted, or disturbing sound that causes discomfort to human ears. It is usually irregular, harsh, and loud, and has no musical quality.

Why is Noise a Nuisance?

Noise becomes a nuisance because it:

- Disturbs concentration in schools, offices, and homes
- Interrupts communication between people



- Causes physical and mental stress
- Interferes with sleep and relaxation
- May lead to permanent hearing damage if exposure is prolonged

Effects of Noise on Health:

Noise pollution is not just an annoyance — it has serious health impacts:

1. **Mental disturbance:** Constant exposure leads to irritation, anxiety, and stress.
2. **Sleep disturbance:** Even low-level noise during sleep can cause fatigue and reduce sleep quality.
3. **Hearing loss:** Long-term exposure to high-decibel sounds can damage ear drums.
4. **Heart problems:** Studies show high noise levels can lead to increased blood pressure and heart disease.

Examples of Noise Pollution:

-  Traffic sounds (horns, engines)
-  Factory machines



Loudspeakers and music at high volume

✈️ Airplanes flying overhead



Construction and drilling machines



Summary:

Noise is more than just a disturbance – it is a harmful form of pollution that affects our health, comfort, and environment. Therefore, controlling noise pollution is essential for peaceful and healthy living.



Q11.17: Describe the importance of acoustic protection.

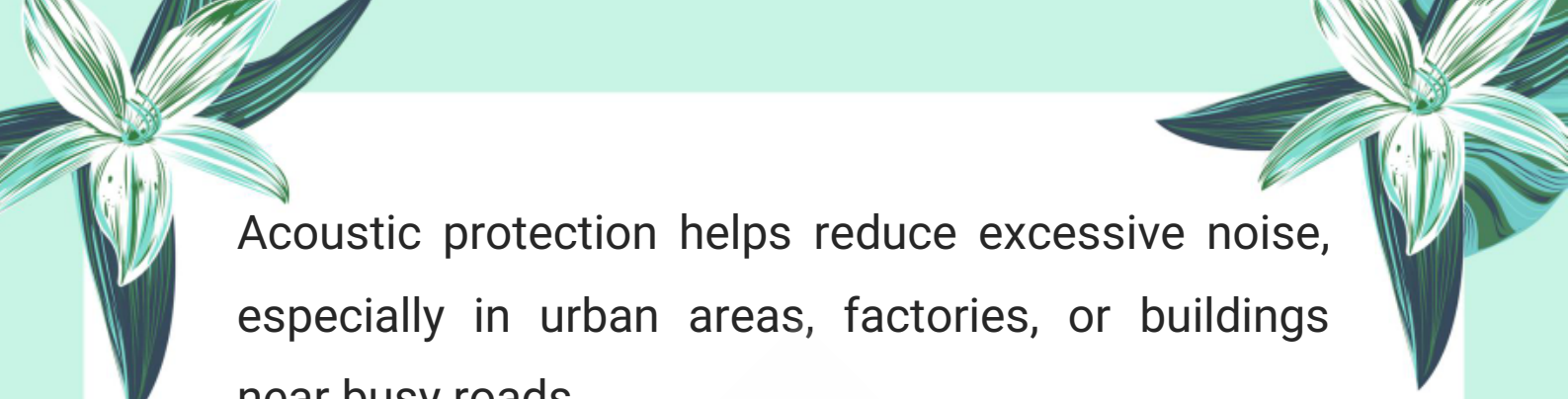
❖ **Answer:**

Acoustic protection refers to the methods used to reduce or absorb undesirable sounds in an environment. This is important to protect human hearing, ensure peaceful surroundings, and improve the acoustic quality of places like classrooms, auditoriums, and hospitals.




Importance of Acoustic Protection:

1. Reduces Noise Pollution



Acoustic protection helps reduce excessive noise, especially in urban areas, factories, or buildings near busy roads.

2. Protects Human Health



By limiting exposure to loud sounds, it helps prevent hearing loss, mental stress, and sleep disorders.

3. Improves Communication

It makes communication clearer and more effective, especially in schools, offices, and meeting halls.

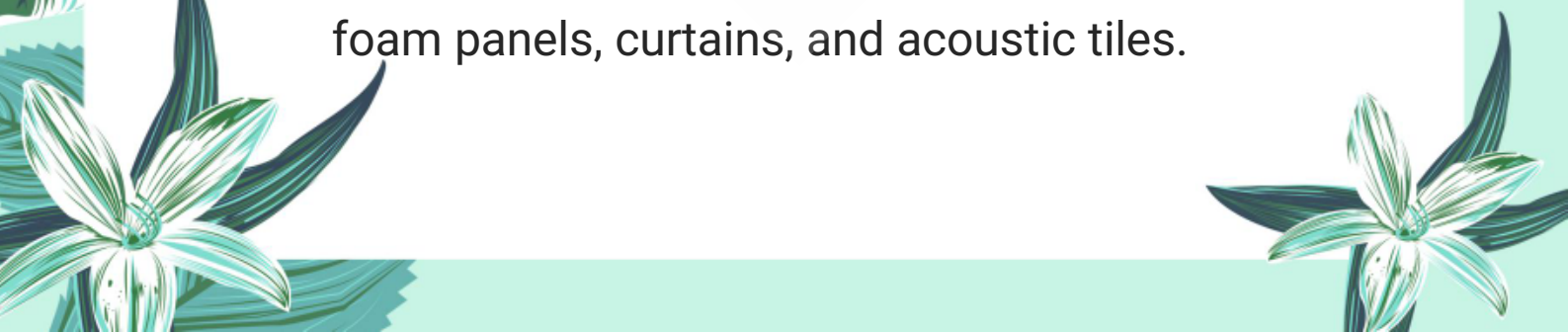
4. Enhances Productivity

Quiet and peaceful work environments lead to better focus and increased productivity.

