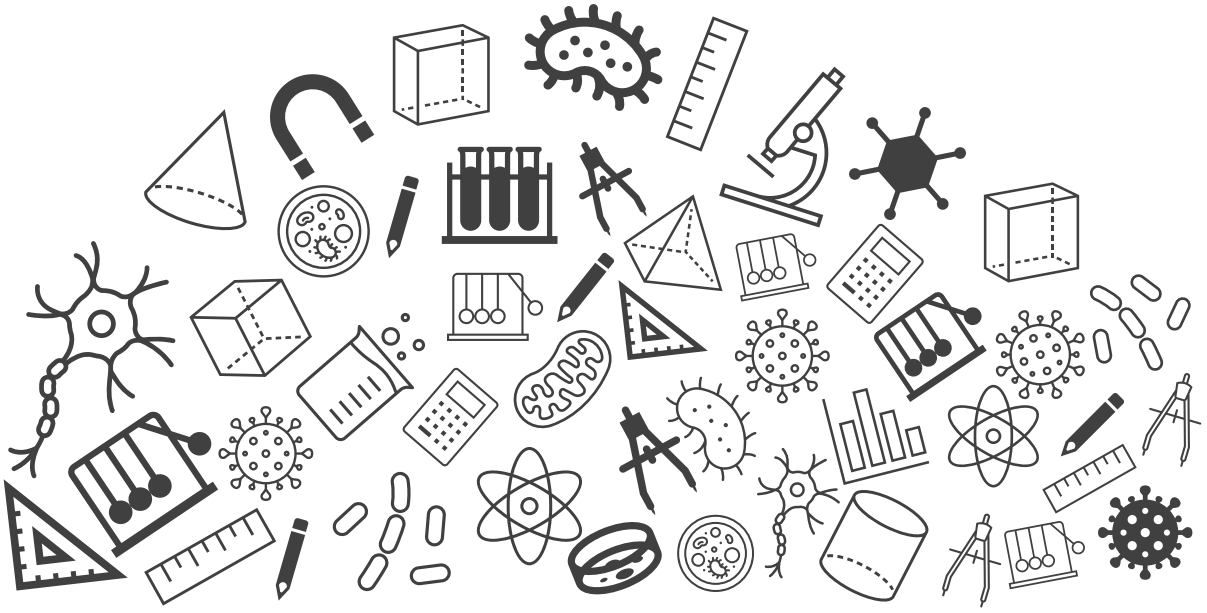
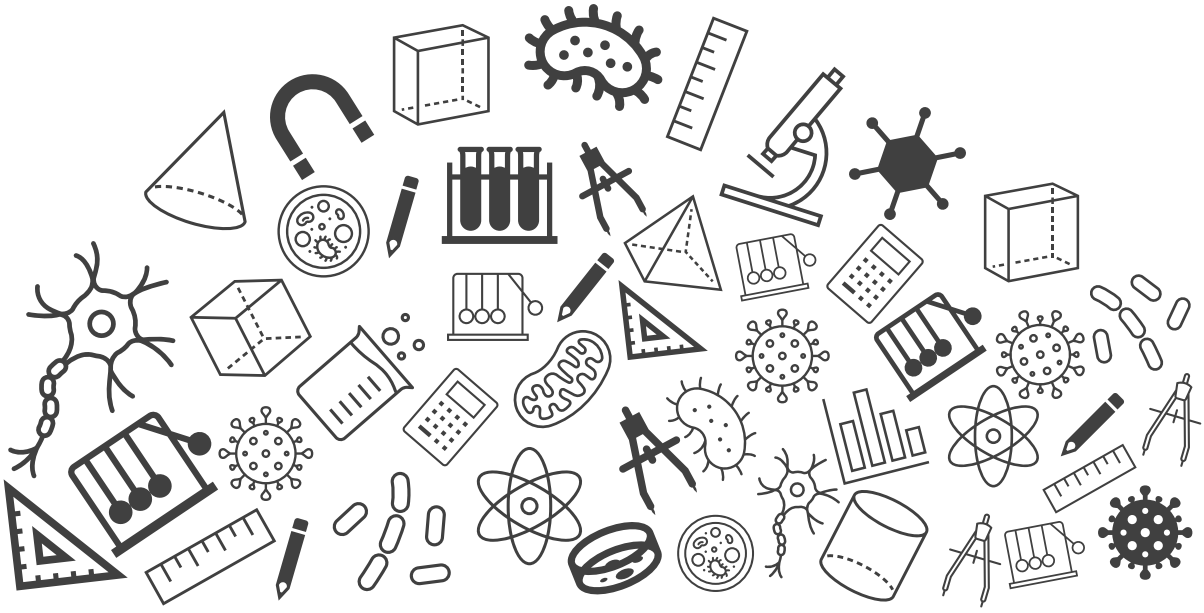
Grade 09
Science Chapter Notes



