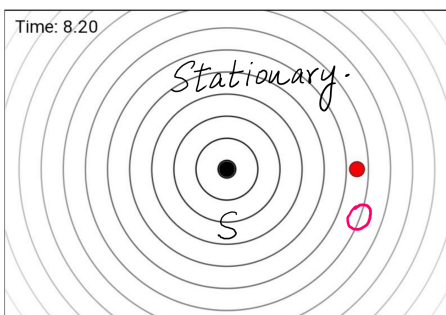


Doppler effect is defined as the **apparent change in the frequency** caused by the **relative motion between the source of the wave and the observer**. A common example is that of an ambulance with its siren blasting. You may recall that as the ambulance travels **towards you**, the **pitch of the siren** (or the **frequency**) of the siren appears to be **high** and then after the ambulance passes by and moves **away from observer** the **pitch/frequency of the siren appears to be low**. This **shift** in the apparent frequency for a wave produced by a moving source is the doppler effect. Another common experience is the shift in the apparent frequency of the sound of a train horn. As the train **approaches**, the sound of its horns is heard at a **high pitch** and as the train moves away, the sound of its horn is heard at a **low pitch**



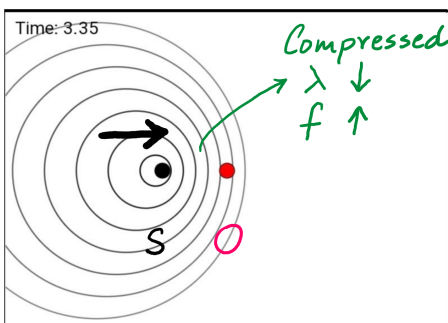
$$f_s = 500 \text{ Hz}$$

$$f_o = 500 \text{ Hz}$$

$$f_o = f_s$$

$f_o = \text{Observed freq.}$
 $f_s = \text{freq. of Source}$

In diagram 1, the wave producing source is **stationary**. In this case, the **observed frequency is equal to the actual frequency**.



$f_o > f_s$
 How to calculate this observed frequency?

$$f_o = \frac{f_s \times v}{v - v_s}$$

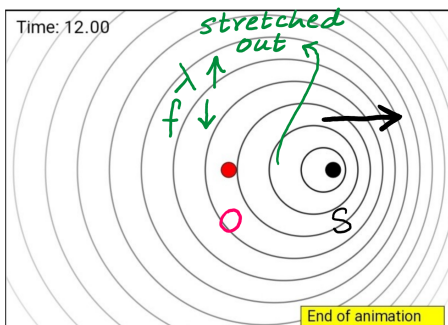
$v = \text{Speed of Sound}$
 $v_s = \text{Speed of the Source}$
 $f_s = \text{freq. of the Source}$
 $f_o = \text{Observed freq.}$

ambulance \rightarrow $f_o > f_s$

Speed of Sound = 330 m/s (v)
 freq of ambulance horn = 500 Hz (f_s)
 speed of ambulance = 45 m/s (v_s)
 Find the Observed freq? (f_o)

$$f_o = \frac{500 \times 330}{330 - 45} = 580 \text{ Hz}$$

In diagram 2, the wave producing source is **moving towards** the stationary observer. In this case the **observed frequency is higher than the actual frequency**.



$f_o < f_s$
 How to calculate this observed frequency.

$$f_o = \frac{f_s \times v}{v + v_s}$$

Same Symbol

$$f_o = \frac{500 \times 330}{330 + 45}$$

$$f_o = 440 \text{ Hz}$$

Ambulance \rightarrow

freq. of Sound produced by ambulance = 500 Hz (f_s)
 Speed of Sound = 330 m/s (v)
 Speed of ambulance = 45 m/s (v_s)
 Observed frequency (f_o)

In diagram 3, the wave producing source is **receding away** from the stationary observer hence the **observed frequency is now lower than the actual frequency**.

- * The above formulas are only for the case when the source is moving & the observer is stationary.
- * Observer moving as well (NOT included).
- * Doppler effect is also valid for other kind of waves eg. light waves. [same principle].