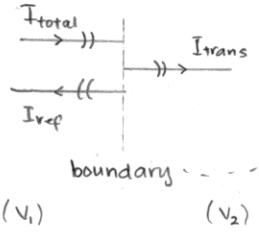
VERSION 2.0
April 22 Concepts – azj

Physical Sciences 3
Lecture 20 – April 23, 2008 – The Doppler Effect and Beats
Reading for Understanding: Chapter 16 s1, 6, 7, 9

WAVES



$v_1 = v_2$ most transmitted

$v_1 < v_2$, $v_1 > v_2$ } most reflected

ECHOLOCATION

emit a sound, wait for the echo = absorption + reemission

$2d = vt$ ← from the time can tell how far something is.

"test" at a boundary...

ASIDE

if there is an angle involved, be sure to use cosθ

DOPPLER SHIFT

Sound appears to have a different frequency if the observer, the source or both are moving.

$\lambda = \frac{v}{f_0}$ ← speed of sound; ← source freq

V_o = velocity of observer
V_s = velocity of source

CASE I: moving observer

$$f' = f_o \frac{v \pm v_o}{v}$$

$+V_o$ if distance decreasing
$-V_o$ if distance increasing

CASE II: moving source

$$f' = f_o \frac{v}{v \mp v_s}$$

$-V_s$ if distance decreasing
$+V_s$ if distance increasing

CASE III: Generalized, both possibly moving

$$f' = f\left(\frac{v \pm v_o}{v \mp v_s}\right)$$

Special case when V_o & V_s are less than v we can invoke $\frac{1}{1-x} = 1+x$ when $x \ll 1$ to get the result: $\Delta f = f' - f_o = f_o\left(\frac{v_o + v_s}{v}\right)$

BEATS

result when you have two waves of slightly different frequencies interfering.

$$D_m \underbrace{\cos(2\pi f_1 t)}_{\text{A wave}} + D_m \underbrace{\cos(2\pi f_2 t)}_{\text{B wave}}$$

$$= 2D_m \underbrace{\cos\left[2\pi \frac{f_1 - f_2}{2} t\right]}_{\text{slowly growing amplitude, envelope}} \underbrace{\cos\left[2\pi \frac{f_1 + f_2}{2} t\right]}_{\text{wiggle; } f_{avg} \approx f_1 \approx f_2}$$

* $f_{beats} = \Delta f = f_1 - f_2$

*the overall frequency is found by taking the average of two source frequencies.