5. Preserves Sound Quality

In places like recording studios, acoustic protection helps maintain high sound quality by preventing echoes and distortion.

◆ How is Acoustic Protection Done?

- Using soft and porous materials like carpets, foam panels, curtains, and acoustic tiles.
- 

- Installing sound-absorbing ceilings and walls.
- Designing buildings with soundproofing techniques.

Summary:

Acoustic protection is essential for creating safe, healthy, and peaceful environments, especially in noisy areas. It helps prevent the harmful effects of unwanted sound and supports a better quality of life.

☀️ Q11.18: What are the uses of ultrasound in medicine?

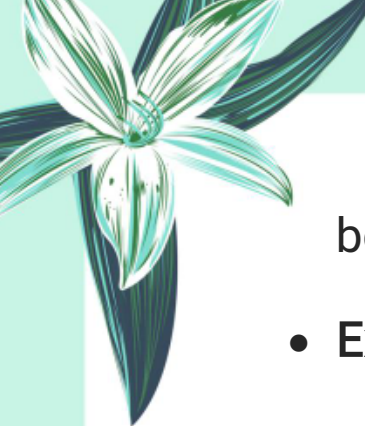
❖ Answer:

Ultrasound refers to sound waves with frequencies above 20,000 Hz, which are inaudible to the human ear. These waves can penetrate the human body and are widely used in medical diagnostics and treatments.

Major Uses of Ultrasound in Medicine:

1. Imaging (Ultrasonography)


- Ultrasound is used to create images of internal



body organs, tissues, and muscles. It helps:

- **Examine heart**, kidneys, liver, and other organs
- Detect gallstones, tumors, and blood clots

2. Pregnancy Monitoring

- 
- It is widely used to monitor the growth and health of a fetus in the womb. It shows:
 - Baby's position, heartbeat, and development
 - Detects any abnormalities at early stages

3. Guided Surgeries and Biopsies

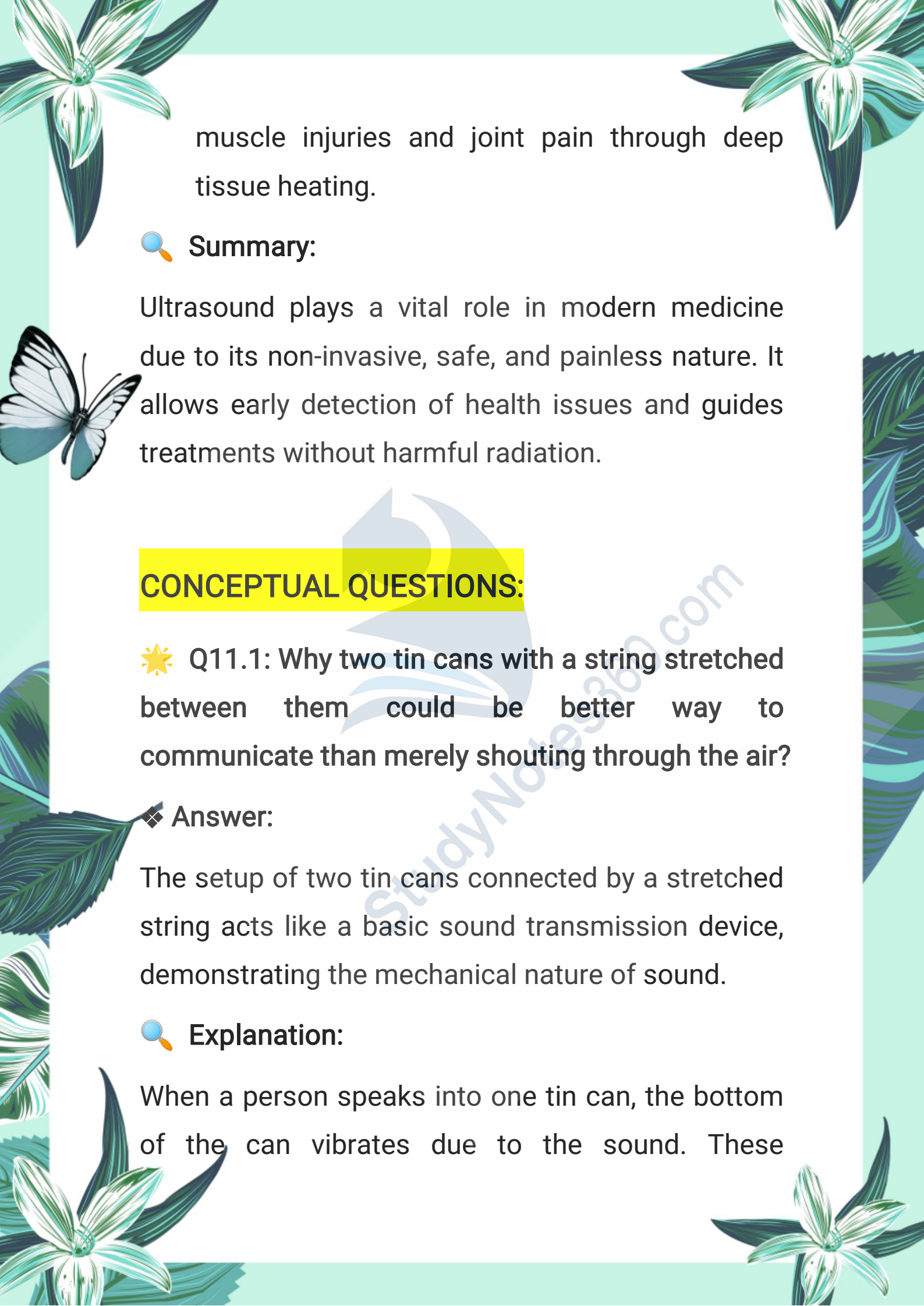
- Ultrasound helps doctors guide needles during biopsies or fluid removal, increasing accuracy and safety.