Sound



1. Cite an experiment to show that sound needs a material medium for its propagation.

   [2 marks]

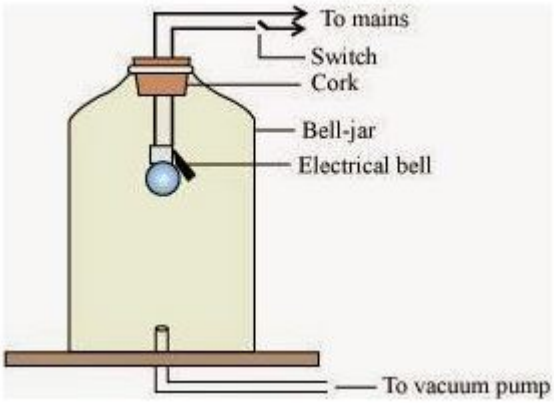
   [NCERT]

   [Bell Jar]

Solution:

Bell-jar Experiment:

Take an electric bell and an air-tight glass bell jar connected to a vacuum pump. Suspend the bell inside the jar, and press the switch of the bell. You will be able to hear the bell ring. Now pump out the air from the glass jar. The sound of the bell will become fainter and after some time, the sound will not be heard. This is so because almost all air has been pumped out.This shows that sound needs a material medium to travel.



[2 marks]

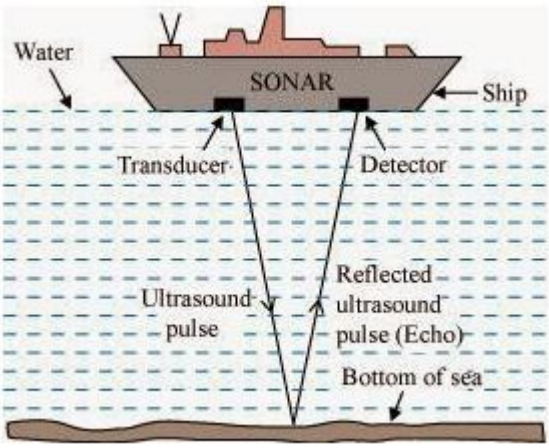
2. Explain the working and application of a sonar.

[2 marks]

[NCERT]

[Sonar]

Solution:
SONAR is an acronym for Sound Navigation And Ranging. It is an acoustic device used to measure the depth, direction, and speed of under-water objects such as submarines and ship wrecks with the help of ultrasounds. It is also used to measure the depth of seas and oceans.



A beam of ultrasonic sound is produced and transmitted by the transducer (it is a device that produces ultrasonic sound) of the SONAR, which travels through sea water. The echo produced by the reflection of this ultrasonic sound is detected and recorded by the detector, which is converted into electrical signals. The distance (d) of the under-water object is calculated from the time (t) taken by the echo to return with speed (v) is given by $2d = v \times t$. This method of measuring distance is also known as `echo-ranging'.

[2 marks]

3. A person has a hearing range from 20 Hz to 20 kHz. What are the typical wavelengths of sound waves in air corresponding to these two frequencies? Take the speed of sound in air as $344 ms^{-1}$.

