Chapter 2 Questions
Cracks in the Mortar

1. Briefly define the following wave properties:
   frequency --

   wavelength --

   amplitude --

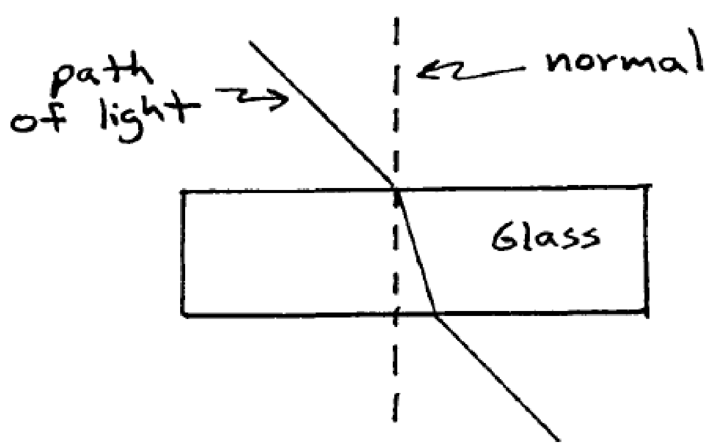
2. What wave property allows you to hear someone conversing in the hallway when you are in the classroom? Explain. (Assume the door is open.)

3. What wave property produces "dead spots" (spots where sounds seem muffled) in a concert hall? Draw pictures to explain.

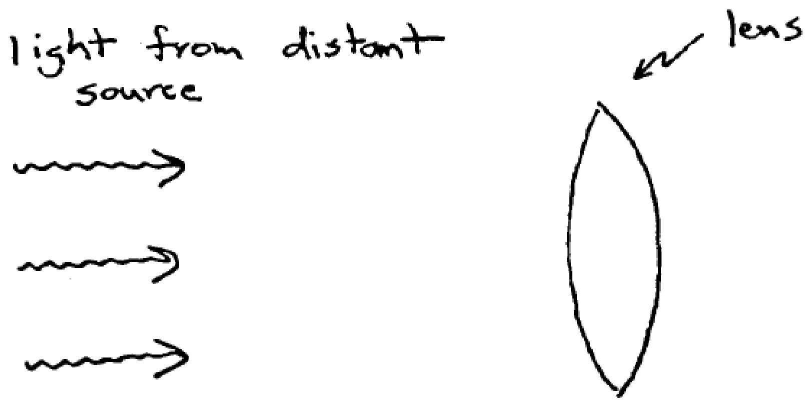
4. An AM radio station applies for a license to broadcast at a wavelength of 50 meters. The FCC agrees to approve the license only if the station blocks its signal to the south, where there is another station broadcasting at the same wavelength. The station engineer says that by building two antennas, the new station can meet the FCC requirements. How does the engineer propose placing the two antennas?

5. The speed of light is about $3 \times 10^{10} cm/sec$. Red light has a wavelength of about $4 \times 10^{-5} cm$ (that is 0.00004 cm).Calculate the frequency of red light. (Hint: Use the relation $c = \lambda f$.)

6. Telescope lenses use refraction to focus light. When light passes from air to glass, it bends toward the normal (the line perpendicular to the surface of the glass).



   Conversely, when light passes from glass to air, it bends away from the normal. Trace the paths of light beams through the bi-convex lens illustrated below to show how astronomers can use the lens to focus parallel beams of light (e.g. light from a distant star). (To focus is to make the parallel beams converge at a single point.)