4. Breaking Kidney Stones

- High-intensity ultrasound waves are used to break kidney stones into smaller pieces that can be passed out with urine. This method is called lithotripsy.

5. Physical Therapy

- Low-intensity ultrasound is used to treat
- 




muscle injuries and joint pain through deep tissue heating.

 **Summary:**

Ultrasound plays a vital role in modern medicine due to its non-invasive, safe, and painless nature. It allows early detection of health issues and guides treatments without harmful radiation.

CONCEPTUAL QUESTIONS:

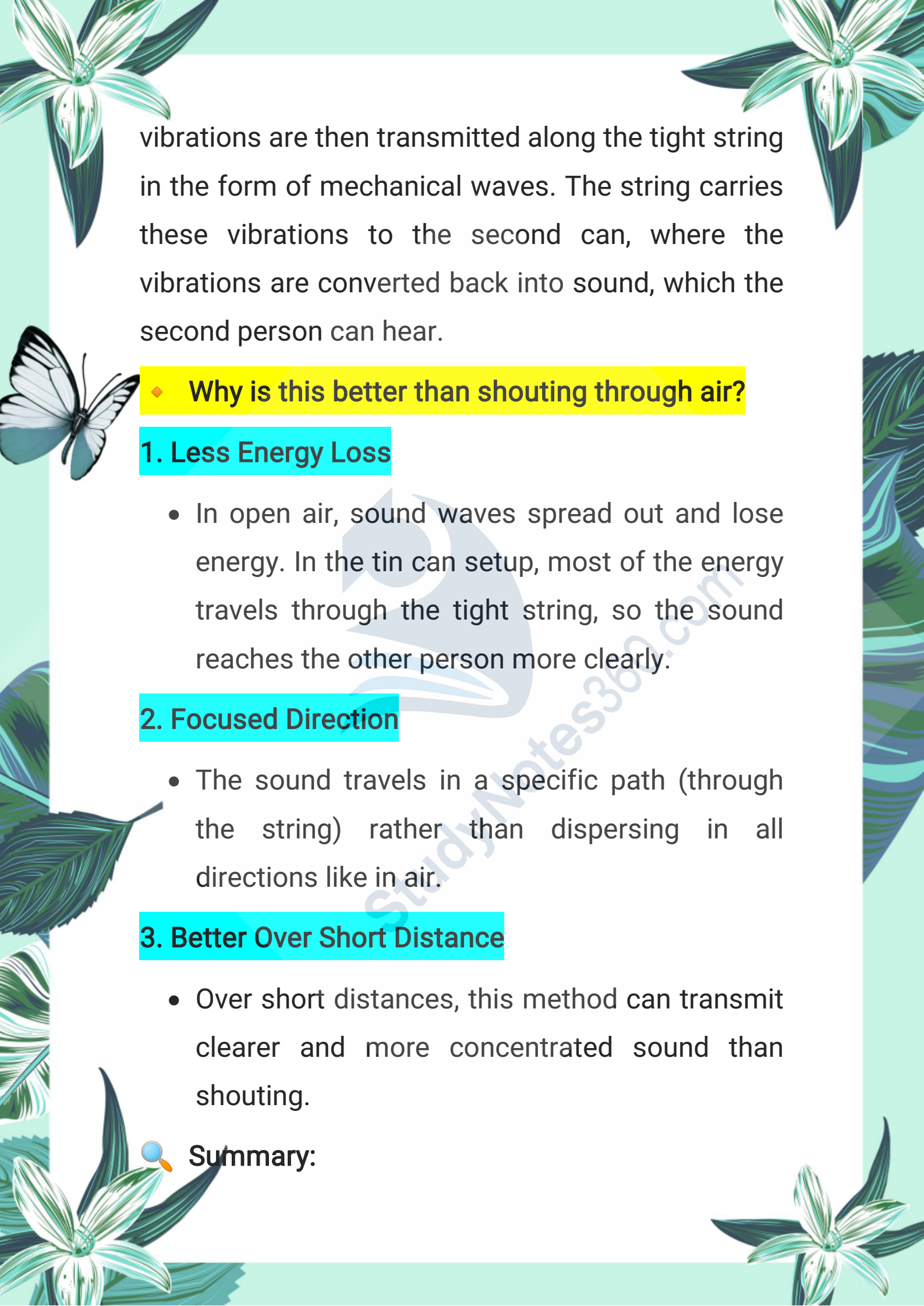
 Q11.1: Why two tin cans with a string stretched between them could be a better way to communicate than merely shouting through the air?

 **Answer:**

The setup of two tin cans connected by a stretched string acts like a basic sound transmission device, demonstrating the mechanical nature of sound.

 **Explanation:**

When a person speaks into one tin can, the bottom of the can vibrates due to the sound. These

The page is decorated with various illustrations: a large white flower with green leaves in the top left and bottom left corners, a white butterfly with black markings on its wings on the left side, and a large green leaf on the right side. The background is a light green color.

vibrations are then transmitted along the tight string in the form of mechanical waves. The string carries these vibrations to the second can, where the vibrations are converted back into sound, which the second person can hear.

◆ Why is this better than shouting through air?

1. Less Energy Loss

- In open air, sound waves spread out and lose energy. In the tin can setup, most of the energy travels through the tight string, so the sound reaches the other person more clearly.

