Announcements – 9 Dec 2014

1. Prayer
2. Tutorial lab: Open during reading days and finals, but the TAs have their own exams to worry about, so staffing may vary significantly from normal.
3. Rate the tutors: http://gardner.byu.edu/tas/tutorrating.php
4. Upcoming dates:
   a. Wed Dec 10 - Y Cappella Showcase, 7 pm Varsity Theater $3
   b. Wed Dec 10 - HW 28 due (final homework!)
   c. Thu Dec 11 - last day of class
   d. Thu Dec 11, 5:30 – 7 pm - Jerika final exam review, C295 ESC
   e. Fri Dec 12, 6 – 7:30 pm - Jerika final exam review, C295 ESC
   f. Fri Dec 12 - All extra credit & late HW must be turned in by midnight; this includes all TA-graded stuff as well as all computer-graded stuff
   g. Sun Dec 14 - BYU Instructor/course ratings due http://studentratings.byu.edu (2 pts extra credit)
   h. Tue Dec 16 - Final exam in class (7-10 am or 8-11 pm)
   i. Wed or Thu Dec 17-18 - Final exams graded, uploaded
5. Photo contest results!
“Which of the problems from last night's HW assignment would you most like me to discuss in class today?”
Standing waves

Combination of forward- and backwards-moving waves


Can be caused by reflection

Web demo:
http://www.colorado.edu/physics/phet/simulations/stringwave/stringWave.swf
When caused by reflection

Only certain vibration frequencies give you a stable pattern.
Demos

¼ inch tubing
“ladies belt” jig saw
Patterns

What kinds of patterns can you get?

Different stable frequencies called: H______________
Harmonics of string, both ends fixed ("closed-closed")

What are the frequencies of these harmonics?

1. 
2. 
3. 

The pattern: \[ f_n = n \times f_1 ; \quad n = 1, 2, 3, \ldots \]
Standing waves in air

Demos: trumpet harmonics
Harmonics of pipes, “open-open”

Same pattern as before: $f_n = n \times f_1$; $n = 1, 2, 3, \ldots$
"Open-closed" pipes

The pattern: \[ f_n = n \times f_1 ; \quad n = 1, 3, 5, \ldots \]
From warmup
You have two pipes which produce sound: one is open at both ends (like an organ pipe) and the other is open at only one end (like a panpipe). If the two pipes have the same length, the fundamental resonant frequency will be ___________ for the two.
   a. the same
   b. different

**Demo:** pipe with removable cap
Demo
Flame tube standing waves
Worked problem
A 2.0 m long air column is open at both ends. The frequency of a certain harmonic is 410 Hz, and the frequency of the next higher harmonic is 492 Hz. Determine the speed of sound in the air column.

Answer: 328 m/s
From warmup

If a vibration is made to happen at a natural oscillating frequency of an object, this is called:

a. beats
b. harmonics
c. resonance
d. standing waves
e. traveling waves
Resonance

Regarding swings and springs…
Demos

Tuning fork sympathetic vibrations
Trumpet, again
Beats

Beats

\[ f_{\text{beat}} = |f_1 - f_2| \]
Demos

Tuning fork beats
Beating “hoot tubes”
From warmup
Ralph read in the textbook that standing waves are produced through the interference between two waves. He also read that beating is similarly produced by the interference between two waves. He is now confused--what makes the difference between when interference between two waves gives you a standing wave and when it gives you beats?

“Think-pair-share”
- Think about it for a bit
- Talk to your neighbor, find out if he/she thinks the same as you
- Be prepared to share your answer with the class if called on

Clicker: I am now ready to share my answer if randomly selected.
   a. Yes

Note: you are allowed to "pass" if you would really not answer.
From warmup
A flute and a clarinet both play the same note at exactly the same pitch. They each have a microphone which picks up the sound wave oscillations. T/F: If each microphone's signal is graphed, the two graphs will look the same.
   a. true
   b. false
Tone quality

Real sounds are not pure sine waves
Different shapes → Different harmonics

\[ \text{In[2]} := \text{Plot}[\sin(x), \{x, -15, 15\}] \]

\[ \text{Out[2]} = \]

\[ \text{In[6]} := \text{Plot}[\sin(x) + 0.5 \sin(2x) + 0.33 \sin(3x), \{x, -15, 15\}] \]

\[ \text{Out[6]} = \]

\[ \text{In[7]} := \text{Plot}[\cos(x) - 0.6 \cos(2x) + 0.1 \cos(5x), \{x, -15, 15\}] \]

\[ \text{Out[7]} = \]
Spectrum analyzer
Demo

“Spectrum Lab” program