Q- A commuter train passes a station platform at a constant speed of 40 m/s. The train horn sounded at its characteristic frequency of 320 Hz. What change in frequency is detected by a person standing on the platform as the train moves past from approaching to receding? (speed of sound in air is 340 m/s)

The effect of change in the frequency of the sound heard due to relative motion between the source and the listener is called Doppler's effect.

The frequency heard by a standing listener when the source approaches to the listener is given by

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

Here n is the actual frequency of the source, c is the speed of sound in air and v is the velocity of approach of the source.

Hence substituting the values the frequency of the sound heard when the train is approaching is

$$n_1 = 320\left(\frac{340}{340-40}\right) = 320 * \left(\frac{340}{300}\right) = 362.67\ Hz \qquad \text{....(1)}$$

The frequency heard by a standing listener when the source resides away from the listener is given by

$$n_2 = n\left(\frac{c}{c+v}\right)$$

Here n is the actual frequency of the source, c is the speed of sound in air and v is the velocity of approach of the source.

Hence substituting the values the frequency of the sound heard when the train is approaching is

$$n_2 = 320\left(\frac{340}{340+40}\right) = 320 * \left(\frac{340}{380}\right) = 286.32\ Hz \qquad \text{....(2)}$$

Hence from equation (1) and (2) the change in frequency of the sound of the horn will be

$\Delta n = n_1 - n_2 = 362.67 - 286.32 = 76.35$ Hz