Please complete the following homework assignment in the space provided. It is due on Tuesday, February 7^{th} at 9:30 am.

1. On a keyboard you strike low C, which is 262 Hz

   (a) What is the period of one vibration at this frequency?
   The period is the reciprocal of the frequency $T = 1/f = 1/262$ Hz $= 0.0382$ seconds.

   (b) What is its wavelength in air? (The speed of sound in air is about 340 m/s.
   The wavelength is given by $\lambda = v/f = 340/262 = 1.30$ metres.

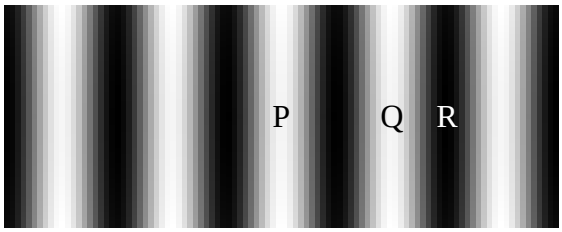
   (c) What is the frequency of the next note in the scale C$^\sharp$?
   In the 12 note scale equal tempered scale the frequencies increase by a factor of $2^{1/12}$ each note. So C$^\sharp$ is $262(2^{1/12}) = 278$ Hz.

2. The buzz of a bee is the sound made by its wings as they flap 600 times per second. How far does the sound travel in the time it takes its wings to flap once?
   The wave travels one wave length in one complete beat of the wings. Given the speed of sound in air is 340 m/s and the frequency is 600 Hz, we get $\lambda = v/f = 340/600 = 0.57$ metres.

3. Violinists sometimes bow a string in such a way that the maximum vibration (antinode) is at one quarter and three quarters of the length of the string, rather than at the middle of the string. What is the effect on the frequency of the string?
   If the anti-node is at one quarter and three quarters of the length of the string, then there is a node in the center. This would correspond to the second harmonic which is double the frequency.

4. A Cello has a string 0.75 m and has a 220 Hz fundamental frequency. How fast is the wave speed along the string?
   Here we use the fact that the fundamental frequency is $f = v/2L$, where L is the length of the string. From this equation we see that $v = 2Lf = 2(0.75)(220) = 330$ m/s.

5. Red light, with wave length λ is incident on two slits. The light passing through the slits forms a fringe pattern on a screen which is a distance 2.2 m from the slits. The fringe pattern is shown on the right. The point P is at the center of the pattern directly opposite the slits. P and Q are maximum intensity and R is a minimum intensity fringe.



(a) Explain why there are dark and light fringes.
There are light fringes because light from the two slits interferes constructively there and there are dark fringes because light from the fringes interferes destructively there.

(b) What is the difference in path length from each of the two slits to the point P? The point Q? The point R? Express your answer in terms of the wavelength λ.
For point P the difference in path length is zero. For Q the difference in path length is one wave length, since it is the first maximum. Since R is the second minimum, the difference in path length is one and a half wavelengths or $3\lambda/2$.

(c) If the distance between P and R is 1.6 mm, find the slit separation in terms of λ.
One fringe separation is the distance between P and Q. This is 2/3 of the distance between P and R ie $1.6 \times 2/3 = 1.1$ mm. Now the slit separation is $d = x\lambda/\Delta y = 2.2\lambda/(1.1 \times 10^{-3}) = 2000\lambda$.

(d) Suppose the width of the slits on the right were decreased without changing the distance between the centers. Would the brightness of at Q increase,decrease or stay the same? What about R? Explain?
At point Q the intensity would decrease since less light would reach there to constructively interfere with light from the other slit. At point R the intensity would increase. There is not enough light from the right slit to completely destructively interfere with the light from the left slit.