ASSIGNMENT 1 WAVES

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Question 27:

A bat is flitting about in a cave, navigating via ultrasonic beeps. Assume that the sound emission frequency of the bat is 40 kHz. During one fast swoop directly toward a flat wall surface, the bat is moving at 0.03 times the speed of sound in air. What frequency does the bat hear reflected off the wall ?

ANSWER:

The Ultrasonic beep frequency emitted by the bat is f = 40kHz.

The velocity of the bat is v_b = 0.03v

where, v is equal to the velocity of sound in air

Then the apparent frequency of sound which is striking the wall is given by

$$f^{'} = (\frac{v}{v - v_b})f \tag{1}$$

From 1,

$$f^{'} = (40/0.97)\, kHz$$

$$f^{'} = 41.24kHz$$

The frequency which is reflected by wall towards the stationary bat is

$$f^{''} = (\frac{v + v_b}{v})f^{'} \tag{2}$$

From 2,

$$f^{''} = (41.2/0.97)\, kHz$$

$$f^{''} = 42.47kHz$$

The frequency reflected by the wall which is heard by the bat is 42.47 kHz.