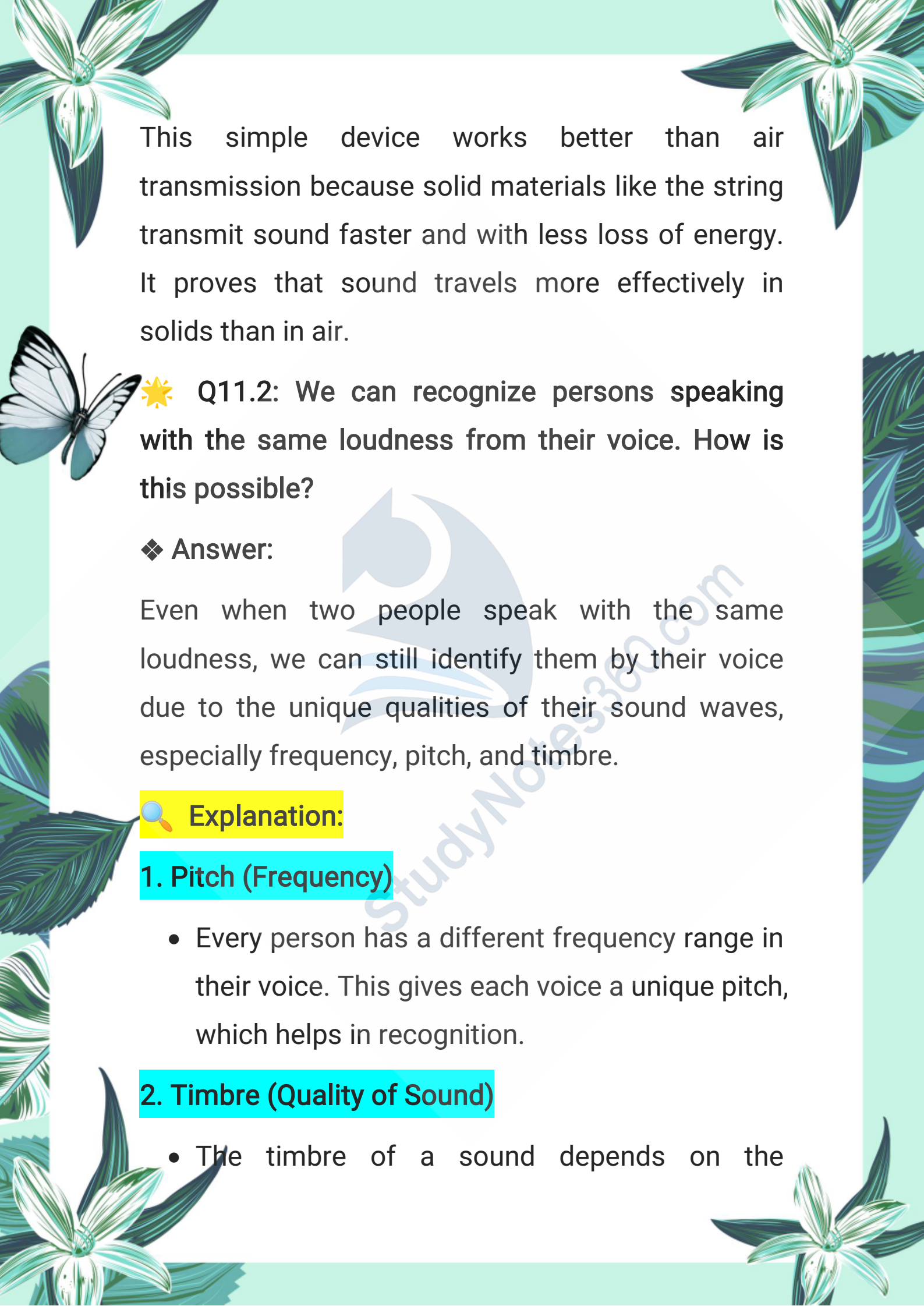
2. Focused Direction

- The sound travels in a specific path (through the string) rather than dispersing in all directions like in air.

3. Better Over Short Distance

- Over short distances, this method can transmit clearer and more concentrated sound than shouting.

 **Summary:**



This simple device works better than air transmission because solid materials like the string transmit sound faster and with less loss of energy. It proves that sound travels more effectively in solids than in air.

☀️ Q11.2: We can recognize persons speaking with the same loudness from their voice. How is this possible?

❖ Answer:

Even when two people speak with the same loudness, we can still identify them by their voice due to the unique qualities of their sound waves, especially frequency, pitch, and timbre.

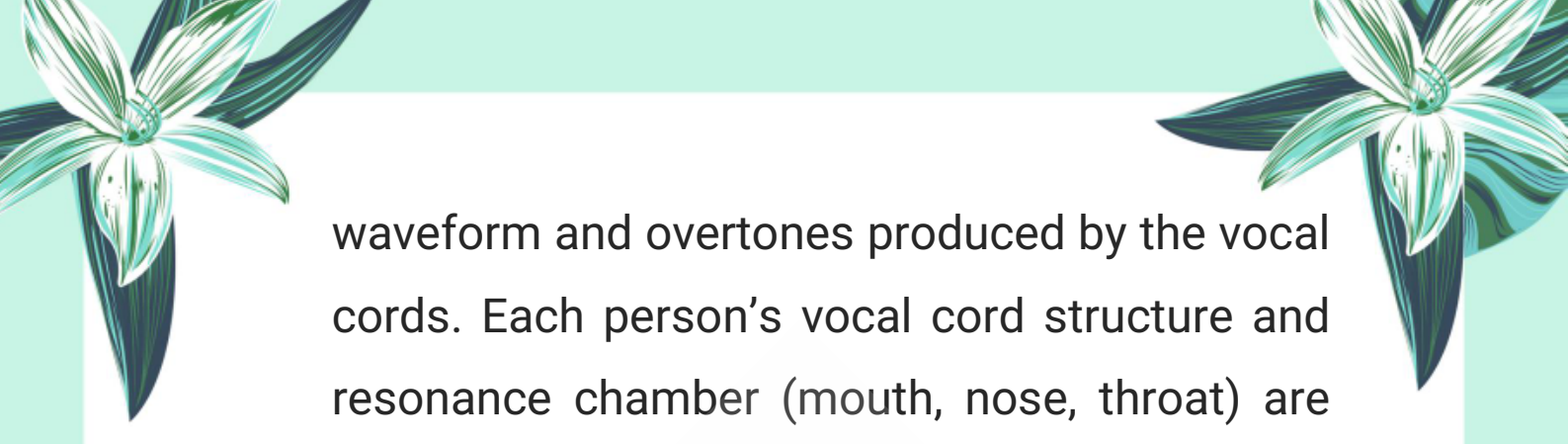
🔍 Explanation:

1. Pitch (Frequency)

- Every person has a different frequency range in their voice. This gives each voice a unique pitch, which helps in recognition.

