Have the students line up as shown below ( top view). The listener will need a stopwatch

1. Have the students line up about 2 m apart. This is done easily if they hold a measuring tape. Each pair of opposing students represents a wave crest.
2. Students ( the waves) should practice walking towards the listener at a steady pace.
3. Once they are able to do so the listener should determine the wave frequency ( count the number of waves and measure the amount of time ) . The wave speed can be found my multiplying the number of waves by 2.0 m and divide by the time. Have the wave crests clap as they pass the student to reinforce the point.

number of waves\_\_\_\_\_\_ time \_\_\_\_\_ frequency \_\_\_\_\_ speed \_\_\_\_\_

1. They should then repeat this process but have the listener walk towards the waves. You will need to measure the distance the listener walks to determine their speed

number of waves\_\_\_\_\_\_ time \_\_\_\_\_ perceived frequency \_\_\_\_\_ walker speed \_\_\_\_\_

1. Finally have the listener move in the same direction as the wave but more slowly than the wave.

number of waves\_\_\_\_\_\_ time \_\_\_\_\_ perceived frequency \_\_\_\_\_ walker speed \_\_\_\_\_

**Questions**

1. How did the actual frequency of the waves change when the observer moved towards or away from the waves?
2. How did the perceived frequency of the waves change when the observer moved towards the waves?
3. How did the perceived frequency of the waves change when the observer moved away from the waves?
4. Under what conditions would the perceived frequency be zero?
5. Use the speed of the walker in parts 4 and 5 and the speed of the wave in part 3 to calculate what the perceived frequency should have been and compare it to the measured values using the equation