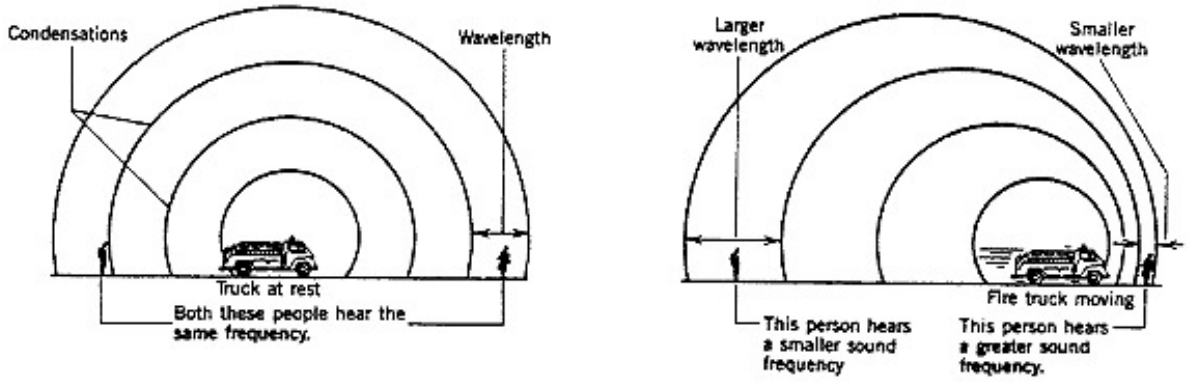
Activity: Doppler Effect

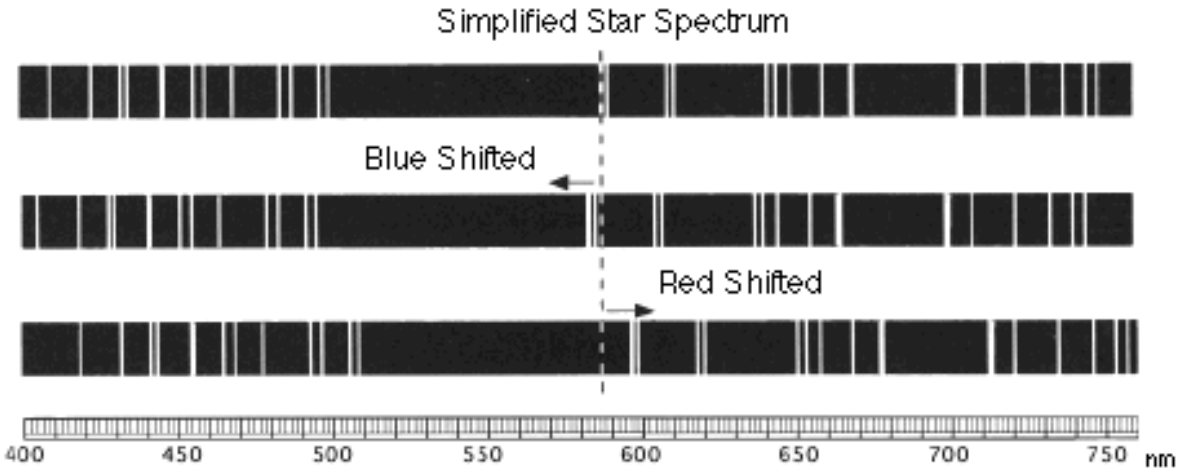
Background:

- The Doppler effect causes a train whistle, car, or airplane to sound higher when it is moving towards you, and lower when it is moving away from you.



From: http://www.physics.purdue.edu/astr263l/inlabs/doppler.html

- For sound: high pitch = high frequency = short wavelength
- Light is also a wave, and affected by the Doppler effect
  - longer wavelengths (lower frequencies) of light appear redder
  - The spectrum of a star moving *towards* you will appear blueshifted (shorter wavelengths / higher frequencies)
  - The spectrum of a star moving *away from* you will appear redshifted (longer wavelengths / lower frequencies)



From: http://www.astrosociety.org/education/publications/tnl/55/astrocappella3.html

Lab Materials:

- computer with internet access

Activity:

Doppler Basics:

- Go to: http://www.fearofphysics.com/Sound/dopwhy2.html

1. Watch the waves reaching your ear if:
   - the source moves *towards* your ear at 100 meters / second
   - the source moves *away* from your ear at 100 meters / second
     a. In which case is the frequency of sound higher?

     b. In which case is the wavelength of the sound waves longest?

     c. If these were light waves, in which case would the light reaching your eye be redder?

     d. If these were light waves, in which case would the light reaching your eye be bluer?

2. Watch the waves reaching your ear if:
   - the source moves *away from* your ear at 100 meters / second
   - the source moves *away from* your ear at 200 meters / second
     a. In which case is the frequency of sound higher?

     b. In which case is the wavelength of the sound waves longest?