2. Timbre (Quality of Sound)

- The timbre of a sound depends on the



waveform and overtones produced by the vocal cords. Each person's vocal cord structure and resonance chamber (mouth, nose, throat) are different, which results in distinctive voice qualities.



3. Voice Patterns

- People have unique ways of pronouncing words, intonation, and speed, which further helps in identifying them.



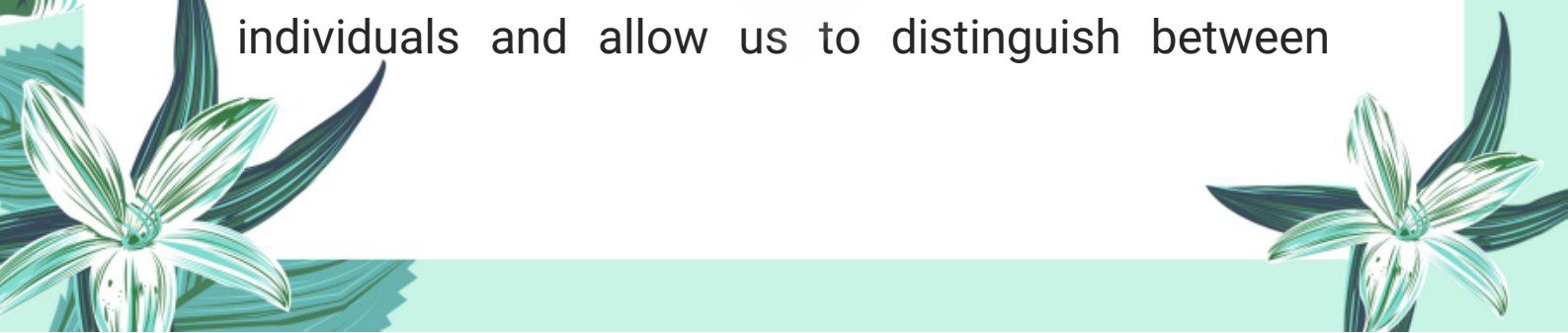
Example:

If two people shout at equal loudness, you can still tell who is speaking – because one may have a deeper voice, while the other has a sharper or more nasal tone. These differences lie in frequency and quality, not just volume.



Summary:

We recognize people not just by loudness, but mainly due to their unique voice frequencies, pitch, and timbre. These features are specific to individuals and allow us to distinguish between






voices, even if the volume is the same.

☀️ Q11.3: You can listen to your friend round a corner, but you cannot watch him/her. Why?

❖ Answer:



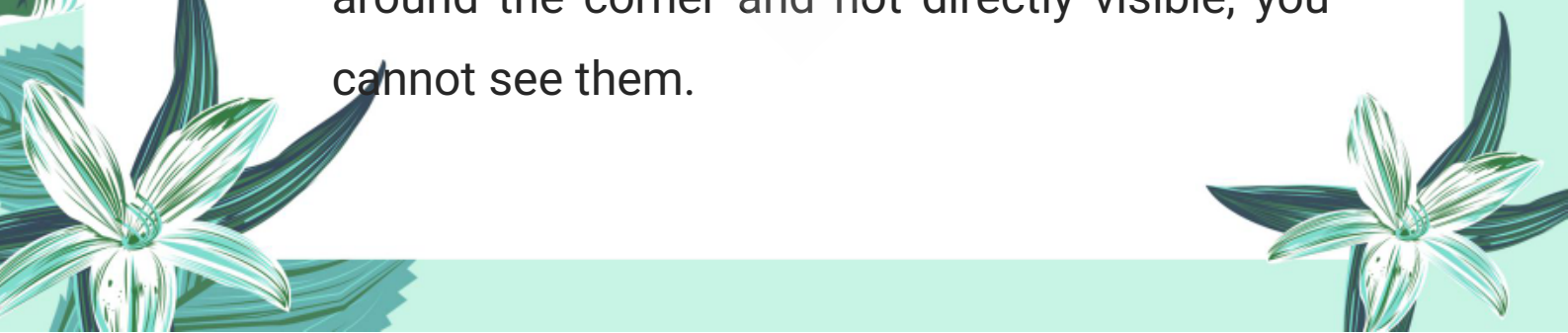
This happens due to the different nature of sound and light waves.

🔍 Explanation:

1. Sound waves are mechanical and can diffract


- Sound waves are longitudinal mechanical waves with larger wavelengths. They can bend around corners or obstacles – a phenomenon called diffraction. That's why you can hear your friend even if they are not in your line of sight.

2. Light waves are electromagnetic and travel in straight lines

- Light waves have a very small wavelength and do not diffract significantly. They travel in straight lines. That's why if your friend is around the corner and not directly visible, you cannot see them.
- 

 **Summary:**

You can hear your friend but not see them around a corner because sound waves can bend (diffract) around obstacles, while light waves cannot due to their straight-line path.

