

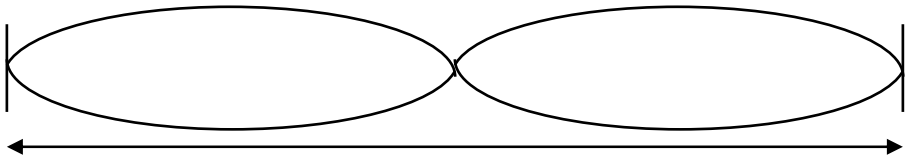
# Announcements – 12 Dec 2013

1. Tutorial lab info: I think it will be open during reading days and finals, but the TAs have their own exams to worry about so staffing may vary significantly from normal.
  
2. Upcoming dates:
  - a. HW 27 – due tonight... but no penalty if turned in before tomorrow (Friday) midnight. Click on calendar on Max to see HW link.
  - b. All TA-graded extra credit and late FBDs must be turned in by midnight Fri, Dec 13
  - c. TA final exam reviews: Fri Dec 13 and Sat Dec 14, both 12:00 – 1:30 pm, C215 ESC.
  - d. BYU Instructor/course ratings must be done by Sun, Dec 15.  
<http://studentratings.byu.edu>
  - e. Rate the tutors, due \_\_\_\_\_. <http://gardner.byu.edu/tas/tutorrating.php>
  - f. Final exam in Testing Center anytime during finals week, Mon – Fri
  - g. All computer-graded late homework must be turned in by midnight Fri, Dec 20
  - h. Possible Colton survey, due Friday Dec 20.
  - i. Grades finalized: Mon Dec 23 (hopefully)

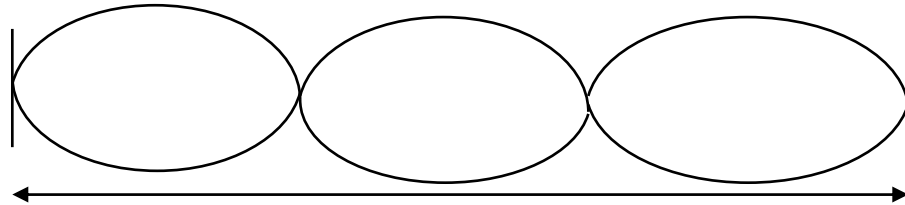
# Harmonics of string, both ends fixed (“closed-closed”)



$$L = \underline{\hspace{2cm}}$$



$$L = \underline{\hspace{2cm}}$$



$$L = \underline{\hspace{2cm}}$$

L

What are the frequencies of these harmonics?

- 1.
- 2.
- 3.

The pattern:  $f_n = n \times f_1 ; n = 1, 2, 3, \dots$

# Standing waves in air

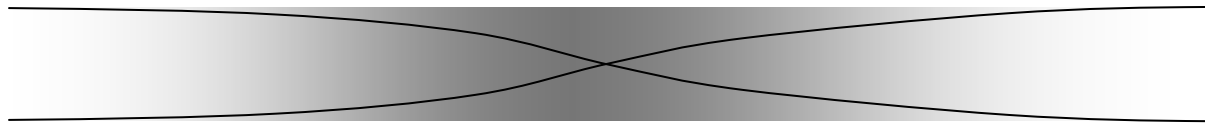
**Demos:** trumpet harmonics

# Harmonics of pipes, “open-open”

Open end

Open end

frequencies



L = \_\_\_\_\_



L = \_\_\_\_\_



L = \_\_\_\_\_

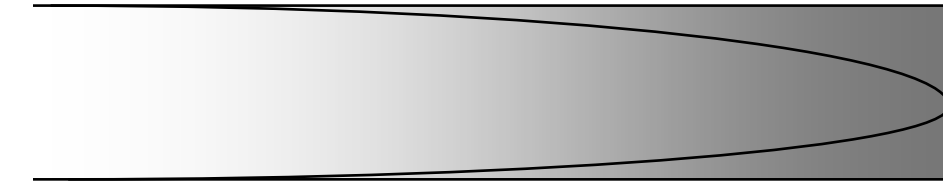
← L →

Same pattern as before:

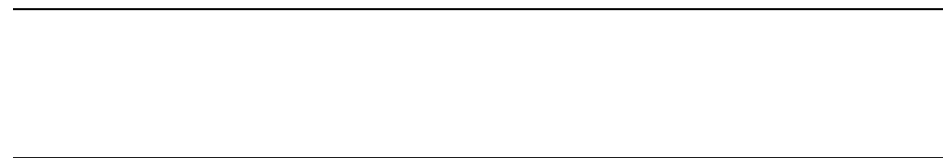
$$f_n = n \times f_1 ; n = 1, 2, 3, \dots$$

