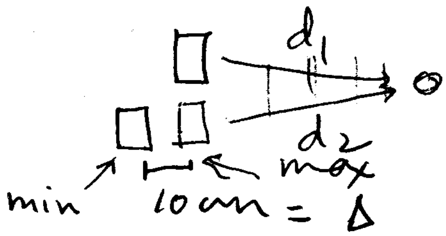
Physics 1C Spring 2010

Quiz 1 form A

1) Interference of sound waves



Condition for maxima $d_2 - d_1 = m\lambda$

minima $d_2 - d_1 = (m+\frac{1}{2})\lambda$

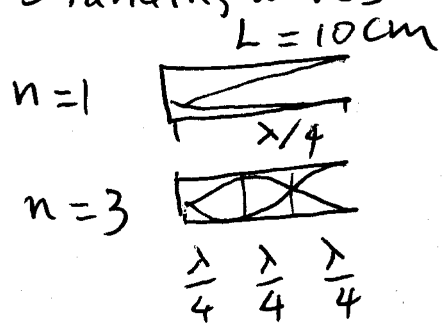
$\Delta = \frac{1}{2}\lambda$ in going from maxima to minimum

$\lambda = 2\Delta$

$$f = \frac{v}{\lambda} = \frac{v}{2\Delta} = \frac{340\ m/s}{2(10\times10^{-2}\ m)} = 1.7\times10^{3}\ Hz$$

1.7 kHz

2) Standing waves:



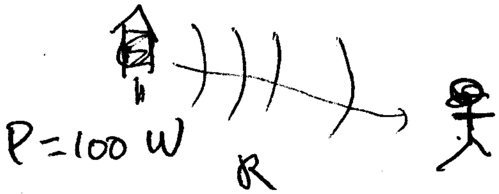
$\lambda = 4L$

$$\lambda = \frac{4L}{3} = \frac{4}{3}(10\times10^{-2}\ m)$$

$= $ **13 cm**

$L = \frac{3}{4}\lambda$

3) Sound Intensity



$\beta = 60\ dB$

$$\beta = 10\log\frac{I}{I_0} = 60$$

$$\log\frac{I}{I_0} = 6 \implies I = 10^{6} I_0 = 10^{6}(10^{-12}\ W/m^2)$$

$$I = 10^{-6}\ W/m^2$$

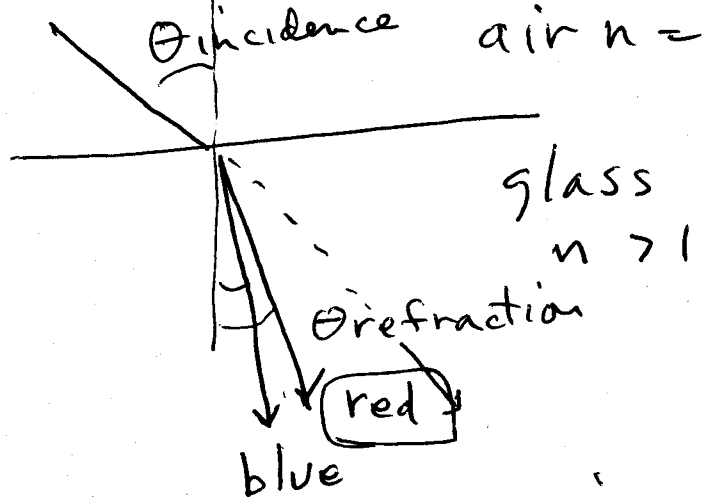
3) Continued

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

$$R = \sqrt{\frac{P}{4\pi I}} = \sqrt{\frac{100\ W}{4\pi(10^{-6} W/m^2)}} = 2.8 \times 10^3\ m$$

2.8 km

4) Dispersion of light



The refractive index increases from red (lowest) to blue (highest). Red light has the lowest refractive index - (closest to 1.0) and will have the largest angle of refraction due to snell's law.

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

~~This~~ i.e. red light will have the lowest deviation of the ray from its original path.

5) Standing wave on a violin string –

$L = 33\,cm$

$f_1 = 660\,Hz$ $\quad v = \sqrt{\frac{F}{m/L}}$

$\vec{F} = 70\,N$

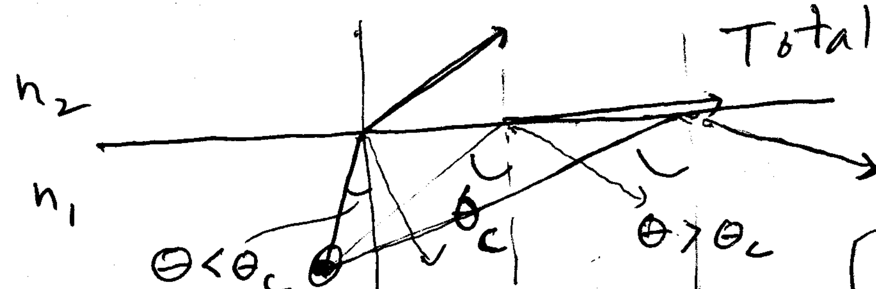
$$f_1 = \frac{v}{\lambda} = \frac{v}{2L} = \frac{1}{2L}\sqrt{\frac{FL}{m}} = \frac{1}{2}\sqrt{\frac{F}{mL}}$$

$$f_1^2 = \frac{1}{4}\cdot\frac{F}{mL}$$

$$m = \frac{F}{4L f_1^2} = \frac{70\,N\left(\frac{kg\,m}{s^2}\right)}{4(33\times10^{-2}\,m)(660\,s^{-1})^2}$$

$$m = 1.2\times10^{-4}\,kg \quad \boxed{= 0.12\,g}$$

6)