 **Q11.4: Why must the volume of a stereo in a room with wall-to-wall carpet be turned higher than in a room with a wooden floor?** **Answer:**

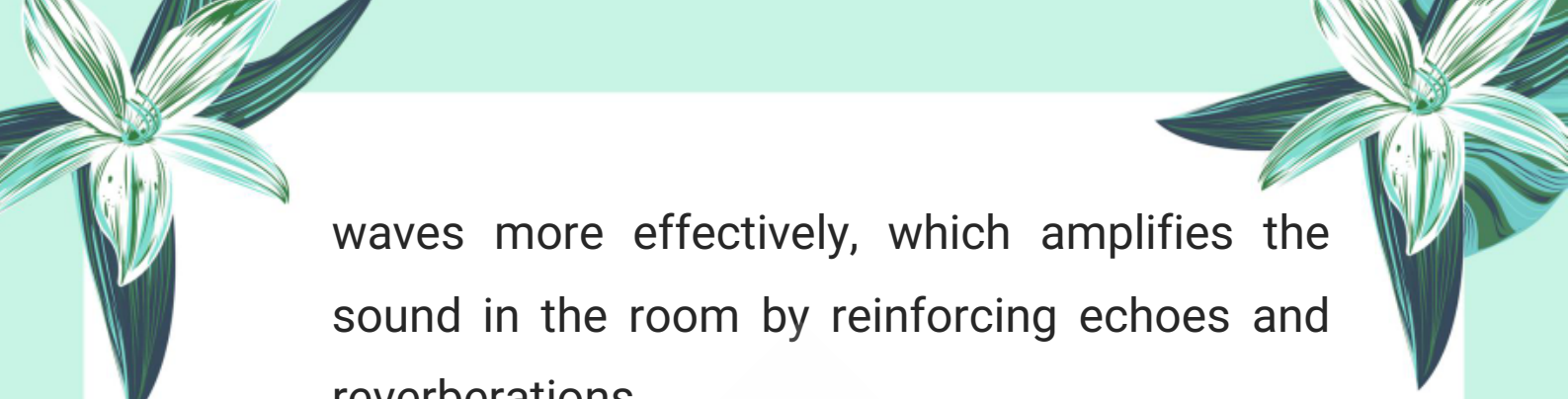
The volume of a stereo needs to be increased in a carpeted room because sound absorption is higher in such environments.

 **Explanation:****1. Carpets absorb sound**

- Soft materials like carpets, curtains, and sofas absorb sound energy, especially the high-frequency components, reducing the overall sound level in the room.

2. Wooden floors reflect sound

- Hard surfaces like wooden floors reflect sound



waves more effectively, which amplifies the sound in the room by reinforcing echoes and reverberations.


3. More absorption = Less loudness

- In a carpeted room, since more sound is absorbed, less of it reaches your ears, making the stereo sound quieter. Hence, the volume must be turned higher to achieve the same level of sound as in a wooden-floored room.



Summary:

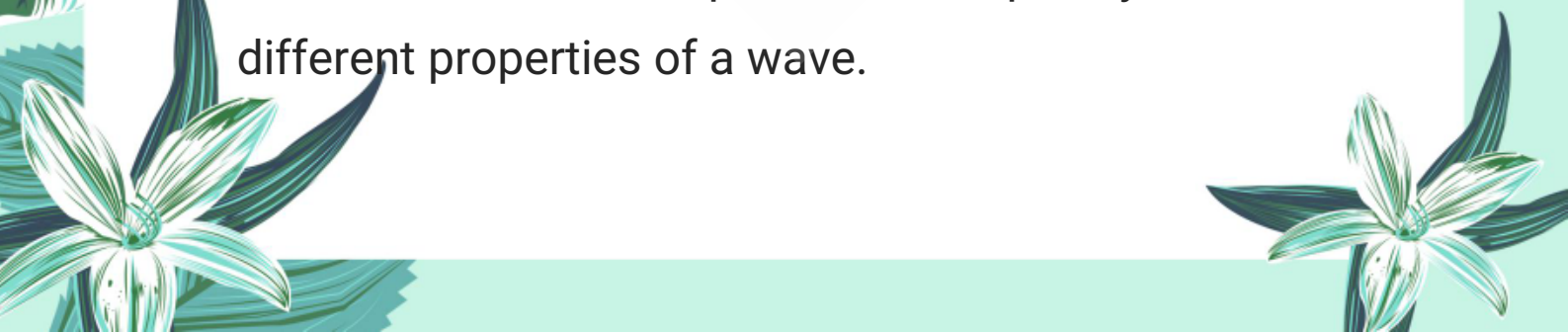
Due to greater sound absorption in a carpeted room, the stereo's volume must be increased to compensate for the loss of sound energy, unlike in a room with reflective surfaces like wood.



Q11.5: A student says that the two terms speed and frequency of the wave refer to the same thing. What is your response?

◆ Answer:

This is not correct. Speed and frequency are two different properties of a wave.



 **Explanation:****1. Speed of a wave**

- The speed of a wave is the rate at which the wave propagates through a medium. It depends on the type of medium (solid, liquid, or gas) and is measured in meters per second (m/s).

2. Frequency of a wave

- The frequency of a wave is the number of wave cycles that pass a point in one second. It is measured in Hertz (Hz) and depends on the source of the wave, not the medium.


3. Different but related

- Although speed and frequency are different, they are mathematically related through the formula:

$$\text{Speed (v)} = \text{Frequency (f)} \times \text{Wavelength (\lambda)}$$

 **Summary:**

Speed and frequency are not the same. Speed depends on the medium, while frequency depends on the source of sound. They are related, but not interchangeable.

