Answer on Question 68265, Physics, Mechanics | Relativity

Question:

A bicyclist pedaling passes an ambulance at a constant speed of $10\ m/s$. The ambulance was at a stop while it's siren is on at a frequency of $320\ Hz$. Determine the frequency detected by the bicyclist as it approaches the location of the ambulance. ($v_{air} = 343\ m/s$)

Solution:

We can find the frequency detected by the bicyclist from the Doppler shift formula (the Doppler shift is the change in frequency of the sound source as it moves: the frequency will appear to increase as the source comes towards the bicyclist and will appear to decrease as the source moves away from the bicyclist):

$$f_B = f_s \frac{(v_{air} + v_B)}{(v_{air} - v_s)},$$

here, f_B is the frequency detected by the bicyclist, $f_s = 320\ Hz$ is the frequency of the sound source, $v_{air} = 343\ m/s$ is the velocity of the sound in the air, $v_B = 10\ m/s$ is the velocity of the bicyclist (it will be with sign plus, since the bicyclist moves toward the stationary source), $v_s = 0\ m/s$ is the velocity of the sound source (since the sound source is at rest its velocity is equal to zero).

Then, we get:

$$f_B = f_s \frac{(v_{air} + v_B)}{(v_{air} - v_s)} = 320\ Hz \cdot \frac{\left(343\ \frac{m}{s} + 10\ \frac{m}{s}\right)}{343\ \frac{m}{s}} = 329\ Hz.$$

Answer:

$f_B = 329\ Hz.$