Physics 1C Spring 2010
Quiz 1: Form A

1) Interference of sound waves

\[ \Delta = \frac{1}{2} \lambda \quad \text{in going from maxima to minima} \]
\[ \lambda = 2 \Delta \]
\[ f = \frac{V}{\lambda} = \frac{V}{2 \Delta} = \frac{340 \text{ m/s}}{2(10 \times 10^{-2} \text{ m})} = 1.7 \times 10^3 \text{Hz} \]
\[ 1.7 \text{kHz} \]

2) Standing waves

\[ L = 10 \text{cm} \]
\[ n = 1 \]
\[ \lambda = 4L \]
\[ n = 3 \]
\[ \lambda = \frac{4L}{3} = \frac{4}{3} (10 \times 10^{-2} \text{ m}) = 13 \text{ cm} \]

3) Sound Intensity

\[ P = 100 \text{ W} \]
\[ \beta = 60 \text{ dB} \]
\[ \beta = 10 \log \frac{I}{I_0} = 60 \]
\[ \log \frac{I}{I_0} = 6 \Rightarrow I = 10^6 I_0 = 10^6 (10^{-12} \text{ W/m}^2) \]
\[ I = 10^{-6} \text{ W/m}^2 \]
3) Continued

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

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

\[ 2.8 \text{ km} \]

4) Dispersion of light

\[ \theta_{\text{incidence}} \quad \text{air} \quad n = 1 \]

\[ \theta_{\text{refraction}} \quad \text{glass} \quad n > 1 \]

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.

\[ n_1 \sin \theta_1 = n_2 \sin \theta_2 \]

Hence, red light will have the lowest deviation of the ray from its original path.
5) Standing wave on a violin string:

\[ L = 33 \text{ cm} \]

\[ f_1 = \frac{V}{\lambda} = \frac{V}{2L} = \frac{1}{2L} \sqrt{\frac{F}{m/L}} = \frac{1}{2} \sqrt{\frac{F}{mL}} \]

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

\[ m = \frac{F}{4\pi L f_1^2} = \frac{70 \text{ N}}{4(33 \times 10^{-2} \text{ m})(660 \text{ s}^{-1})^2} \]

\[ m = 1.2 \times 10^{-4} \text{ kg} = 0.12 \text{ g} \]

6) Total internal reflection:

\[ n_1 < n_2 \]

\[ \theta < \theta_c \]

\[ \theta > \theta_c \]

\[ (n \text{ decreases}) \]

\[ n_2 \text{ must be greater than } n_2 \text{ so that } \theta_2 \text{ is greater than } \theta_1 \text{ - from Snell's law.} \]

\[ \theta \text{ must be greater than } \theta_c. \]
7) Doppler Shift.

\[ f_1 = \frac{v}{v_0} \]

\[ f_1 = \frac{f_s}{v_0} \]

\[ f_2 = \frac{v + v_0}{v} \]

\[ f_2 = f_s \left( 1 + \frac{v_0}{v} \right) \]

\[ \Delta f = f_2 - f_1 = f_s \left( \frac{2v_0}{v} \right) \]

\[ V_0 = \frac{\Delta f}{2f_s} \]

\[ V = \frac{150 \text{ H}_3}{2(1000 \text{ H}_3)} = 26 \text{ m/s} \]

8) Oscillation of a mass on a spring – f

\[ F = k \Delta y \]

\[ k = \frac{F}{\Delta y} = \frac{m_5 g}{\Delta y} \]

\[ f = \frac{1}{2\pi} \sqrt{\frac{k}{M_c + m_5}} = \frac{1}{2\pi} \sqrt{\frac{m_5 g}{\Delta y (M_c + m_5)}} \]

\[ f = \frac{1}{2\pi} \sqrt{\frac{50 \text{ kg} (9.8 \text{ m/s}^2)}{(2 \times 10^{-2} \text{ m})(1500 + 50 \text{ kg})}} \]

\[ f = 0.63 \text{ H}_3 \]
9) Vibration of water molecule

\[ \text{O-H} \quad \rightarrow \quad \text{O-D} \]
\[ m_\text{H} \quad \rightarrow \quad m_\text{D} = 2 m_\text{H} \]

\[ f_\text{H} = \frac{1}{2\pi} \sqrt{\frac{k}{m_\text{H}}} \]

\[ f_\text{D} = \frac{1}{2\pi} \sqrt{\frac{k}{m_\text{D}}} = \frac{1}{2\pi} \sqrt{\frac{k}{2m_\text{H}}} \]

\[ f_\text{D} = \frac{1}{\sqrt{2}} f_\text{H} = 0.71 f_\text{H} \]

10) Visible light has wavelengths from 400 nm - 700 nm Close to 1 \mu m