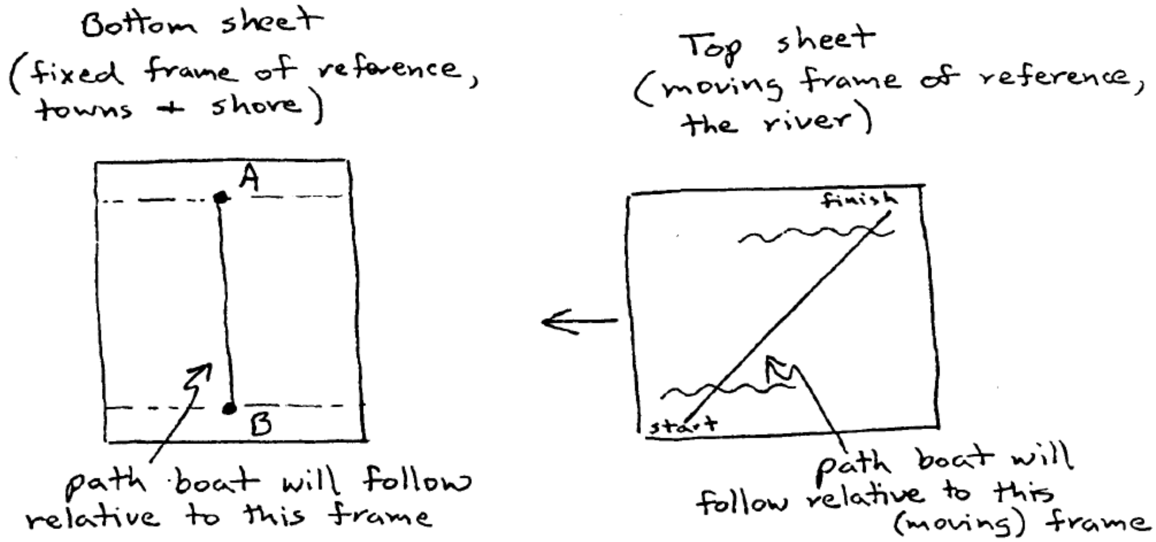


7. A ship receives warning of an approaching tidal wave. The captain orders the vessel to sail into the lee of an island for protection, but the first mate warns the captain such a position may subject the ship to waves of even higher amplitude. Explain why the mate is concerned.(Hint: think in terms of wave diffraction and interference.)

8. Suppose Michelson and Morley had no mirrors with which to build their experimental apparatus. Can you design another apparatus to test for the effects of the ether?

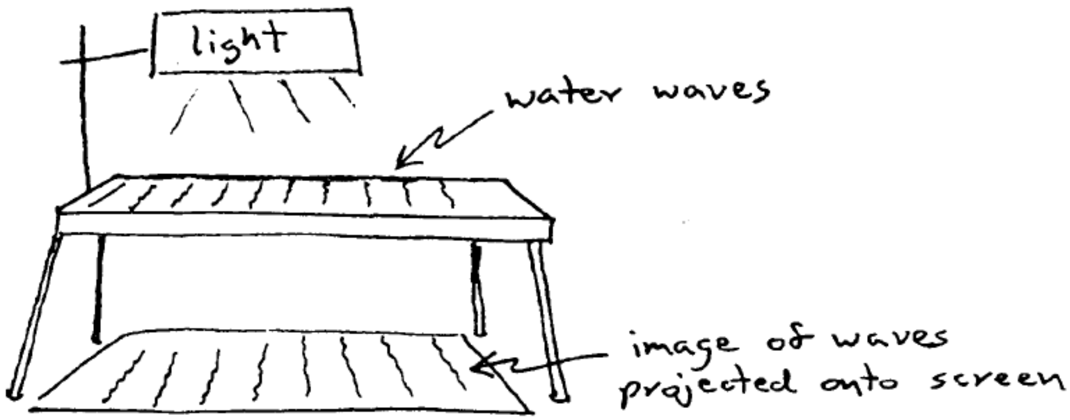
Chapter 2
Experiments

1. Moving frames of reference: •
   Find a piece of paper and a sheet of clear plastic, such as the sheets used on overhead projectors, both 8 ½ by 11 inches. Also find a matchbox car that rolls smoothly and easily. Consider the paper the fixed frame of reference of the shore along a river. Draw a straight line across it from town A on one shore to town B on the other, and tape it to a table top. Consider the plastic the frame of reference of water flowing down the river. This frame of reference (the water) moves with respect to the first. Orient this sheet between the "shores" of the fixed frame of reference.

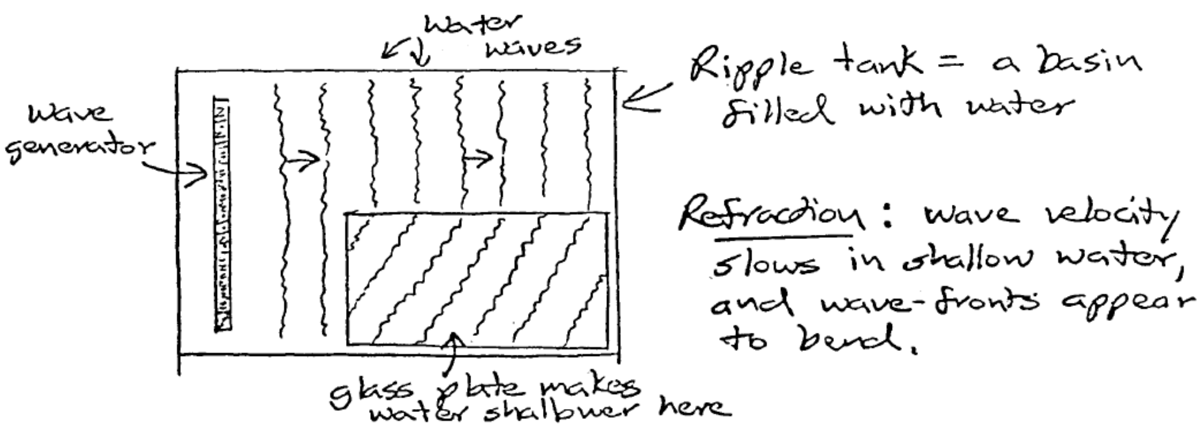


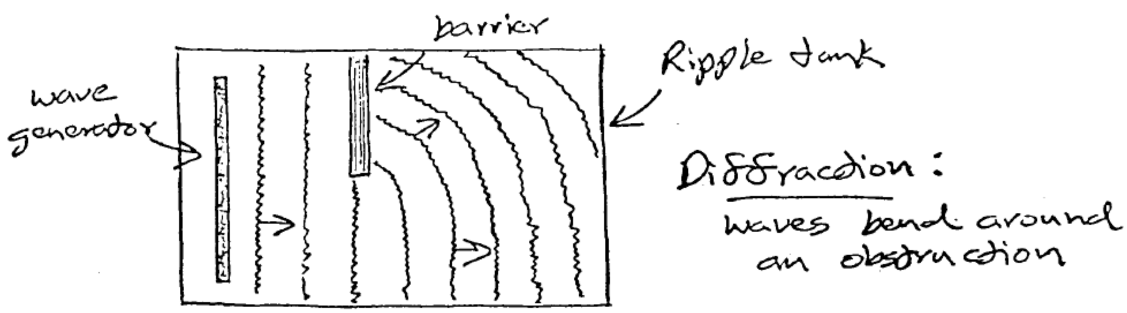
Attach a 12 inch string to its bumper and place the car on the plastic "river" (imagine the car is a boat). Pull it on a diagonal across the "river" so that, as the river "current" flows past the towns, the car rolls on a straight line (relative to the fixed paper frame) between A and B. With some practice, you can demonstrate that the "boat" must traverse a longer (diagonal) path on the frame of reference of the river in order to cross directly between the two towns.

4. Wave phenomena in a ripple tank:
   A ripple tank is a shallow tray with a glass bottom. Light shining through the tank projects wave motion on ascreen below. If you do not have a pre-built ripple tank, you can fashion one from a rectangular glass baking pan. Put the pan on an overhead projector and project the waves on a screen,or place it on white paper under a bright light.

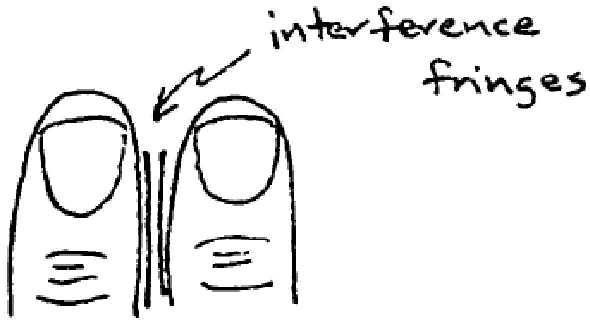


You can readily demonstrate the following wave phenomena:





5. Wave behavior of light: •
   You can demonstrate interference of light waves rather simply: hold your thumbs nearly touching each other about two or three inches from your eye, and look toward a bright light. You will see interference fringes – alternating bright and dark bands – in the slit between your thumbs. (Or, instead of your thumbs, try looking through the slit between two nearly-touching playing cards.)

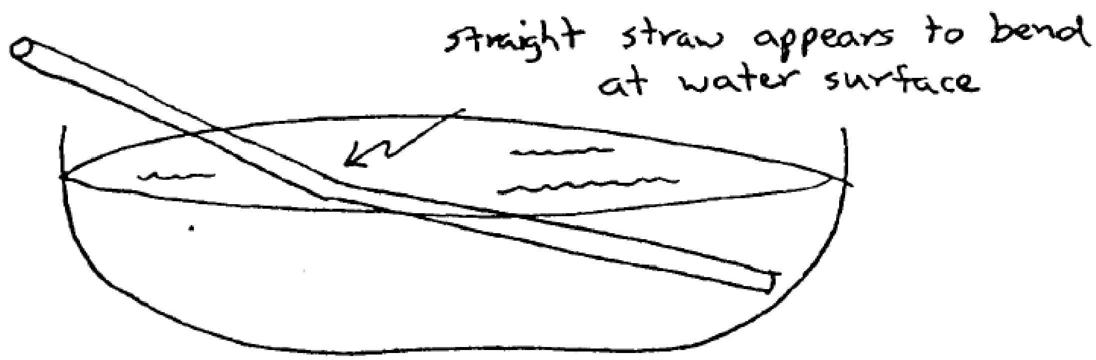


If your school laboratory has a laser, try the following: Set the laser on a table top. Note where the beam hits the wall. Now hold a lens in the beam and note how the lens "bends" (refracts) the path of the beam to a new position on the wall.

