Midterm Physics 9B fall 2001

Use a law blue book. Closed book. One 3”x5” note card. PRINT your name on your blue book. To get credit, you must show your work. Be neat, clear, and organized. If we can’t read it or figure it out, we can’t give you any points. I am sure that none of you want to grow up to be like the person who sent the Mars Climate Orbiter to its death. Thus give the units for your answers. You **will** lose points for an answer with incorrect units.

1) (20 points) Consider a string which is infinitely long in both directions and on which the wave speed is 10 m/s. Which of the following functions describe possible motions of the string? Answer yes or no for each and give your reasoning or a direct calculation.

a) $y(x,t)=(5cm)\sin(50t/s-4x/m)$

b) $y(x,t)=(2cm)\cos(50t/s+5x/m)$

c) $y(x,t)=(3cm)\cos(10t/s)\sin(x/m)$

d) $y(x,t)=(10cm)/[2+(x/m-10t/s)^2]$

2) (15 points) A string with clamped ends has a normal mode with frequency 10Hz. (In the following, explain any that you select. You need not explain those that you do not select.)

a) Which of the following are *definitely* other normal mode frequencies? 5Hz, 20Hz, 30Hz, 35Hz.

b) Which of the following *could* be the frequencies of other normal modes? 5Hz, 15Hz, πHz, $\sqrt{2}$Hz.

c) Which of the following are *definitely not* the frequencies of other normal modes? 5Hz, 15Hz, πHz, $\sqrt{2}$Hz.

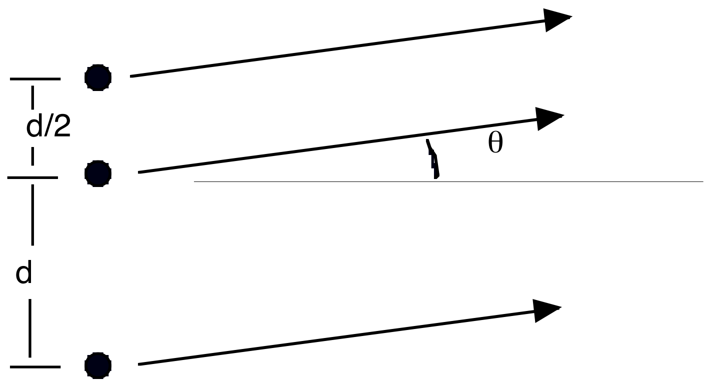
3) (15 points) Consider the standing wave $y(x,t)=(2cm)\sin(3\pi vt/L)\sin(3\pi x/L)$ on a string clamped at x=0 and x=L and on which waves travel with speed v.

a) Sketch the string at t=0.

b) Sketch the string at $t=L/(6v)$.

c) Compute $v_y(x)=\partial y(x,t)/\partial t$ at t=0 and $t=L/(6v)$.

d) The conservation of energy demands that the energies in the string at t=0 and $t=L/(6v)$ are equal. Using your results from a, b, and c, explain in a qualitative way how that could be true.



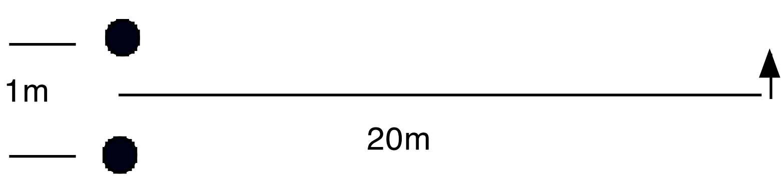
4) (20 points) Three coherent sources are arranged as drawn. There is a principle maximum with intensity I_0 at $\theta=0$.

a) What are the directions θ_1 and θ_2 to the next two principle maxima with intensity I_0? $(0<\theta_1<\theta_2)$

b) In terms of I_0, what is the intensity at $\theta_1/2$?

5) (15 points) a) In a laboratory experiment on earth, a certain kind of atom produces a particular characteristic wavelength of light. That light makes an intensity pattern when it passes through a slit 0.1mm wide. The first minimum of the pattern is 0.6cm from central maximum on a screen 1m from the slit. What is the wavelength of the light?
b) A long time ago in a galaxy far, far away, the same kind of atoms emitted light with the same characteristic wavelength. However when the light arrives at earth and passes through the slit, the first minimum is farther from the central maximum. What qualitative statement can you make about the motion of the galaxy? Explain.

6) (15 points) Two speakers are driven in phase by the same 2kHz signal. They are separated by 1m. You are standing on the centerline 20m from the speakers.



In that position, the sound intensity is I_0. If you step 1m off the centerline, by what factor does the sound intensity decrease?
Use 300 m/s for the speed of sound.