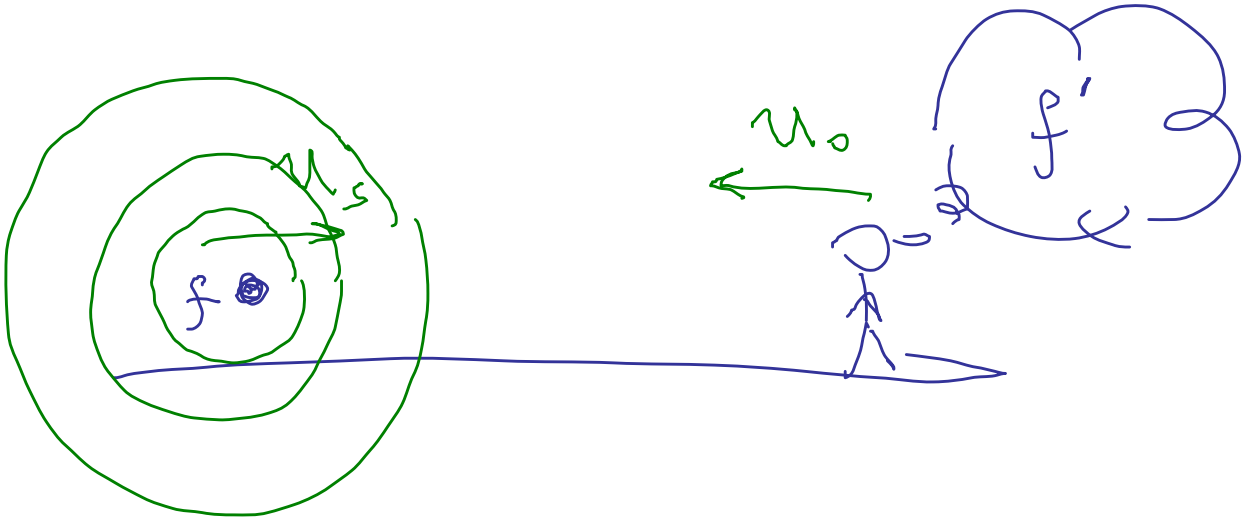
Phys 2110-5 12/05/12

Note Title 12/5/2012

Doppler shift



$$f' = f \frac{\left(1 \pm \frac{v_o}{v}\right)}{\left(1 \mp \frac{v_s}{v}\right)}$$

v = speed of sound

$343 \frac{m}{s}$

Example: Moving source plays $f = 440\ Hz$

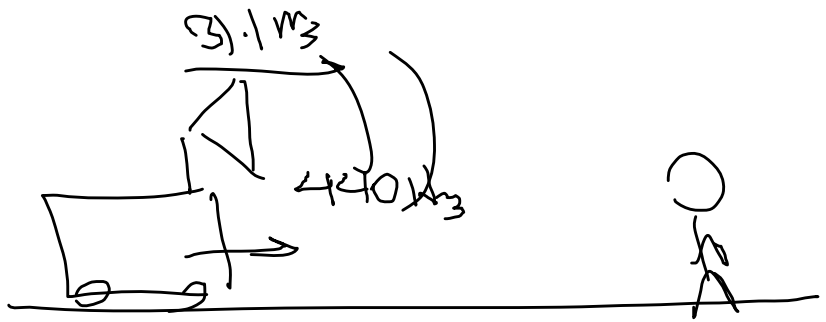
Source moves toward obs at $112\ \frac{km}{hr}$

Find f'

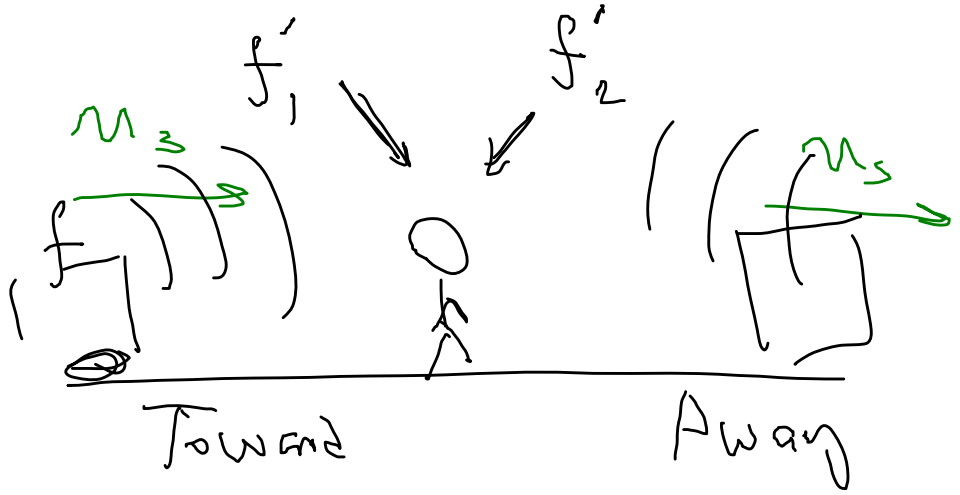
$$112\ \frac{km}{hr} = 31.1\ \frac{m}{s}$$

$$f' = (440 Hz)\left(\frac{1}{1 - \frac{31.1\ m/s}{343\ m/s}}\right)$$

$$= 484\ Hz$$



14.73 You're standing roadside as truck approaches & measure frequency 1100 Hz. As truck frequency drops to 950 Hz. What's the truck's speed?



$$f_1' = f\frac{1}{\left(1 - \frac{v_s}{v}\right)} = 1100\ \text{Hz}$$

$$f_2' = f\frac{1}{\left(1 + \frac{v_s}{v}\right)} = 950\ \text{Hz}$$

$x = \frac{v_s}{v}$ Divide f cancel.

$$\frac{1100}{950} = \frac{\left(\frac{1}{1-x}\right)}{\left(\frac{1}{1+x}\right)}$$

$$x = \frac{v_s}{V}$$

Solve for x

$$\frac{1100}{950} = \frac{(1+x)}{(1-x)} = 1.158$$

$$(1+x) = (1.158)(1-x)$$

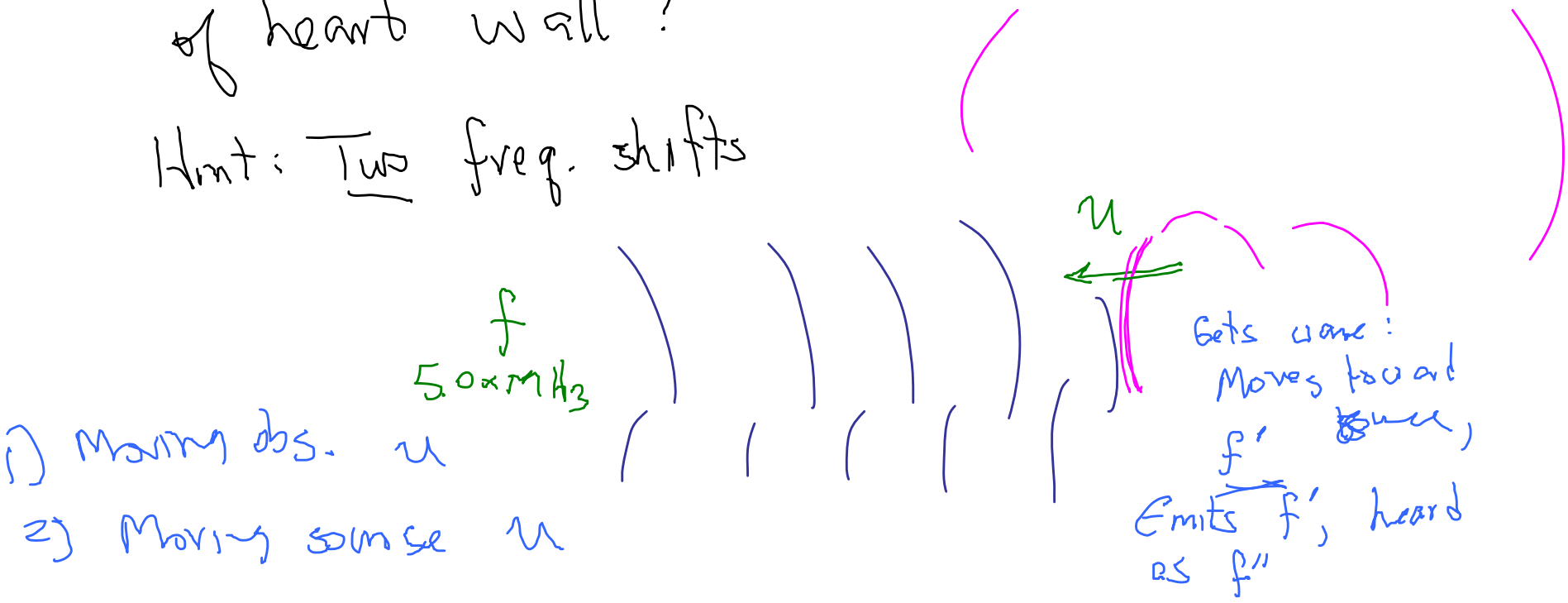
$$x = 0.0732$$

$$v = 25.13 \frac{m}{s}$$

14.78 Use ultrasound to hear fetal heartbeat.

5.0 MHz ultrasound reflects off moving wall of health with 100 Hz. Speed of heart wall?

Hint: Two freq. shifts



$$f' = f\left(1 + \frac{u}{v}\right)$$

$$f'' = f'\left(\frac{1}{1 - u/v}\right) = f\left(\frac{1 + \frac{u}{v}}{1 - \frac{u}{v}}\right) \qquad x = \frac{u}{v}$$

$$f'' = f\left(\frac{1+x}{1-x}\right)$$

Shift: $\Delta f = f'' - f = f\left(\frac{1+x}{1-x} - 1\right) = 100\ \text{Hz}$

$f = 5.0\ \text{MHz}$

$x = 1.0 \times 10^{-5} = \frac{u}{v}$ $\quad v$ = speed of sound

v = speed sound water, $\sim 1400 \frac{m}{s}$ in baby etc.