# “Open-closed” pipes

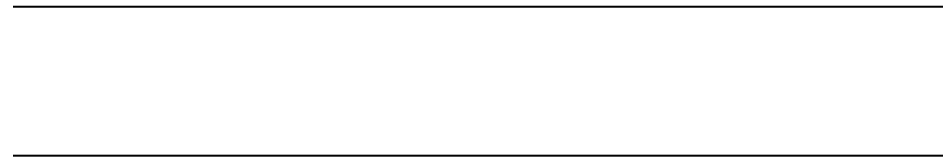
frequencies



$$L = \frac{\lambda}{4}$$



$$L = \frac{3\lambda}{4}$$



$$L = \frac{5\lambda}{4}$$



The pattern:  $f_n = n \times f_1 ; n = 1, 3, 5, \dots$

## From last 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

## 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

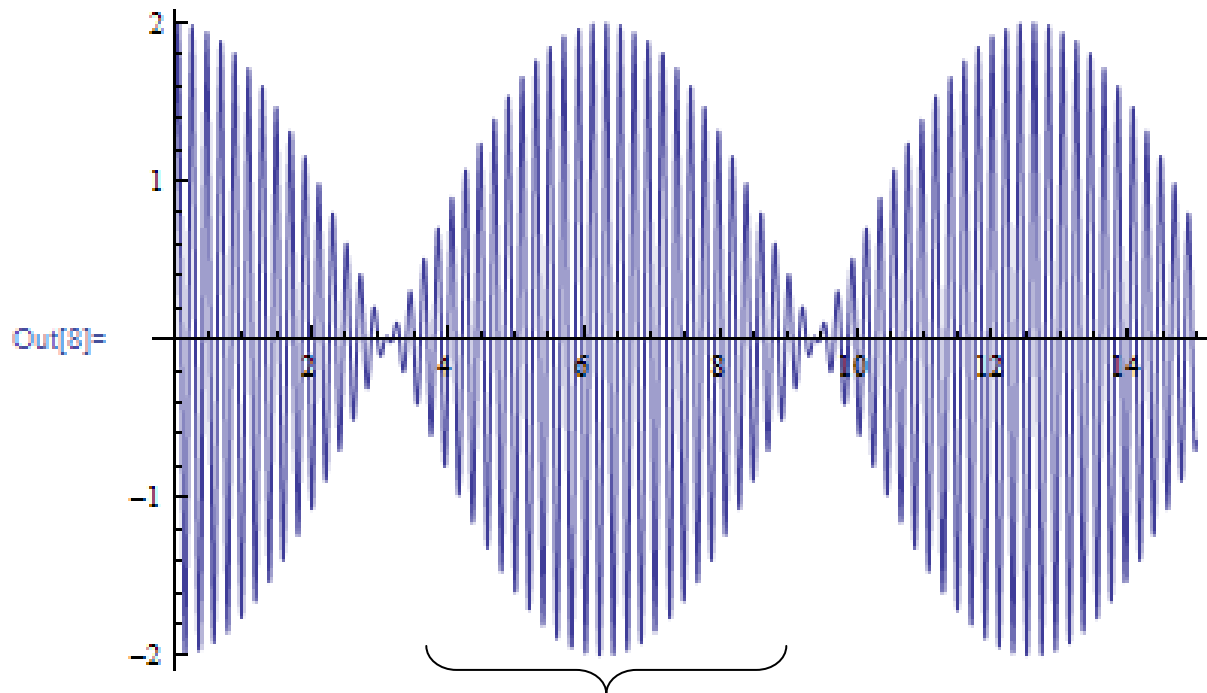
Tuning fork sympathetic vibrations  
Trumpet, again

# Beats

```
In[3]:= f[t_] = Sin[30 t] + Sin[31 t]
```

```
Out[3]= Sin[30 t] + Sin[31 t]
```

```
In[8]:= Plot[f[t], {t, 0, 15}]
```



“beat period”

