Exam 1; Phys 186 Name ________________

Note: As I walk around, you can ask me for help; for example, to supply an equation or a number you have forgotten down, or to give you algebra aid. If you do, however, I will write down what help I provided on your exam, and grade your answer accordingly.

1. (30 points) You have a mass m attached to a frictionless spring with spring constant k, and you set the mass oscillating. In the following list of variables that might describe the resulting motion, draw a circle around those that depend on the mass m:

amplitude, wavelength, period, phase, diffraction

Sketch a graph of this dependence (with m on the horizontal axis) for each variable you circle.

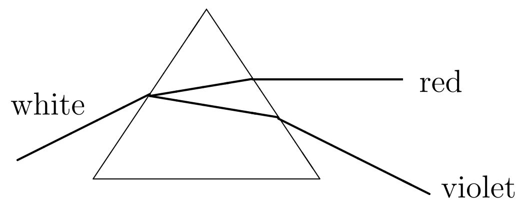
2. (15 points) If you get a sonic boom due to constructive interference, can you get areas where zones of destructive interference passes over the surface as well? If so, if you're within such an anti-boom, would it silence the other sources of sound present? Explain.

3. (15 points) Could you get destructive or constructive interference between a red laser beam and a green laser beam? Explain.

4. (15 points) Why do noise-canceling headphones fail to cancel out an annoying conversation you don't want to overhear? Explain.

5. (15 points) When underwater, you don't see the colors of objects outside the water change. How is this observation evidence that the color-sensitive cone cells in your eyes respond to frequency rather than wavelength? Explain.

6. (15 points) If you see a prism separating color such that red is refracted less than violet, can you conclude that its index of refraction n increases as a function of frequency f, or does it decrease? Explain.



7. (15 points) In some fiction, the protagonists get shrunk to the size of insects, and try to talk with unshrunken people. Assuming the shrinking process involves nothing but a scaling down (there's no speeding up or anything), would the shrunken people's speech be understood by those who remain normal? Explain.

8. (20 points) You have sound waves in air, with a frequency of f and speed of v_a, incident on a solid surface. The angle between the normal to the interface and the direction of wave propagation in air is θ_a. The speed of sound in the solid is v_s. Find an equation for θ_s, the angle the sound transmitted into the solid makes between the normal to the interface and its new direction of propagation. (*Hint:* Start by drawing a diagram of the situation, and ask me to look at it to see if it's right.)

9. (40 points) You have an electric dipole arranged on the x-axis: a $+q$ charge at $x = +a$ and a $-q$ charge at $x = -a$. The charges are connected by a rigid rod, so the distance between them never changes.

(a) Calculate the electric field created by this dipole on point on the x-axis, for $x > a$. Get both magnitude and direction.

(b) Calculate the force the first dipole exerts on another dipole further down the x-axis. Get both magnitude and direction.

(c) You now have the second dipole oriented perpendicular to the first:

Qualitatively sketch the forces on this second dipole due to the first dipole. Also indicate in what direction (clockwise or counterclockwise) it rotates. Very briefly explain why.

(d) What can you conclude about dipole-dipole interactions from this problem? Do dipoles attract or repel one another? How do they orient themselves relative to each other?

10. (20 points) Draw equipotential lines and electric field lines for the following configuration of charges: