## Modern Physics

## Assignment 2: Turn in the problems below on Friday, September 14.

1. A source emits sound at a frequency of 400Hz. It is moving away from a stationary observer at a speed of 30m/s. What is the frequency heard by the observer if the speed of sound is 340m/s?

2. A source emits sound at a frequency of 1000Hz. It is moving toward a cliff at a speed of 10m/s. It, the source, also hears the waves <u>reflected</u> from the cliff. What is the frequency it hears if the speed of sound is 340m/s.

3. A source (e.g. a bat) emits sound at a frequency of 40,000Hz. It is moving toward a bug at a speed of 20m/s. The bug is moving toward the bat with a speed of 5m/s. The bat hears the waves reflected from the bug. What is the frequency the bat hears?

4. An airplane is initially flying toward a train moving in the direction shown. The train is moving with a speed of 50m/s (relative to the air, but in a direction away from the plane.) A person on the train hears a 1200 Hz sound <u>when the plane is moving toward the train</u>, but the frequency changes to 700Hz when the <u>plane passes the train and moves away from the train</u>. How fast is the plane moving?
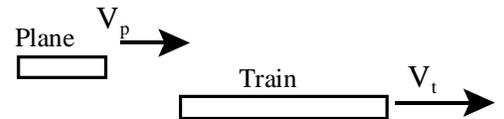

5. You shine light of wavelength 500nm on a diffraction grating and the spacing between the <u>first</u> bright spot and the central maximum is 0.8m on a screen 1.2m from the grating. What is the spacing of the "lines" on the grating?

6. A grating has a line spacing of 1.5µm. What is the highest order diffraction spot if the wavelength of the light is 550nm.

7. The pattern at the right is produced on a screen either by a single slit or a double slit when light of 600nm shines on it. The slit or slits are 3.0m from the screen. The dark spots above the central maximum are at 2cm, 6cm etc. (Note that the vertical scale is different than the horizontal scale and the <u>darkened regions are bright spots</u> for the pattern.)
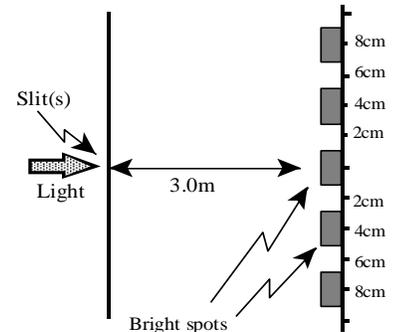
   a. Is it a double slit or a single slit? <u>Give a reason for your choice!</u>
   b. If it is a single slit, how wide is it? If it is a double slit, what is the slit separation?

8. The pattern at the right is produced on a screen either by a single slit or a double slit when light of 400nm shines on it. The slit or slits are 1.2m from the screen. The dark spots above the central maximum are at 2cm, 4cm etc. (Note that the vertical scale is different than the horizontal scale and the darkened regions are bright spots for the pattern.)
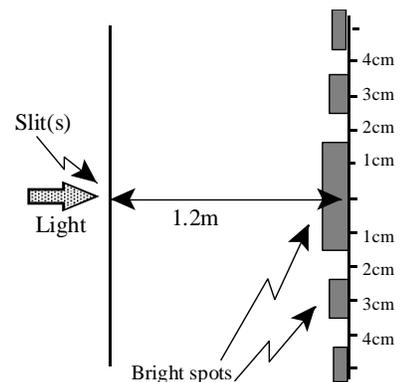
   a) Is it a double slit or a single slit? <u>Give a reason for your choice!</u>
   b) If it is a single slit, how wide is it? If it is a double slit, what is the slit separation?

9. Calculate the maximum kinetic energy of a standing wave on a string of length L, mass per unit length µ, wave velocity c, amplitude A, and frequency ω. Assume it is has the form

   $$y(x,t) = A\sin(kx)\cos(\omega t)$$

   Calculate it at a time when the displacement y = 0, i.e. when all the energy is kinetic energy.