Sound and Waves

Equipment

- Various tuning forks
- Microphone
- Resonant objects

Waves	
Velocity	$v = \lambda f$
Wave Equation	$y(x,t) = A\sin(kx - wt + \phi)$
Wave number	$k = \frac{2\pi}{\lambda}$
Angular frequency	$w = 2\pi f$

Objective

Data collection

- Quantitative analysis of sound wave

Data analysis

- Measure frequency

Physics Concepts

- Wave equation
- Fourier Transform gives frequency spectrum of time data
- Connection between Reciprocal-Space and Real-Space

Conceptual (C-Level)

Sketch a picture of a sinusoidal wave and identify the wavelength, period and amplitude.

- Are the wavelength and period of a wave related?

The most general form for a wave is the wave equation (see above).

- Write the wave equation for a wave with 2 cm amplitude, 2 second period, 3 cm wavelength and a phase shift of 0.
- Draw *y* vs. *x* for this wave at t = 3 seconds.
- Draw *y* vs. *t* for this wave at x = 5 cm.
- How do your functions change if the phase shift is $\pi/2$?

EXPLORE: Determine your ability to produce a pure note. Try to sing a C or A and see how many other frequencies get mixed in. Determine your "voice print" saying a word. Compare to your group mates. You should look at both the time and frequency space graphs. Could you use a person's "voice print" as a unique identifier? In other words, could CSI Moorhead use the voice recording from a crime scene and match it to a suspect? What would be easier or more reliable to use – the frequency spectrum or the time spectrum graphs?

Basic Lab (B-level)

- Determine the frequency of sound from a tuning fork:
  - Measure the period of oscillation from a sinusoidal curve-fit to the recorded wave.
  - Examine the frequency spectrum (take the Fourier Transform of your data).
- Examine the frequency spectrum of a solid rod and determine if it behaves like a open pipe, closed pipe or pipe with one open end.

Advanced/Extended Lab Ideas (A-level)

- Using a function generator compare the higher order harmonics present in sinusoidal, triangle and square waves. You will probably need a speaker to connect to the function generator.
- Demonstrate constructive and destructive interference.
- Examine the beat frequency (in both Fourier and real space) for two similar sound sources.
- Determine the sound intensity as a function of distance.
- What might you be curious to investigate?