

Sound Waves

Doppler Effect, Sonic Boom

Objectives

- Explain the Doppler Effect with a diagram
- Use the Doppler equation
- Understand when Sonic Booms occur



Doppler Effect

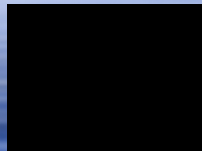
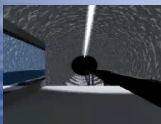


Doppler Effect

Christian Doppler
(1803-1853)



Doppler Effect Explained



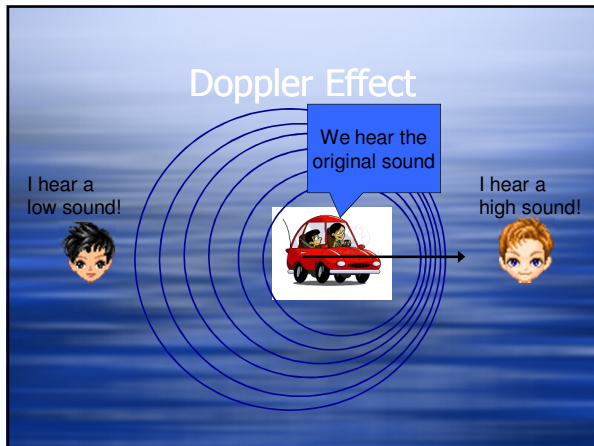
Doppler Effect

I hear a sound!



I hear the same sound!





- ### Doppler Effect
- ◆ Frequency of source does not change
 - ◆ Velocity of sound (wave) doesn't change, frequency increase.
 - ◆ Can happen with all types of waves (not just sound)

Doppler Effect

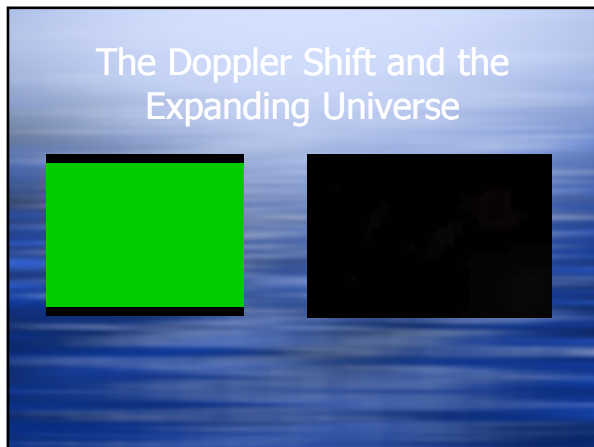
Used in:

- ◆ Radar detectors (measure speed)
- ◆ Astronomy by using the shift in frequency of light (measure distance)
- ◆ Bats (catch flying insects)

Doppler Effect

$$f_D = f_S \left(\frac{v + v_D}{v - v_S} \right)$$

f_D = Frequency at the detector
 f_S = Source frequency
 v = Speed of sound ($\sim 330\text{m/s}$)
 v_D = Detector velocity
 v_S = Source velocity
 $(v_D/v_S \text{ are } +\text{ve if they are moving towards one another})$



Sonic Boom

- ◆ The sound heard when planes pass through the sound barrier.
- ◆ Caused by the compression of sound and air at these high speeds.

Summary

- ◆ Doppler Effect causes pitch of an approaching sound to increase (decrease when object leaves)
- ◆ Doppler Effect explains the expanding universe theory.
- ◆ Sonic Boom occurs when planes exceed the speed of sound.



Iron Man Sound Barrier.mkv