160.

Problem 20.69 (RHK)

A person in a car blows a trumpet sounding at 438 Hz. *The car is moving toward a wall at* $19.3\ \text{m s}^{-1}$. *We have to calculate* (a) *the frequency of sound as received at the wall and* (b) *the frequency of the reflected sound arriving back at the source*.

Solution:

Sound waves of frequency 438 Hz is emitted by a car moving with speed$19.3\ \text{m s}^{-1}$. We will first estimate the frequency of sound received at a wall facing the moving car. The wavelength of sound received at the wall will be

$$\lambda_{wall} = \left(\frac{v_s}{438} - \frac{19.3}{438} \right) \text{m} = \frac{v_s}{438}\left(1 - \frac{19.3}{v} \right) \text{m},$$

where $v_s = 343\ \text{m s}^{-1}$ is the speed of sound in air.

Therefore, the frequency ν_{wall} of the sound received at the wall will be

$$\nu_{wall} = \frac{v}{\lambda_{wall}} = \frac{438}{\left(1 - \frac{19.3}{343}\right)} \text{ Hz} = 464 \text{ Hz}.$$

Frequency of the reflected sound waves received by the observer moving toward the wall with speed of 19.3 m s^{-1} will be

$$\nu_r = \left(\nu_{wall} + \frac{19.3}{343/464}\right) \text{ Hz} = 464\left(1 + \frac{19.3}{343}\right) \text{ Hz} = 490 \text{ Hz}.$$