Introduction:

In this week's we will investigate a variety of wave properties using water waves and sound waves. In the first experiment we will investigate the properties of water waves in a ripple tank, and in the second we will investigate standing waves in an air column

Experiment 1: Ripple Tank

Procedure:

Wave Speed, Wave Length and Frequency

Before turning the tank on touch the water at the back of the tank with a pencil or pen, and observer the wave pulse as it travels towards the front. Time how long it takes to reach the edge of the tank. Measure the distance the wave travels. How fast is it moving? Now put the dipper attached to the ripple generator into the water and turn the vibrator on. You should see periodic waves moving in circles away from the source. To measure the wave length we'll "freeze" the waves by adjusting the generator so it flashes with the same frequency as the flashing light (about 60 hz). That way, each time the light flashes the waves move forward by one wavelength. Now measure the wavelength (it is better to measure 10 wavelengths and then divide by 10). Find the wave speed.

Two Source Interference

Turn off the ripple generator; replace the single dipper with double dippers.
Adjust the two dippers so they barely touch the surface of the water and so that they are separated by a distance *d* of about 4-5 cm. Turn on the ripple generator, and adjust the strobe as above. Draw the pattern you see in your lab notebook. The constructive interference of wave fronts appears as lines of alternating bright or dark spots. The destructive interference of wave fronts appears as grey lines with little disturbance. Label the lines appropriately in your lab notebook. Measure the angle of each of the lines of maximum displacement and confirm the equation, $d \sin \theta = m\lambda$, where to *m* is the order (1, 2 etc) of the line of constructive interference decrease the distance *d* between the two point dippers to 2-3 cm and repeat the experiment. Explain the changes in the interference pattern with variation of distance between dippers.

Diffraction

Turn off the ripple generator; replace the two standard dippers, with the plane wave dipper. Now observe the wave motion. Place two barriers parallel to the plane wave close to the plane wave dipper. Leave a gap of about 4-5 cm, and sketch the pattern in your lab notebook. Measure the angle of any lines of destructive interference that you see and confirm the equation, $a \sin \theta = \lambda$,for the angle of diffraction, where *a* is the gap width.

Refraction
Remove the barriers and place a transparent piece of Plexiglas in the tank with its edge parallel to the plane waves in. Make sure there is sufficient water to *barely* cover the surface. Measure the wave length of the waves when they are over the Plexiglas. Determine the speed. Now change the angle of the edge of the glass so that it is 45 degrees to the incident plane wave. Measure the angle the refracted wave makes with edge of the class. Is this angle more than or less than 45 degrees?

Equipment
- 6 Ripple tanks and accessories
- 6 Stopwatches
- 6 Rulers and protractors

Experiment 2: Standing Waves

The fundamental frequency of vibration f of sound in a column that is closed at one end and open at the other depends on the length of the column L and the velocity of sound in air v according to the relation

$$f = \frac{v}{4L}$$

The purpose of this experiment is to verify the relationship between frequency and length and hence determine the velocity of sound in air.

Procedure:
A tall plastic tube partially filled with water is used as a resonance column. The length of the column can be adjusted by changing the level of the water. To cause the air to vibrate in the column a tuning fork can be placed at the open end. When the frequency of the tuning fork is at the fundamental frequency the tube will resonate resulting in a note that is louder than normal (but with the same frequency as the tuning fork).

Hit the tuning fork on the sole of you shoe and place it near the open end. Then adjust the level of the water until you hear resonance. It is easiest to start with the water level high and then let it fall. Once you have a rough idea of where the resonance level is get a more accurate reading by allowing the water level to fall more slowly. Repeat the using as many different tuning forks as you can.

Use the concept of proportionality to test the above relationship and to determine the speed of sound. Compare to the expected value. Note: In practice the effective length of the column is longer than the physical length because the sound wave extends beyond the open end of the column by a small amount called the end correction. The end correction is expected to by about one third of the diameter of the tube, so you might want to add that to the lengths before testing for proportionality.

Equipment
- 6 clear plastic tubes with rubber stoppers and rubber hose with clamp
- Tuning forks
- 6 Meter sticks, and masking tape
- Basin for holding water.