

Q- One trumpet player is on a flatcar drawn by a locomotive and another player is near tracks. If each player blows a 440 Hz note, and if there are 4 beats/s as they approach each other, what is the speed of the flatcar? (Speed of sound in air is 340 m/s)

According to the theory of Doppler's effect when the source emitting wave of frequency n is moving towards the stationary listener with velocity v , the frequency n_1 heard by the stationary listener is given by

$$n_1 = n \left(\frac{c}{c - v} \right)$$

Here c is the speed of the wave in the medium.

Hence the frequency of the sound from the moving trumpet as heard by the stationary listener is

$$n_1 = 440 \left(\frac{340}{340 - v} \right) \quad \text{----- (1)}$$

Now when two waves are present in the medium with different frequencies the phenomenon of beats takes place and the intensity of the sound changes periodically. The beat frequency is equal to the difference in the frequency of the two waves and hence we have

$$n_1 - n = 4$$

Gives $n_1 = n + 4 = 440 + 4 = 444 \text{ Hz}$

Substituting the value of n_1 in equation (1) we have

$$444 = 440 \left(\frac{340}{340 - v} \right)$$

$$\text{Or } \frac{440}{444} = 1 - \frac{v}{340}$$

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$$\text{Gives } v = \frac{340}{111} = 3.06 \text{ m/s}$$