QUES 06:-

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?

Sol. Ultrasonic beep frequency emitted by the bat, v = 40 kHz

Velocity of the bat, v_b = 0.03 v

Where, v = velocity of sound in air

The apparent frequency of the sound striking the wall is given as:

$$v' = \left(\frac{v}{v-v_b}\right)v$$

$$= \left(\frac{v}{v-0.03v}\right)40$$

$$= \frac{40}{0.97}kHz$$

This frequency is reflected by the stationary wall (v_s = 0) toward the bat.

The frequency (v") of the received sound is given by the relation:

$$v'' = \left(\frac{v}{v+v_s}\right)v'$$

$$= \left(\frac{v+0.3v}{v}\right) \times \frac{40}{0.97}$$

$$= \frac{1.03 \times 40}{0.97} = 42.47 kHz$$