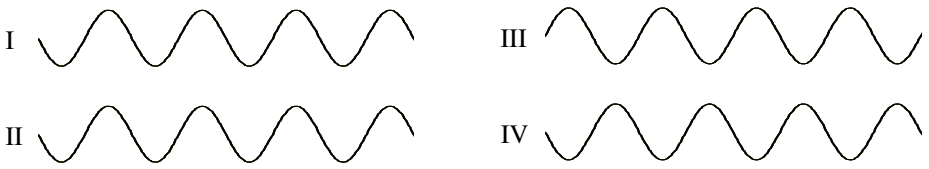
PreAP Harmonic Motion 11

From "Wave Action" notes:

1. Use the four waves shown at the right for the following.
   A. Which pair of waves are in-phase: I and II OR III or IV?
   B. Which pair of waves will produce destructive interference?
   C. Below each pair of waves, sketch the result of the interference that will result.



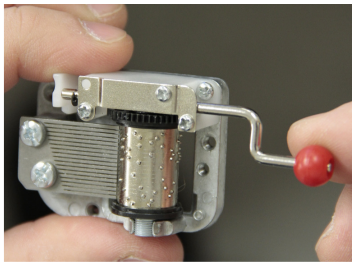
I + II:

III + IV:

2. A small music box organ plays when the handle is turned, but it is not very loud when held in your hand.
   A. How can you make it louder?

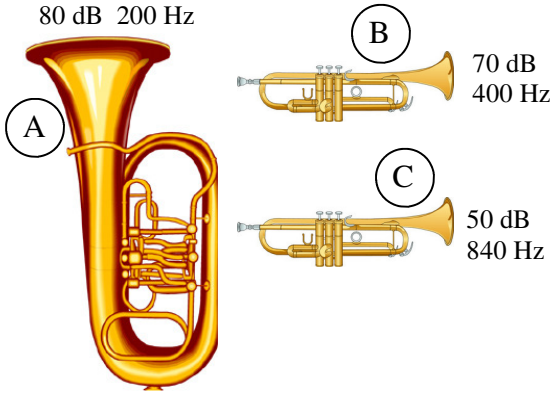
   B. What is this called?

   This is true ANY time that one object (one force) causes another object to vibrate a lot (like a loud sound). A forced vibration can cause an object to vibrate at any frequency, but it will not be a large vibration because it doesn't "fit".



3. So, why are guitar strings attached to a wood frame (the guitar's body)?

4. Give the other two names for the first harmonic.

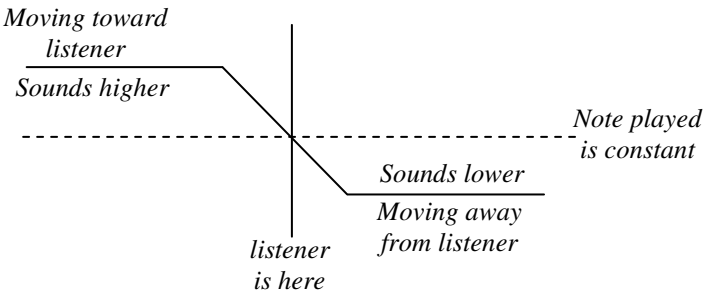


5. Use the three instrument pictures at the left to answer the following.
   A. Which one has the greatest amplitude?
   B. Which one has the highest frequency?
   C. Which two have the same timbre?
   D. Which one is playing the longest wavelength?
   E. Which one is producing the fastest speed of sound?
   F. Which one has the smallest period?

   Musical notes sound "in tune" when they are simple harmonics of each other or of another note. H_1 and H_2 sound in tune. H_3 and H_3 are "in tune".
   G. * Which two will sound "in tune"?
   H. Why?

