Name_____

Phys 121
Quiz #5

1. A student in a physics lab uses an oscillator of frequency 210 Hz to set up a standing wave on a string which is the *third* harmonic of that string. The string has length 1.20 m. A 1.35 kg mass is hung on the end opposite the oscillator.

a) Draw a picture of the wave pattern that the string makes

b) What is the wavelength of the waves?

Length ℓ is 3 half-wavelengths: $\ell = 3\frac{\lambda}{2}$

So $\lambda = \frac{2}{3}\ell = \frac{2}{3}(1.20\text{ m}) =$ **0.80 m**

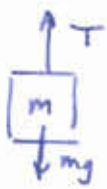
c) What is the speed of waves on the string?

$v = \lambda f = (0.80\text{ m})(210/\text{s}) =$ **168 m/s**

d What is the tension of the string?

It is equal to the weight of the hanging mass:

$T = mg = (1.35\text{ kg})(9.80\text{ m/s}^2) =$ **13.2 N**



e) What is the mass density (mass per length) of the string?

Since $v = \sqrt{\frac{T}{\mu}}$, then

$v^2 = \frac{T}{\mu}$ $\quad \mu = \frac{T}{v^2} = \frac{13.2\text{ N}}{(168\text{ m/s})^2} =$ **4.69×10^{-4} kg/m**

2. A person playing a trumpet is running toward a stationary observer. The trumpeter blows a note of frequency 440 Hz, but the observer hears it as 452 Hz.

At what speed is the trumpeter running?

Since $v_o = 0$ and the source moves toward the observer,

$f' = f\left(\frac{1}{1 - v_s/v}\right)$ with $f' = 452$ Hz and $f = 440$ Hz, we get

$1 - \frac{v_s}{v} = \frac{f}{f'} = \frac{440\ \text{Hz}}{452\ \text{Hz}} = 0.973$

$\frac{v_s}{v} = 1 - 0.973 = 2.65\times10^{-2}$ $\quad v_s = (2.65\times10^{-2})(340\ \frac{\text{m}}{\text{s}})$

$= \boxed{9.03\ \frac{\text{m}}{\text{s}}}$

3. When sound of an unknown frequency is played simultaneously with sound of frequency 360 Hz, we hear pulses at a rate of 3 per second. When the unknown frequency is *raised* by some small amount it is found that the pulses come at 2 per second.

What is the unknown frequency?

From the first piece of information, since $|f_{unk} - 360\ \text{Hz}| = 3\ \text{Hz}$

then $f_{unk} = 357\ \text{Hz}$ or $f_{unk} = 363\ \text{Hz}$.

Now when f_{unk} is increased to f'_{unk}, $|f'_{unk} - 360\ \text{Hz}|$ is a smaller number. This could not be true if f_{unk} was 363 Hz, so the unknown frequency was $\boxed{357\ \text{Hz}}$

You must show all your work!

$$g = 9.80\tfrac{\text{m}}{\text{s}^2} \qquad \lambda f = v \qquad v_{\text{string}} = \sqrt{\frac{F}{\mu}}, \quad \text{with} \quad \mu = \frac{m}{L}$$

Use $340\frac{\text{m}}{\text{s}}$ for the speed of sound.

$$f_{\text{beat}} = |f_1 - f_2| \qquad f' = f\left(\frac{1 \pm \frac{v_o}{v}}{1 \mp \frac{v_s}{v}}\right) \quad \text{(Top sign goes with motion "toward")}$$