[3 marks]

[NCERT]

[Speed of Sound]

Solution:

For a sound wave,

Speed = Wavelength $\times$ Frequency

$V = \lambda \times f$

Speed of sound in air = 344 m/s (Given)

[1 mark]

(i) For, f = 20 Hz

$\lambda_1 = \frac{V}{f} = \frac{344}{20} = 17.2m$

[1 mark]

(ii) For, f = 20000 Hz

$\lambda_2 = \frac{V}{f} = \frac{344}{20000} = 0.0172m$

Hence, for humans, the wavelength range for hearing is 0.0172 m to 17.2 m.

[1 mark]

4. Two children are at opposite ends of an aluminium rod. One strikes the end of the rod with a stone. Find the ratio of times taken by the sound wave in air and in aluminium to reach the second child.

[3 marks]

[NCERT]

[Speed of Sound]

Solution:

Velocity of sound in air = 346 m/s

Velocity of sound wave in aluminum = 6420 m/s

Let length of rode be 1m.

Time taken for sound wave in air, $t_1 = \frac{1}{Velocity\ in\ air}$

[1 mark]

Time taken for sound wave in aluminum, $t_2 = \frac{1}{Velocity\ in\ aluminum}$

[1 mark]

Therefore, $\frac{t_1}{t_2} = \frac{velocity\ in\ aluminium}{velocity\ in\ air} = \frac{6420}{346} = 18.55 : 1$

[1 mark]

5. A stone is dropped from the top of a tower 500 m high into a pond of water at the base of the tower. When is the splash heard at the top? Given, $g = 10ms^{-2}$ and speed of sound = $340ms^{-1}$.

   [5 marks]

   [NCERT]

   [Reflection of Sound]

   Solution:
   Height of the tower, s = 500 m
   Velocity of sound, $v = 340ms^{-1}$
   Acceleration due to gravity, $g = 10ms^{-2}$
   Initial velocity of the stone, u = 0 (since the stone is initially at rest)

   [1 marks]

   Time taken by the stone to fall to the base of the tower is t_1.
   According to the second equation of motion:
   $S = ut_1 + \frac{1}{2}gt_1^2$
   $500 = 0 \times t_1 + \frac{1}{2} \times 10 \times t_1^2$
   $t_1^2 = 100$
   $t_1 = 10s$

   [2 marks]

   Now, time taken by the sound to reach the top from the base of the tower,
   $t_2 = \frac{500}{340} = 1.47s$
   Therefore, the splash is heard at the top after time, t.
   Where, $t = t_1 + t_2 = 10 + 1.47 = 11.47s$.

   [2 marks]

6. Define longitudinal and transverse waves.

   [2 Mark]

   [Types of Waves]

   Solution:
   The waves in which the particles vibrate perpendicular to the wave porpagation are known as transverse waves. [1 Mark]
   The waves in which the particles vibrate parallel to the wave propagation are known as longitudinal waves. [1 Mark]

7. List down the properties of sound as a wave?

[3 Mark]

[Properties of Sound]

Solution:
1. Sound needs a material medium for its propagation. [0.5 Mark]
2. Sound travels faster in solids, then in liquids and slower in gases. [0.5 Mark]
3. Sound waves are mechanical waves. [0.5 Mark]
4. Sound is produced by vibrating objects. [0.5 Mark]
5. They are characterised by intensity, pitch and quality or timbre. [0.5 Mark]
6. Sound like other waves can also be reflected. [0.5 Mark]

8. Define Amplitude and loudness of a sound wave.

[2 Mark]

[Characteristics of Sound]

Solution:
Amplitude - The maximum displacement of the particles of medium above or below the mean- position line is called as the amplitude of a wave. SI unit to measure the amplitude is meter (m). [1 Mark]
Loudness - The amount of sound energy reaching a listener's ear per second is called as the loudness of the sound. Loudness of a sound depends upon amplitude of the sound wave such that high loudness is associated with high amplitude. [1 Mark]

9. List down the examples of transverse wave and longitudinal wave.

[3 Mark]

[Types of Wvaes]

Solution:

Examples:
Longitudinal wave
- Sound waves
- Pressure waves
- Seismic P-waves (generated by explosion and earthquake) [1.5 Mark]

