Problem Set IX- Assign November 8, 2006 Due November 15, 2006.
Fall 2006 Physics 200a
R. Shankar

1. Write the equation for a wave moving along $+x$ with a amplitude $.4m$, speed $6m/s$ and frequency $17Hz$. If these are waves on a string with mass per unit length $\mu = .02kg/m$, what is the u, the energy per unit length ? What is the power being fed into the vibrating string?

2. The speed of sound in water and air is $1450m/s$ and $330m/s$ respectively. Sound from explosion on the surface of a lake first reaches me when my head is under water and $5s$ later when my head is above the water. How far away was the explosion?

3. A block of mass M sits on an frictionless inclined plane of angle $\alpha = \pi/4$ as in Figure (1). It is connected by a wire of linear mass density $\mu = .03kg/m$ that goes over a pulley that supports mass m. Both masses are at rest. If transverse waves travel at $v = 80m/s$ in the wire find M and m, using symbols till the end. Ignore the mass of the string in computing the tension on the string, use it just to find the velocity of waves.

4. What is the ratio of sound intensity for which the difference is $1dB$?

5. A source of sound in three dimensions radiates uniformly in all directions. Along a radial line from the source are two points separated by $2m$ such that the intensity at the nearer point is $4dB$ above that of the more distant point. How far is the nearest one from the source?

6. I place a massless speaker emitting sound at $600Hz$ on top of a mass connected to a spring. I now set the mass-spring system in an oscillatory state, vibrating horizontally at $4\ Hz$ with an amplitude A. Given $v_{sound} = 330m/s$, and that the difference between the highest and lowest frequencies I hear is $2Hz$, what is A? If I now turn another identical sound source, what will be the largest beat frequency I will hear?
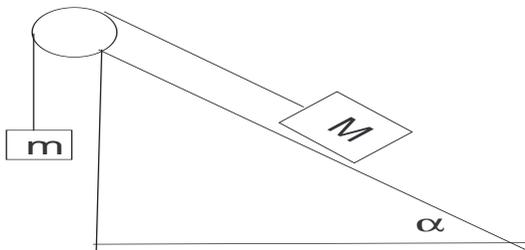
FIG. 1. The masses are at rest and the wire carries transverse waves at $v = 80m/s$.
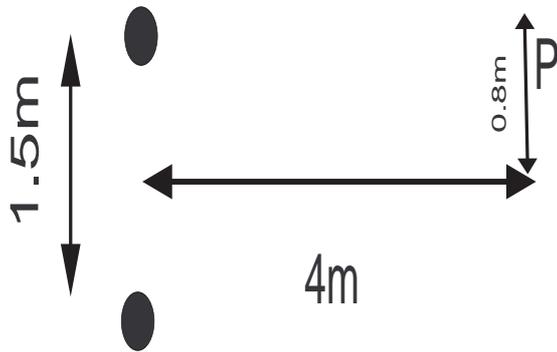
FIG. 2. The speakers are 1.5 m apart. The first minimum occurs $4m$ to the right, $0.8m$ above the line of symmetry, at point P.

7. A mass M hangs vertically at the end of a cable of mass m and length L.
   (i) How long will take a transverse pulse to travel from bottom to top if you ignore m, the cable mass?
   (ii) Now repeat, including m and remembering that the velocity of the signal varies with the distance from bottom end. Show that the answer reduces to part (i) if you set $m = 0$.

8. Two speakers emitting sound at 550 Hz are 1.5 m apart. The first destructive interference takes place $4m$ to the right and $0.8m$ above the line of symmetry, as in Figure 2. What is the velocity of sound? Do this using the Pythagoras theorem to calculate distances exactly and compare to the small-angle approximation $d \sin \theta = (n + \frac{1}{2})\lambda$.

9. The ear canal is about $3cm$ long and can be viewed at a tube open at one end and closed at the other. relate this to the fact that we seem to hear best at around 3000 Hz.

10. Longitudinal waves on a metal rod travel at $3450m/s$. Find two of the lowest standing wave frequencies on a rod of length $2m$ clamped at one end and free at the other. Draw figures. Repeat if rod is clamped at both ends.

11. How far part are the nodes on a string 80 cm long vibrating at 1600 Hz assuming a wave velocity of $320m/s$.