

Doppler Effect.

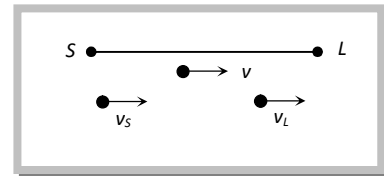
Whenever there is a relative motion between a source of sound and the listener, the apparent frequency of sound heard by the listener is different from the actual frequency of sound emitted by the source.

When the distance between the source and listener is decreasing the apparent frequency increases. It means the apparent frequency is more than the actual frequency of sound. The reverse is also true.

$$\text{General expression for apparent frequency } n' = \frac{[(v + v_m) - v_L]n}{[(v + v_m) - v_S]}$$

Here n = Actual frequency; v_L = Velocity of listener; v_S = Velocity of source

v_m = Velocity of medium and v = Velocity of sound wave



Sign convention: All velocities along the direction S to L are taken as positive and all velocities along the direction L to S are taken as negative. If the medium is stationary $v_m = 0$ then $n' =$

$$\left(\frac{v - v_L}{v - v_S} \right) n$$

Special cases:

(1) Source is moving towards the listener, but the listener at rest
$$n' = \frac{v}{v - v_S} . n$$

(2) Source is moving away from the listener but the listener is at rest
$$n' = \frac{v}{v + v_S} . n$$

(3) Source is at rest and listener is moving away from the source
$$n' = \frac{v - v_L}{v} n$$

(4) Source is at rest and listener is moving towards the source
$$n' = \frac{v + v_L}{v} . n$$

(5) Source and listener are approaching each other
$$n' = \left(\frac{v + v_L}{v - v_S} \right) n$$

(6) Source and listener moving away from each other
$$n' = \left(\frac{v - v_L}{v + v_S} \right) n$$

(7) Both moves in the same direction with same velocity $n' = n$, i.e. there will be no Doppler effect because relative motion between source and listener is zero.

(8) Source and listener moves at right angle to the direction of wave propagation. $n' = n$

It means there is no change in frequency of sound heard if there is a small displacement of source and listener at right angle to the direction of wave propagation but for a large displacement the frequency decreases because the distance between source of sound and listener increases.

Important points

(i) If the velocity of source and listener is equal to or greater than the sound velocity then Doppler Effect is not seen.

(ii) Doppler Effect gives information regarding the change in frequency only. It does not says about intensity of sound.

(i) Doppler Effect in sound is asymmetric but in light it is symmetric.