

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} .

Soln: As we know that the frequency of sound does not change with medium, So the frequency in water is equal to in air.

As,

$$\text{wavelength } (\lambda) \cdot \text{frequency } (f) = \text{speed } (v) \quad (1)$$

Parameter	Description	Value	Formulae
v	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 in air		v_a/f
λ_w	Wavelength of sound in water		v_w/f

TABLE 1
Parameters

So,

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

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

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

And similarly,

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

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

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

The general equation of a sound wave is

$$S = S_m \sin(\omega t - kx) \quad (8)$$

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

TABLE 1
Results

where

$$\omega = 2\pi f \quad (9)$$

$$\text{Maximum displacement} = S_m \quad (10)$$

$$k = \frac{\lambda}{2\pi} \quad (11)$$

So angular frequency = $2\pi f$

$$\omega = 2 \cdot \pi f \quad (12)$$

$$\omega = 2 \cdot 3.14 \cdot 10^6 \quad (13)$$

$$\omega = 6.28 \cdot 10^6 \quad (14)$$

The value of wave number in air (K_a) = $\frac{\lambda_a}{2\pi}$

$$K_a = \left(\frac{0.34 \times 10^{-3}}{2 \times 3.14} \right) \quad (15)$$

$$K_a = 54 \times 10^{-6} \text{m}^{-1} \quad (16)$$

The value of wave number in water (K_w) = $\frac{\lambda_w}{2\pi}$

$$K_w = \left(\frac{1.486 \times 10^{-3}}{2 \times 3.14} \right) \quad (17)$$

$$K_w = 236 \times 10^{-6} \text{m}^{-1} \quad (18)$$

Equation of sound wave in air is

$$S = S_m \sin(6.28 \times 10^6 t - 54 \times 10^{-6} x) \quad (19)$$

Equation of sound wave in water is

$$S = S_w \sin(6.28 \times 10^6 t - 236 \times 10^{-6} x) \quad (20)$$