Doppler Shifting of Spectral Lines:

- Go to: http://www.classzone.com/books/earth_science/terc/content/visualizations/es2802/es2802page01.cfm?chapter_no=visualization

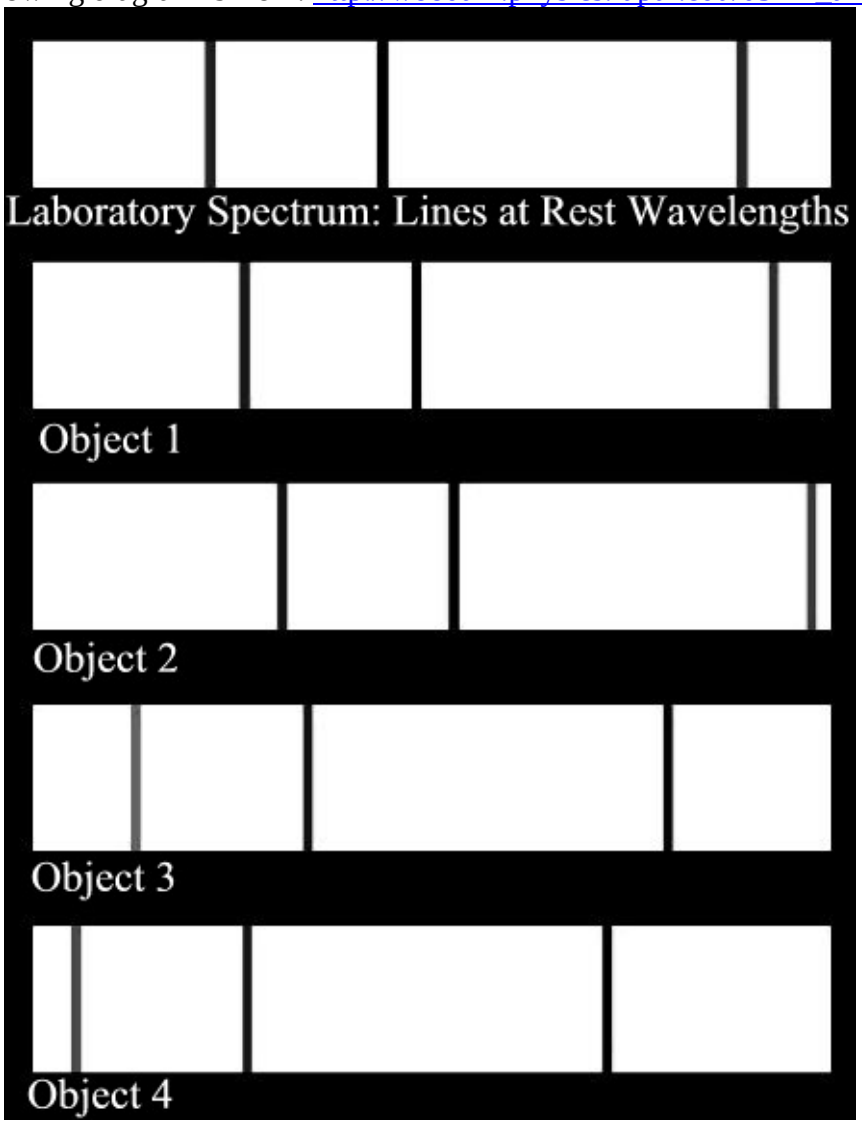
3. Adjust the motion of the star (both towards and away) and its speed relative to the Earth.
   a. Describe what happens to the spectrum of the star if it is moving towards Earth. What if it is moving away from Earth?

   b. Describe what happens to the shift in the spectrum of the star if the star moves more quickly.

4. Go to: http://www.pbs.org/wgbh/nova/universe/moving_nf_04.html
   a. Order the spectra, starting with the one that is moving the fastest toward us and ending with the one that is moving the fastest away from us. What sequence do you come up with?

   b. Scroll to the bottom of the page to make sure you got it right.

5. The following diagram is from: http://woodahl.physics.iupui.edu/05-22_anno.jpg



   a. Which objects are moving towards Earth? _____

   b. Which object is moving towards Earth fastest? _____

   c. Which objects are moving away from Earth? _____

   d. Which object is moving away from Earth fastest? _____

Astronomical Applications:

- Go to: http://www.astronomy.ohio-state.edu/~pogge/Ast162/Movies/specbin.html
- Watch the movie:
  - The top panel shows two stars (Blue = "A"; red = "B") orbiting one another. The green dot represents the Earth. This diagram is NOT TO SCALE.
  - The bottom panel shows the combined absorption-line spectrum of the stars (with the lines from each star labeled "A" and "B"). A thin "stationary" absorption line appearing between the two lines shows the un-shifted location of each line.

6. From your examination of the movie and what you've learned so far:
   a. Which star is moving faster in its orbit: "A" or "B"?

   b. Which star's absorption lines show the largest Doppler shifts: "A" or "B"? Explain why.

   c. How is star "B" moving relative to Earth when its lines are shifted the most to the blue?

   d. How is star "B" moving relative to Earth when its lines are shifted the most to the red?

- Go to: http://www.howstuffworks.com/planet-hunting2.htm
- Read the material and watch the animation.

7. How do we use the Doppler effect to help us detect the presence of planets around other stars?