Palm Pipe Activity

Palm Pipes are simply pipes whose open ends are struck on the palm of the hand. When you do this, you send a pressure pulse down the pipe, and the pipe's length determines the sound you hear. The Exploratorium has a wonderful write-up on palm pipes at:

http://www.exo.net/~donr/activities/Palm_Pipes_Plus_Tunes.pdf

Little Shop of Physics from Colorado has another write-up at:

http://littleshop.physics.colostate.edu/docs/PalmPipes.pdf

Yet another write-up with songs exists at:

http://www.allencountyesc.org/files/7414/0985/8883/Palm_Pipes_Emailed.pdf

Want a more advanced look at the physics of palm pipes? Go on to the 2nd page of this document.

Palm Pipe Activity

Background:

Speed is defined as the distance traveled per unit time. If a wave travels a distance equal to one wavelength, the time elapsed is equal to the period (T) of the wave. Period (T) is actually the time for one complete vibration of a wave.

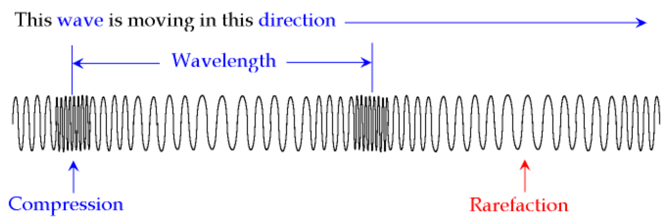
Thus, for a wave, the speed is equal to the wavelength (λ) divided by the period (T).

$V = \lambda/T$ → (equation 1)

But period (T) is the reciprocal of frequency (f). Frequency tells us how many waves/vibrations there are per unit time. So, substituting the period in the equation by 1/f, we get

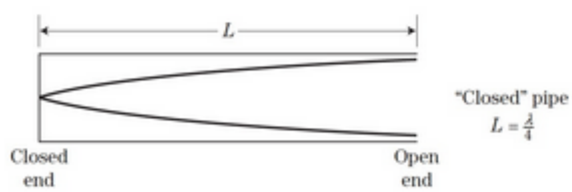
$V = \lambda f$ → (equation 2)

Sound waves are longitudinal or compressional waves, which means that the wave form consists of compressions and rarefactions as shown below.



In a palm pipe, the air molecules in the bottom of the tube are squeezed together as you hit the pipe against your palm. The compression pulse travels up, reflects from the open end as an expansion, the expansion reflects from your hand, then it reflects from the open end as a compression, and the process repeats.

The repetition of this process results to standing sound waves. Since the pipe is closed on one end and open on the other end, the wave profile will look like the figure below where there is maximum displacement at the open end. At the fundamental frequency (first harmonic), the length of the pipe is ¼ of the wavelength.



Since $L = \lambda/4$, → (equation 3)

Solving for λ would give us $\lambda = 4L$ → (equation 4)

1. If you substitute equation 4 into equation 2, what would be the formula for wave speed (V)? *V = 4LF*
2. Choose one among the 15 palm pipes and calculate the wave speed, which is the speed of sound. *V = 4 LF so V = 4 (23.6cm) (349/s) = 32,945.6 cm/s or roughly 329.5 m/s.*
3. Using the value of the speed of sound calculated in #2, what would be the frequency of sound produced in a 30.0 cm palm pipe? *V = 4LF so let's round off 32,945 as 33,000 cm/s then 33,000 cm/s = 4 (30 cm) f or 33,000 cm/s = 120cm f divide both sides by 120 cm. Then 275/s = f or f = 275 hertz.*

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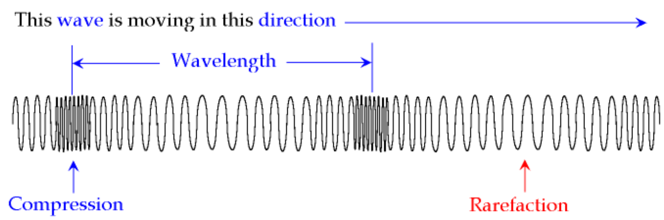

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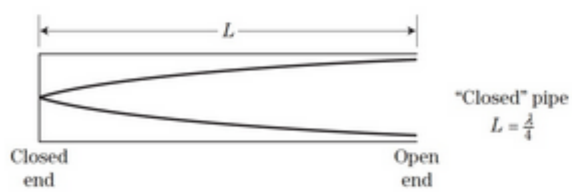

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