More on the Doppler Effect:

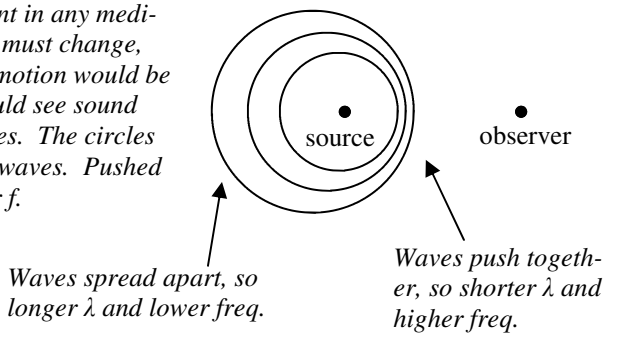
The diagram at the right shows the change of frequency of an object moving past a stationary (at rest) listener. The moving object plays a constant note (the dashed line), but note (pitch) is perceived as different by the listener. The pitch only falls when the object passes the listener. Amazingly enough, the same phenomenon occurs if the listener moves and the sound source does not.

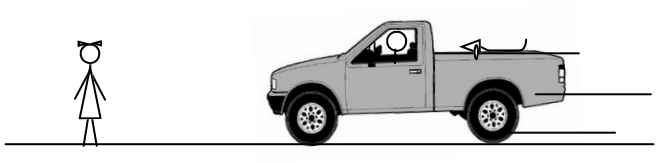


Why this change of pitch?

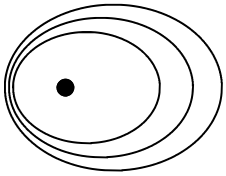
If the object making the waves is moving, it pushes into its waves, compressing them, like a boat chasing its waves. (This shape is true if the ship is moving slower than the waves.)

$v = f\lambda$ and v is constant in any medium. So if λ changes, f must change, too. The direction of motion would be obvious to us if we could see sound waves, like water waves. The circles show the crests of the waves. Pushed together means higher f.





6. Slim Jim is driving his truck and honks its horn when he sees Slim Kim on the side of the road.
   A. What does Kim hear as the truck passes?
   B. What does Bim the dog hear in the back of the truck?
   C. What is this called?
   D. If Kim was blowing an air horn while Jim passes in the truck, what would Jim hear?



7. Sound waves are produced that create the Doppler Effect shown at the left.
   A. If the sound source is moving, which way is it moving?
   B. If a stationary (at rest) observer hears a higher frequency, on which side of the moving object are they?
   C. If a stationary observer hears a lower frequency, on which side of the moving object are they?
   D. How could the sound source be stationary and the observer hear a higher frequency?

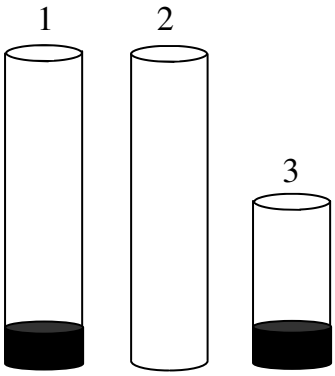
8. A sound source has an intensity of 2.1×10^{-7} W/m^2 from 10 m away.
   A. How powerful is the sound source?

   B. * What would be the intensity twice as far away?

Intensity Due to a Spherical Wave

$$\text{intensity (in W/m}^2\text{)} = \frac{\text{Power (in watts)}}{4\pi r^2}$$

← *Surface area of a sphere*



9. Pipes 1 and 2 are exactly twice as long as pipe 3. Pipe 2 is open at both ends. Also, remember that a harmonic must have at least 1 node and 1 antinode. (*If you don't remember this, come early to class and use the gear.*)
   A. Which pipe has a higher notes 1 or 2?
   B. Which pipe has a lower note 1 or 3?
   C. Which pipe has a lower note 2 or 3?
   D. Is the open end of a pipe a node or antinode?
   E. How many antinodes does pipe 1 have?
   F. How many antinodes does pipe 2 have?
   G. * How many nodes does pipe 2 have?
   H. Label the location of the nodes (N) and antinodes (A) for pipe3.
   I. * How many wavelengths long is pipe 3?
   J. * If pipe 3 is 12 cm long and the speed of sound is 330 m/s, what is are the frequencies of the first possible harmonics of pipe 3?

5G) A and B because the notes are harmonics of each other (octaves, actually).

8B) 1/4 as much, so 5.25×10^{-8} W/m^2

9G) 1 (in the middle)

9I) 1/4 wavelength

9J) 688 Hz, 2064 Hz, 3440 Hz