

NCERT-Analog-11.15-6

EE22BTECH11004 - Allu lohith

- 1) A bat emits ultrasonic sound of frequency 1000kHz 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 is 1486ms^{-1} .

| Parameter | Description | Value | Formulae |
|-------------|-----------------------------------|----------------------|------------------|
| f | Frequency of sound | 1000kHz | |
| v_a | Speed of sound in air | 340ms^{-1} | |
| v_w | Speed of sound in water | 1486ms^{-1} | |
| λ_a | Wavelength of sound wave in air | - | v_a/f |
| λ_w | Wavelength of sound wave in water | - | v_w/f |
| K_a | Wavenumber of sound wave in air | - | $\lambda_a/2\pi$ |
| K_w | Wavenumber of sound wave in water | - | $\lambda_w/2\pi$ |

TABLE 1
Parameters

Soln: The frequency of sound does not change with medium. And,

$$\lambda \cdot f = v \quad (1)$$

So,

$$\lambda_w = v_w/f \quad (2)$$

$$\lambda_w = 1486/1000\text{kHz} \quad (3)$$

$$\lambda_w = 1.486\text{mm} \quad (4)$$

$$\lambda_a = v_a/f \quad (5)$$

$$\lambda_a = 340/1000\text{kHz} \quad (6)$$

$$\lambda_a = 0.34\text{mm} \quad (7)$$

The general equation of a sound wave is

$$y(t) = A \sin(2\pi ft - kx) \quad (8)$$

| Parameter | Description |
|-----------|--|
| f | Frequency of sound |
| A | Amplitude of the wave |
| t | Time |
| x | Position |
| y(t) | Position of particle as a function of time |

$$K_a = \left(\frac{0.34 \times 10^{-3}}{2 \times 3.14} \right) \quad (9)$$

$$K_a = 54 \times 10^{-6} \text{m}^{-1} \quad (10)$$

$$K_w = \left(\frac{1.486 \times 10^{-3}}{2 \times 3.14} \right) \quad (11)$$

$$K_w = 236 \times 10^{-6} \text{m}^{-1} \quad (12)$$

$$y(t)_{\text{Air}} = A \sin(6.28 \times 10^6 t - 54 \times 10^{-6} x) \quad (13)$$

$$y(t)_{\text{Water}} = A \sin(6.28 \times 10^6 t - 236 \times 10^{-6} x) \quad (14)$$

| Parameter | Description | Formula | value |
|-------------|------------------------------------|------------------|----------------------------|
| λ_a | Wave length of the reflected sound | v_a/f | $0.34mm$ |
| λ_w | Wave length of the reflected sound | v_w/f | $1.486mm$ |
| K_w | Wavenumber of sound wave in air | $\lambda_a/2\pi$ | $54 \times 10^{-6}m^{-1}$ |
| K_a | Wavenumber of sound wave in water | $\lambda_w/2\pi$ | $236 \times 10^{-6}m^{-1}$ |

TABLE 1
Results

| Parameter | Description | Formula | Variables | Variables Description |
|-----------|----------------|--------------------------------------|-----------|-----------------------|
| V | Speed of sound | $\sqrt{\frac{\gamma \cdot P}{\rho}}$ | γ | adiabatic index |
| | | | V | Speed of sound |
| | | | P | Pressure of Medium |
| | | | ρ | Density of medium |

TABLE 1
GENERAL EQUATION OF SPEED OF SOUND

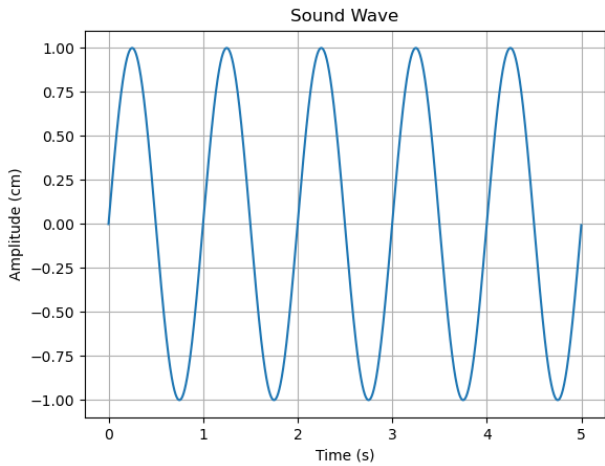


Fig. 1. A Sound wave