“beat frequency”:  $f_{beat} = |f_1 - f_2|$

# 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 give you beats?

**“Pair share”**—I am now ready to share my neighbor’s answer if called on.

a. Yes

## From warmup

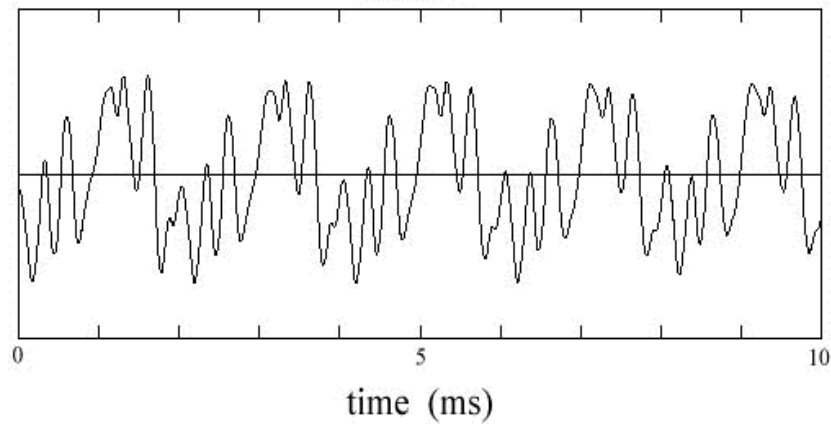
A flute and a clarinet both play the same note. They each have a microphone which picks up the sound wave oscillations. T/F: If each microphone's signal is graphed, the two graphs will look the same.

