Example 2:
Howler monkeys, found in Central and South America, can emit a sound that can be heard by humans several miles away. The power associated with the sound is roughly 3.00×10^{-3} W. If the threshold of hearing of a human is approximately 1.0×10^{-12} W/m^2, how far away can a howler monkey be heard in meters and in miles? (1 mile = 1600 m)

$P = 3.00 \times 10^{-3}$ W $\quad I_0 = 1.0 \times 10^{-12}$ W/m^2

$I = \frac{P}{4\pi r^2}$

$P = I \cdot 4\pi r^2$

$r^2 = \frac{P}{I \cdot 4\pi}$

$r = \sqrt{\frac{P}{I \cdot 4\pi}}$

$r = \sqrt{\frac{3.00 \times 10^{-3}}{(1.0 \times 10^{-12}) \cdot 4\pi}}$

$r = \sqrt{\frac{3.00 \times 10^{-3}}{1.256 \times 10^{-11}}} = 15{,}451$ m

$15{,}451\text{ m} \left| \frac{1\text{ mile}}{1600\text{ m}} \right. = 9.67$ miles

Doppler Effect:

Example 3
The siren of a police car at rest emits a frequency of 1600 Hz. What frequency will you hear if you are at rest and the police car moves at 25.0 m/s...
(Assume the velocity of sound in air = 343 ms)

A. Toward you
B. Away from you

$f_o = f_s \left(\frac{v \pm v_o}{v \pm v_s} \right)$

$f_s = 1600$ Hz
$v_o = 0$ m/s
$v_s = 25.0$ m/s
$v = 343$ m/s

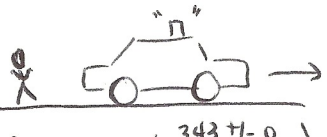
A.)

$f_o = 1600 \left(\frac{343 + 0}{343 - 25} \right)$

$f_o = 1600 (1.078621)$

$f_o = 1726$ Hz

B)



$f_o = 1600 \left(\frac{343 + 0}{343 + 25} \right)$

$f_o = 1600 (0.932065)$

$f_o = 1491$ Hz

Example 4
A **stationary** sound source emits a frequency of 392 Hz. You, as the observer, are traveling at a velocity of 20.0 m/s. Calculate the observed frequency of the sound at the locations listed below. (Again use 343 m/s as the velocity of sound in air)

A. As you approach the sound
B. As you are directly in front of the sound
C. As you are moving away from the sound

$v_s = 0$ m/s
$v_o = 20$ m/s
$f_s = 392$ Hz

A.)

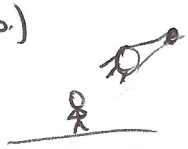
$f_o = f_s \left(\frac{v + v_o}{v + v_s} \right)$

$f_o = (392) \left(\frac{343 + 20}{343 + 0} \right)$

$f_o = (392)(1.058309)$

$f_o = 415$ Hz

B.)



$f_o = f_s = 392$ Hz

C.)

$f_o = f_s \left(\frac{v - v_o}{v - v_s} \right)$

$f_o = (392) \left(\frac{343 - 20}{343 - 0} \right)$

$f_o = (392)(0.941691)$

$f_o = 369$ Hz