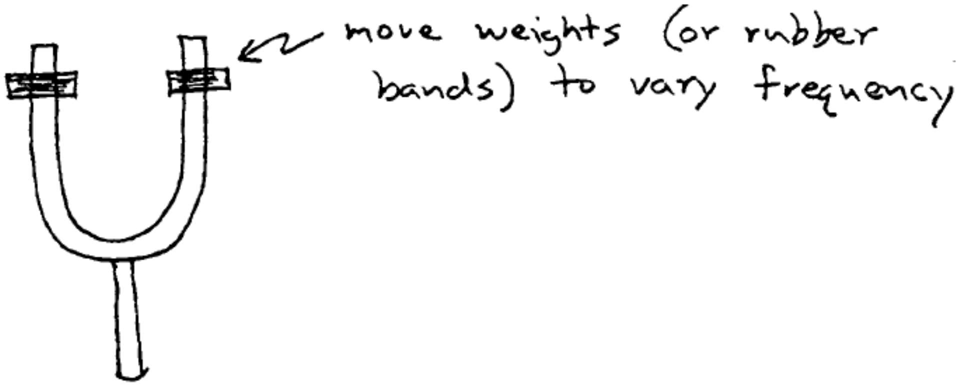
Hold a playing card, or other opaque object with sharp edge, in the beam. Note how the card "spreads" the beam (by diffraction) on the target wall.

Hold a diffraction grating in the path of the beam. (Best, set the grating in a stable holder.) What happens tothe beam after it passes through the grating, and why?

6. <u>Refraction</u>: •
   Put a straight drinking straw in a bowl of water.   Look at it from above and somewhat to the side. What is the apparent shape of the straw, and why?



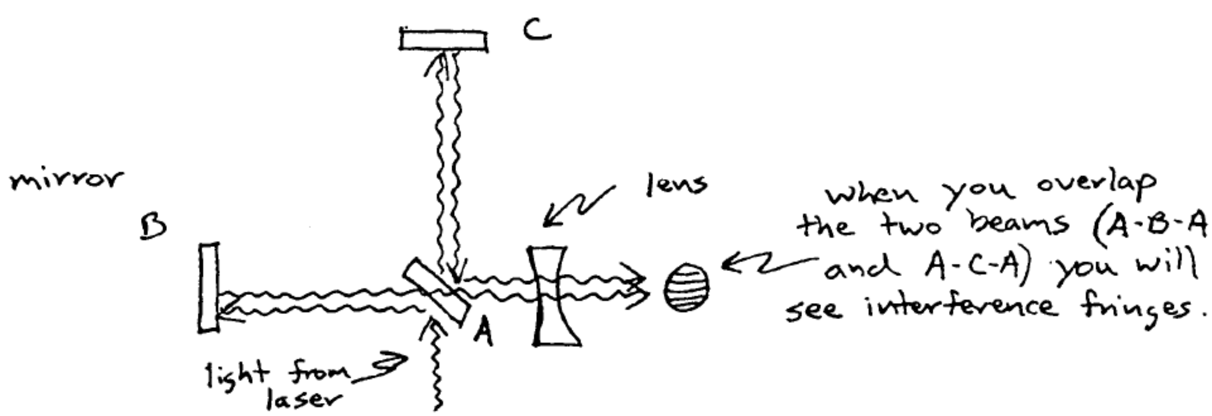
7. <u>Interference of sound waves</u>:
   Find two tuning forks of the same pitch (same frequency). For this experiment, one of them should be adjustable: a sliding weight can vary the frequency.   If the adjustable fork is not available, wrap rubber bands around the tines of one fork to vary the pitch.



Strike the forks simultaneously, and listen for "beats:" the loudness varies in intensity, louder, softer, louder, softer . . . , at a (beat) frequency that depends on the difference in the frequencies between the two forks. What do the beats represent? What happens to the beat frequency if you increase the frequency difference between the two forks (more rubber bands, or increase the displacement of the adjustable weight)?

Now set the forks at the same frequency, and place them, vibrating, two or more feet apart. Slowly walk a semi-circle in front of the forks. Do you notice any variation in loudness at different locations? Why?

7. The Michelson interferometer:
   Your school laboratories may have access to a Michelson interferometer and laser. If so, align the laser and mirrors so the beams from the two light paths overlap. Spread the output beam with a concave lens, so you can see the interference pattern. What happens to the interferencepattern if you change the length of one of the paths?



Put the apparatus on a cart, and reproduce the Michelson-Morley experiment: do you see any change in the interference pattern as you rotate the cart relative to the presumed "ether current?"