- a. true
- b. false

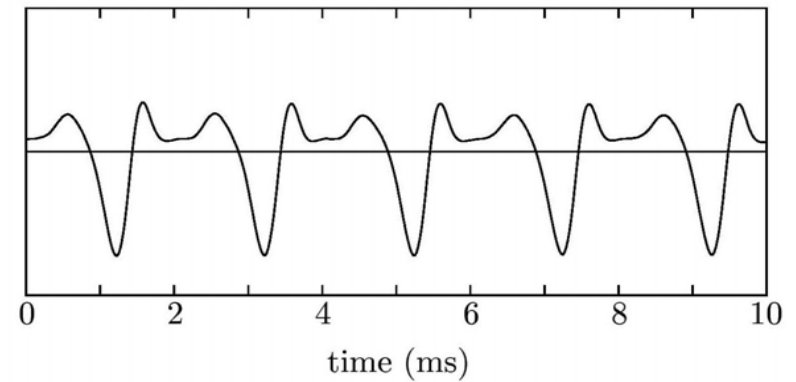
# Tone quality

Real sounds are not pure sine waves

Violin

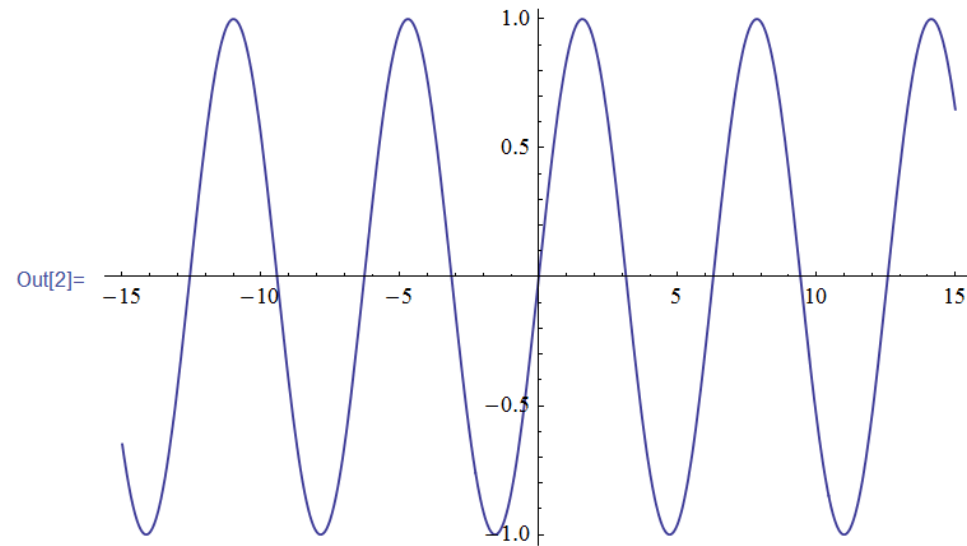


Trumpet

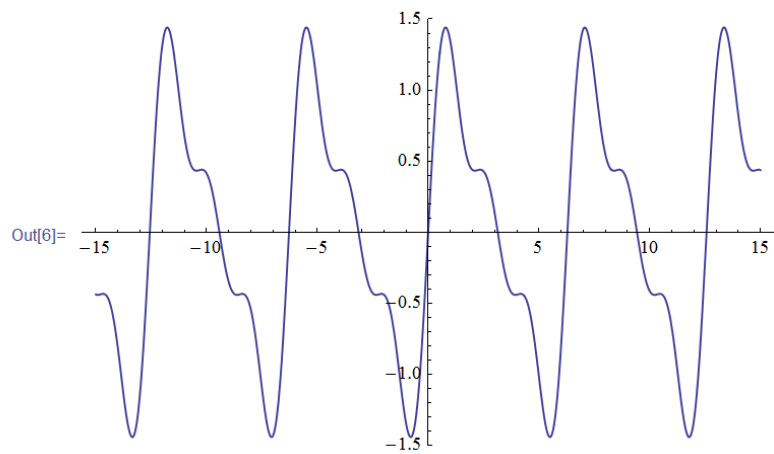


# Some Plots

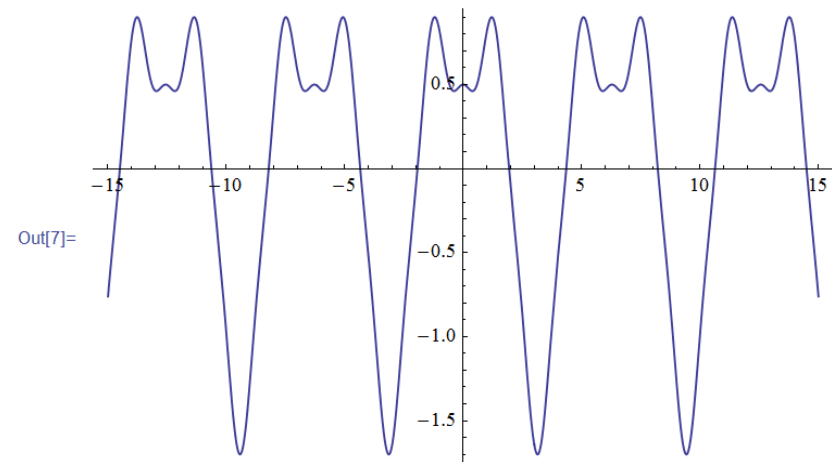
```
^ In[2]:= Plot[Sin[x], {x, -15, 15}]
```



```
^ In[6]:= Plot[Sin[x] + 0.5 Sin[2 x] + 0.33 Sin[3 x], {x, -15, 15}]
```



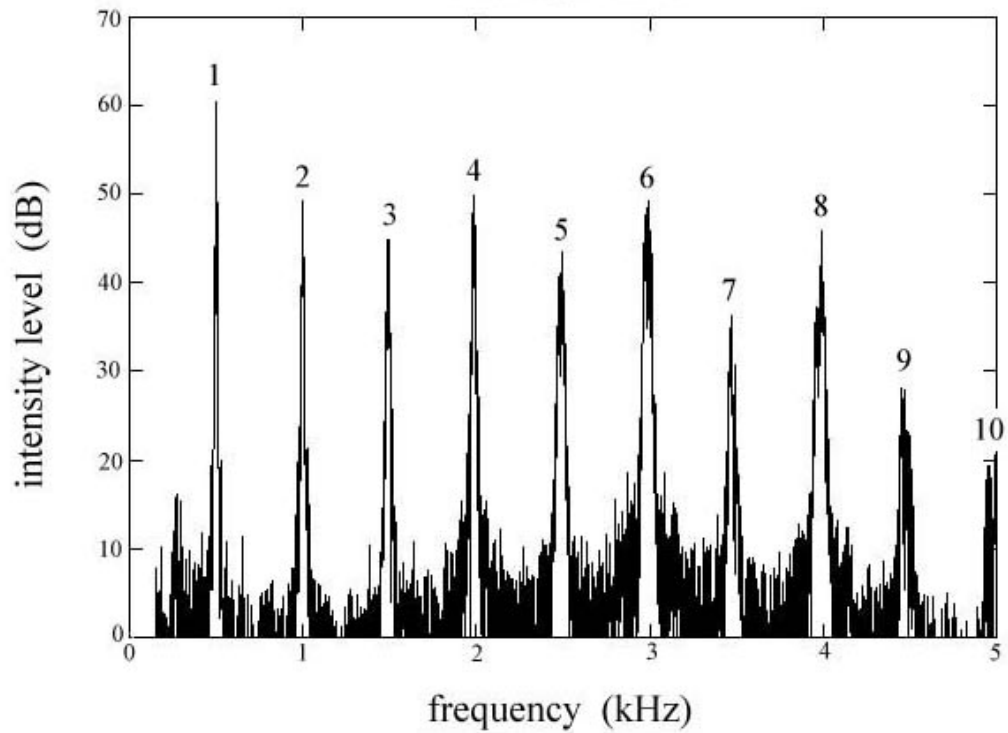
```
^ In[7]:= Plot[Cos[x] - 0.6 Cos[2 x] + 0.1 Cos[5 x], {x, -15, 15}]
```