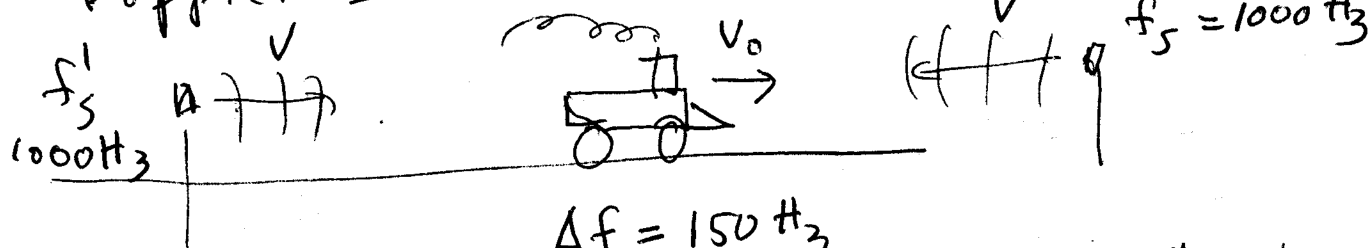
Total internal reflection

(n decreases)

n_1 must be greater than n_2 so that θ_2 is greater than θ_1 – from Snell's Law.

θ must be greater than θ_c.

7) Doppler Shift.



$\Delta f = 150$ Hz

The observer on the train hears 2 Doppler shifted frequencies.

$$f_o^1 = f_s\left(\frac{v - v_o}{v}\right) = f_s\left(1 - \frac{v_o}{v}\right)$$

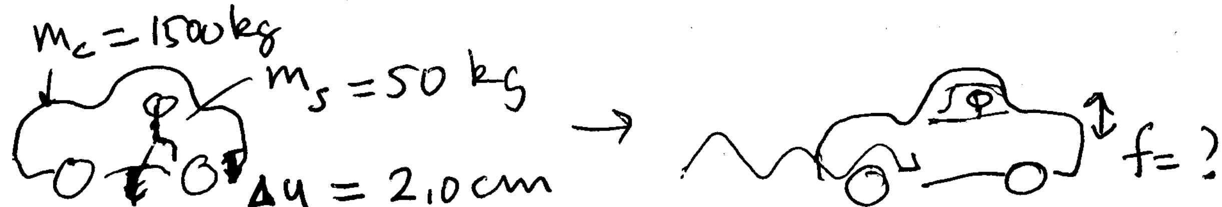
$$f_o^2 = f_s\left(\frac{v + v_o}{v}\right) = f_s\left(1 + \frac{v_o}{v}\right)$$

Beat frequency

$$\Delta f = f_o^2 - f_o^1 = f_s\left(2\frac{v_o}{v}\right)$$

$$v_o = \frac{\Delta f}{2 f_s} v = \frac{150 \text{ Hz}}{2(1000 \text{ Hz})}(340 \text{ m/s}) = \boxed{26 \text{ m/s}}$$

8)



oscillation of a mass on a spring $- f$

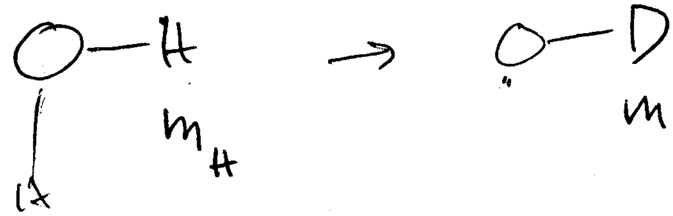
$$F = k\,\Delta y$$

$$k = \frac{F}{\Delta y} = \frac{m_s g}{\Delta y}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{M_c + m_s}} = \frac{1}{2\pi}\sqrt{\frac{m_s g}{\Delta y (M_c + m_s)}}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{50 \text{ kg}(9.8 \text{ m/s}^2)}{(2\times10^{-2} \text{ m})(1500 + 50 \text{ kg})}} = \boxed{0.63 \text{ Hz}}$$

9) Vibration of water molecule



m_H $\qquad$ $m_D = 2m_H$

$$f_H = \frac{1}{2\pi}\sqrt{\frac{k}{m_H}}$$

$$f_D = \frac{1}{2\pi}\sqrt{\frac{k}{m_D}} = \frac{1}{2\pi}\sqrt{\frac{k}{2m_H}}$$

$$f_D = \frac{1}{\sqrt{2}} f_H = \boxed{0{,}71 f_H}$$

10) Visible light has wavelengths from 400 nm – 700 nm Close to $\boxed{1\,\mu m}$