 **Q11.6:** Two people are listening to the same music at the same distance. They disagree on its loudness. Explain how this could happen. **Answer:**

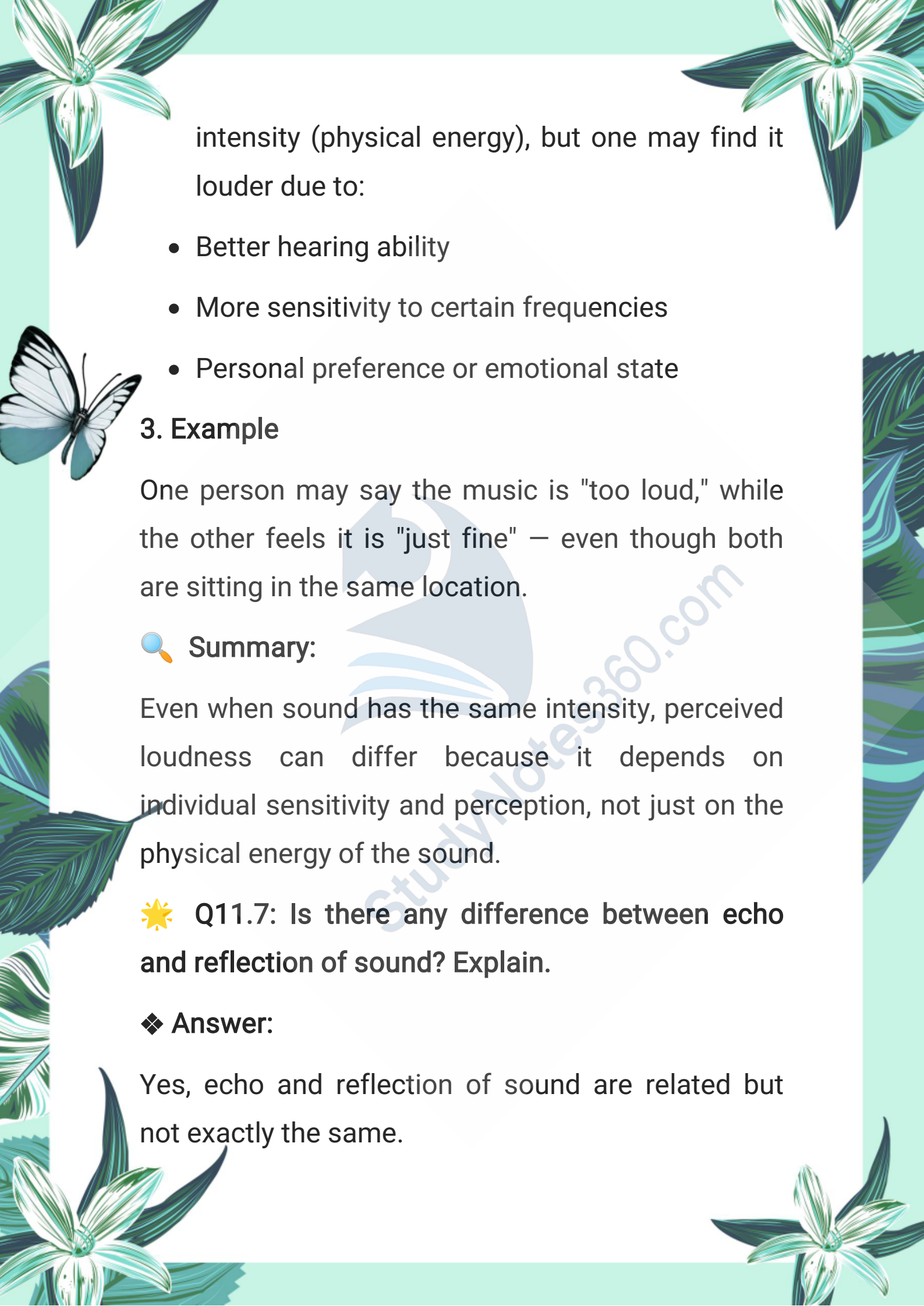
This difference in perception occurs because loudness is a subjective quantity, while intensity is objective.

 **Explanation:****1. Loudness is subjective**

- Loudness is how humans perceive the intensity of sound. It can vary from person to person based on hearing sensitivity, age, or health of ears.

2. Same intensity, different perception

- Both people may be receiving the same sound



intensity (physical energy), but one may find it louder due to:

- Better hearing ability
- More sensitivity to certain frequencies
- Personal preference or emotional state

3. Example

One person may say the music is "too loud," while the other feels it is "just fine" – even though both are sitting in the same location.

Summary:

Even when sound has the same intensity, perceived loudness can differ because it depends on individual sensitivity and perception, not just on the physical energy of the sound.

☀️ Q11.7: Is there any difference between echo and reflection of sound? Explain.

❖ Answer:

Yes, echo and reflection of sound are related but not exactly the same.



Explanation:

1. Reflection of Sound

- It is the bouncing back of sound waves when they strike a hard surface.
- This phenomenon is just like how light reflects from a mirror.
- It always occurs when sound hits a barrier.
- It may not always be audible.

2. Echo

- Echo is the audible result of the reflection of sound.
- We hear the same sound again after a short delay.
- For a clear echo to be heard, the reflected sound must reach the ear after 0.1 seconds or more.
- This needs a minimum distance of 17 meters between the source and reflecting surface.



Summary:

- All echoes are reflections, but not all reflections produce echoes.
- Echo is a special case of sound reflection that is audible due to time delay and distance.

☀️ Q11.8: Will two separate 50 dB sounds together constitute a 100 dB sound? Explain.

❖ Answer:

No, combining two 50 dB sounds does not result in 100 dB.

🔍 Explanation:

1. Sound intensity level (dB)

- Sound is measured in decibels (dB), which is a logarithmic scale, not a simple linear scale.
- This means we cannot simply add the numbers directly.

2. What happens when two sounds are combined?

- Two sounds of equal intensity (like 50 dB + 50 dB) will increase the total loudness by only 3 dB.

- So, $50 \text{ dB} + 50 \text{ dB} = 53 \text{ dB}$, not 100 dB .

3. Why?

- Because decibels measure the logarithm of the ratio of sound intensities.
- It takes 10 times more intensity to increase the level by 10 dB .