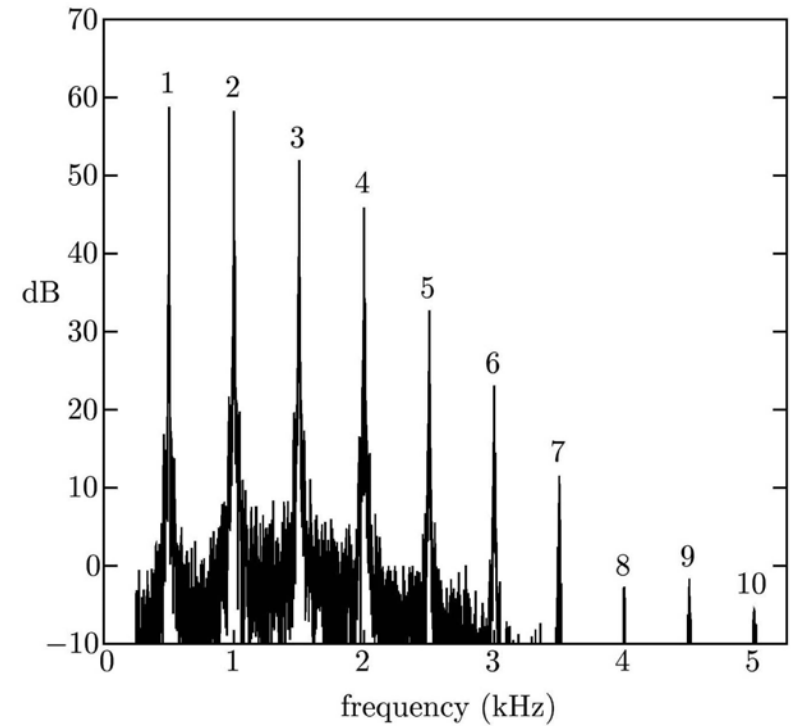


# Spectrum analyzer

violin spectrum



Trumpet Spectrum



# Demo

“Spectrum Lab” program

# Quick Semester Review

aka “What was this class all about?”

1. The universe makes sense!
  - a. To me: the order in the universe reflects the order of God
  - b. The job of a scientist is to discover and make sense of this order
  
2. The universe can be described *mathematically*
  - a. Algebra. Example: Kinematics equations
    - i. Position
    - ii. Velocity
    - iii. Acceleration
  - b. Geometry. Example: Area/volume of sphere
  - c. Trigonometry. Examples: Vectors, oscillations
  - d. Logarithms. Example: decibel scale, work in isothermal process
  - e. Calculus. We mostly skipped, but derivatives are crucial to velocity & acceleration; integrals when calculating work

3. Natural phenomena follow natural laws. Examples:
  - a. Newton's Laws of Motion
    - i. Newton 1: Inertia
    - ii. Newton 2: Forces
      1. Bag of tricks: Weight, normal, tension, friction, etc.
      2. Torques & rotational quantities
    - iii. Newton 3: Partner forces
  - b. Gravity
    - i. Kepler's Laws
    - ii. Newton's Law of Gravity
  - c. Conservation of energy
    - i. including work
    - ii. including rotational energy
    - iii. including random energy: "internal energy"
      1. First Law of Thermodynamics
  - d. Conservation of momentum (if no outside net force)
  - e. Conservation of angular momentum (if no outside net torque)

4. Fluids: the behavior of large numbers of objects (e.g. molecules) can be described using overall/average properties
  - a. Basics
    - i. Static: Archimedes (buoyancy)
    - ii. Dynamic: Bernoulli (cons. of energy; pressure vs. speed)
  - b. Kinetic theory to connect microscopic to macroscopic
  - c. Gases
    - i. ideal gas law
    - ii. PV diagrams
    - iii. Engines
      1. Carnot theorem
  - d. First and Second Laws of Thermodynamics
  
5. Waves: transferring energy via oscillations
  - a. Mechanical waves
  - b. Light waves (e.g. radiation)
  - c. Sound waves

## ***Requested Problems from Past Exams...***













