Question :

A train, standing in a station yard, blows a whistle of frequency 400 Hz in still air. The wind starts blowing in the direction from the yard to the station with a speed of 10 m/s.What are the frequency,wavelength,and the speed of sound for an observer standing on station's platform?Is the situation exactly identical to the case when the air is still and the observer runs towards the yard at a speed of 10 m/s ? The speed of sound in still air can be taken as 340 m/s.

Soltuion :

For the stationary observer:

$$\text{Frequency of the sound produced by the whistle, } v = 400\,\text{Hz}$$
$$\text{Speed of sound} = 340\,\text{m/s}$$
$$\text{Velocity of the wind, } v = 10\,\text{m/s}$$

As there is no relative motion between the source and the observer, the frequency of the sound heard by the observer will be the same as that produced by the source, i.e., 400 Hz.

The wind is blowing toward the observer. Hence, the effective speed of the sound increases by 10 units, i.e.,

$$\text{Effective speed of the sound, } v_e = 340 + 10 = 350\,\text{m/s}$$

The wavelength (λ) of the sound heard by the observer is given by the relation:

$$\lambda = \frac{v_e}{v} = \frac{350}{400} = 0.875\,\text{m}$$

For the running observer:

$$\text{Velocity of the observer, } v_o = 10\,\text{m/s}$$

The observer is moving toward the source. As a result of the relative motions of the source and the observer, there is a change in frequency (v'). This is given by the relation:

$$v' = \frac{(v + v_o)v}{(340 + 10) \times 400} = 411.76\,\text{Hz}$$

Since the air is still, the effective speed of sound $= 340 + 0 = 340\,\text{m/s}$. The source is at rest. Hence, the wavelength of the sound will not change, i.e., λ remains 0.875 m.

Hence, the given two situations are not exactly identical.