Summary:

Two 50 dB sounds do not make a 100 dB sound. They make only 53 dB combined due to the logarithmic nature of the decibel scale.


☀️ Q11.9: Why is ultrasound useful in the medical field?

❖ Answer:

Ultrasound is useful in the medical field because it allows safe, non-invasive, and detailed imaging of internal organs, tissues, and fetal development without the harmful effects of X-rays.

Explanation:

1. What is Ultrasound?

- 
- The page is decorated with various illustrations: a large white flower with green leaves in the top left and bottom left corners; a white butterfly with black markings on its wings on the left side; and a large green leaf on the right side. The background is a light green color.
- Ultrasound refers to sound waves with frequencies above 20,000 Hz, which are inaudible to the human ear.
 - These waves have high energy and short wavelengths, making them suitable for penetrating body tissues.

Medical Uses of Ultrasound:

1. Imaging of Internal Organs

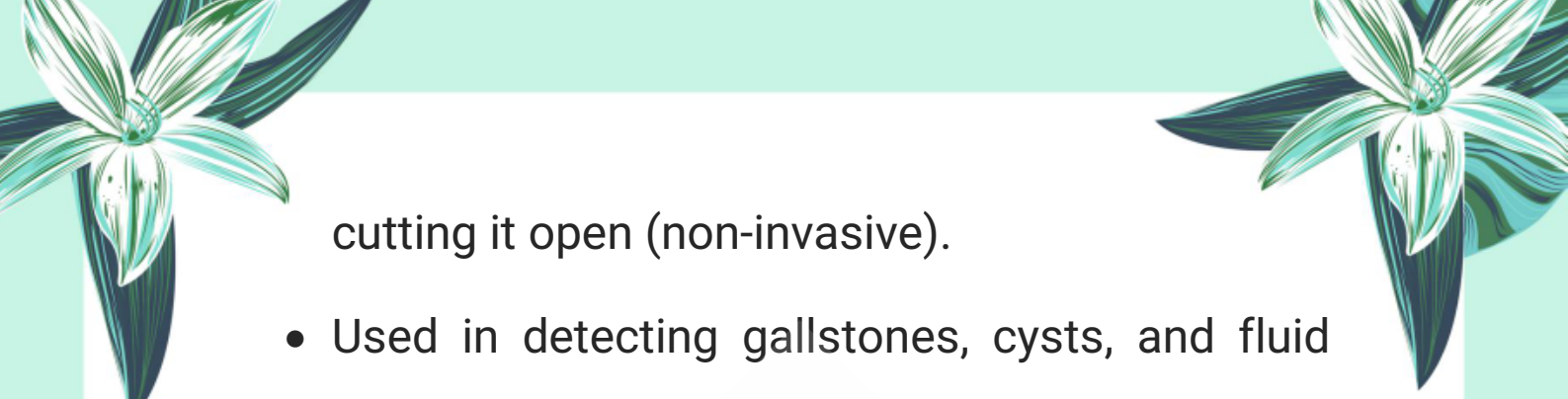
- It is widely used to observe heart, liver, kidneys, and other organs.
- Detects abnormalities like tumors, stones, or infections.

2. Prenatal (Fetal) Monitoring

- Used to monitor the growth and position of a baby in the womb.
- Detects birth defects, confirms heartbeat, and determines the due date.

3. Diagnosis without Surgery


- Helps doctors to see inside the body without



cutting it open (non-invasive).

- Used in detecting gallstones, cysts, and fluid build-up.

4. Therapeutic Applications

- 
- Ultrasound is also used in physiotherapy to relieve muscle pain.
 - It breaks up kidney or gallbladder stones (lithotripsy).

- ◆ **Why is it Preferred?**

- ✗ No harmful radiation (unlike X-rays)

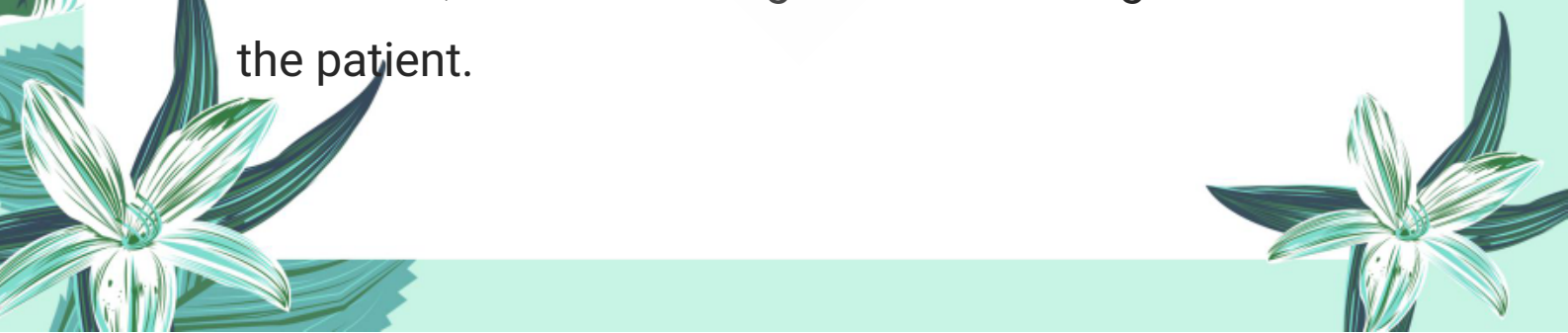
- ✓ Safe for pregnant women

- ✓ Real-time imaging

- ✓ Portable and quick

- 🔍 **Summary:**

Ultrasound is a valuable tool in modern medicine due to its safety, accuracy, and ability to visualize internal body parts. It is essential in diagnosis, treatment, and monitoring without causing harm to the patient.





Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

Author: Muhammad Asghar

Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.

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