Transverse wave

- Light waves
- An oscillating string
- Seismic S-waves [1.5 Mark]

10. Establish the relationship between speed of sound, its wavelength and frequency. If velocity of sound in air is $340ms^{-1}$, Calculate

(i) wavelength when frequency is 256 Hz.
(ii) frequency when wavelength is 0.85 m.
[2 Marks]
[Speed of sound]

Solution:
The relationship between the speed of sound, its wavelength and frequency is given by the formula,

$V = v\lambda$

where V = speed of sound
v = frequency
λ = wavelength

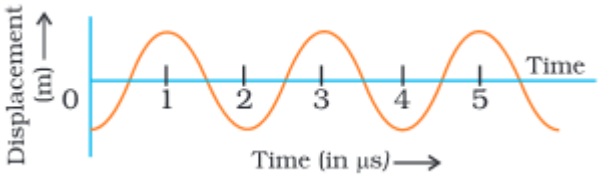
(i) Given, v = 256 Hz
$340 = 256\ \lambda$. [1 Mark]
$\lambda = 1.33\ m$

(ii) Given, $\lambda = 0.85\ m$
$340 = v(0.85)$ [1 Mark]
$v = 400\ Hz$

11. Sound produced by a thunderstorm is heard 10 s after the lightning is seen. Calculate the approximate distance of the thunder cloud. (Given speed of sound = $340\ ms^{-1}$)
[2 Mark]
[Reflection of Sound]

Solution:
Given, time taken by the sound after lightening = 10 seconds
Speed of the sound $= 340\ ms^{-1}$.
Let s be the distance travelled.
We know, $speed = \frac{distance}{time}$
$\therefore distance = speed \times time$ [1 Mark]
$\Rightarrow Distance, s = 340 \times 10 = 3400\ m$ or $3.4\ km$ [1 Mark]

12. The given graph shows the displacement versus time relation for a disturbance travelling with velocity of $1500\ ms^{-1}$. Calculate the wavelength of the disturbance.
[2 Mark]
[Characteristics of sound]



Solution:
Given, V = $1500\ ms^{-1}$

From the graph
Time period, $T = 2 \times 10^{-6} s$

Frequency, $v = \frac{1}{T} = \frac{1}{2 \times 10^{-6}} Hz$ [1 Mark]
Wavelength, $\lambda = \frac{V}{v} = V \times T$
$\lambda = 1500 \times 2 \times 10^{-6}$
$\lambda = 3 \times 10^{-3}\ m$ [1 Mark]

13. How can reverberations in a big hall or auditorium be reduced?
[1 Mark]
[Reflection of sound]

Solution:
Reverberation can be reduced by covering the walls and ceiling with sound absorbent materials like curtains and false ceilings. [1 Mark]

14. A bat emits ultrasonic sound of frequency 1000 kHz in air. If the sound meets a water surface, what is the wavelength of (a) the reflected sound, (b) the transmitted sound? Speed of sound in air is $340ms^{-1}$ and in water $1486ms^{-1}$.
[3 Mark]
[Reflection of sound]

Solution:

Frequency of the ultrasonic sound, $\nu = 1000kHz = 10^6Hz$
Speed of sound in air, $v_a = 340m/s$
The wavelength (λ_r) of the reflected sound is given by the relation:
$\lambda_r = \frac{v}{v}$ [1 Mark]
$= \frac{340}{10^6} = 3.4 \times 10^{-4}m$
Frequency of the ultrasonic sound, $\nu = 1000kHz = 10^6Hz$
Speed of sound in water, v_w = 1486 m/s
The wavelength of the transmitted sound is given as:
$\lambda_r = \frac{1486}{10^6} = 1.49 \times 10^{-3}m$ [2 Mark]

15. What is meant by an echo ? State two conditions necessary for an echo to be heard distinctly.
[3 marks]

Solution:

Reflection of sound is known as echo. [1 mark]
The two conditions for echo to be heard are:

1. The minimum distance between source and reflecting surface should be 17.2 m. [1 Mark]

2. To hear a distinct echo, the interval between original and reflected sound must be 0.1 second. [1 Mark]