Please complete the following homework assignment in the space provided. It is due on Tuesday, February 10$^{\text{th}}$ at 9:00 am.

1. Light and Matter (online text):

   `http://www.lightandmatter.com/html_books/3vw/ch04/ch04.html`

   Problems 1, 3 and 4, 5

2. Hobson Ch 8 Ex 8 and 9 and Problems 1, 7, and 10.

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. Monochromatic light illuminates a narrow slit which is 4.0 m from a screen. Two very narrow parallel slits 0.5 mm apart are placed halfway between the single slit and the screen so that interference fringes are obtained.

   If the spacing of five fringes is 10 mm calculate the wavelength of the light.
   $y = \frac{n\lambda L}{d} \Rightarrow \lambda = \frac{yd}{nL}$ Note: $n = 4$ not 5 since the central peak is $n = 0$
   so $\lambda = \frac{(10 \times 10^{-3})(0.5 \times 10^{-3})}{(4)(2.0)} = 625$ nm
   What will be the effect on the fringes of

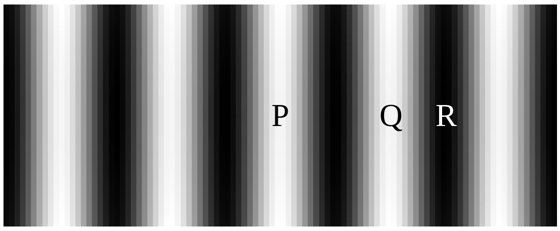
   (a) halving the distance between the double slit and the screen;
   The fringe separation is halved.

   (b) halving the slit separation;
   The fringe separation is doubled.

   (c) covering one of the double slits;
   The interference pattern is lost (There may be an observable diffraction pattern.)

   (d) using white light.
   The fringes separate into component colours with read spreading further and blue less – The central fringe will remain white.

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.