

# TSAAPT

## Texas Section of the American Association of Physics Teachers

Connecting physics teachers in the state of Texas

### Palm Pipes

#### What to do?

Hold a palm pipe in one hand and hold your other hand open with the palm facing up. Tap one of the openings of the palm pipe squarely onto the palm of your hand. You should hear a musical note.

#### What's going on?

When you tap the palm pipe you excite a longitudinal pulse of sound, which through interference settles into a standing wave pattern. Since palm pipes are closed at one end, the wavelength of the fundamental tone is four times the length of the pipe. The frequency (pitch) of the note then is given by  $\text{Frequency} = (\text{Speed of sound in air})/(\text{Four times the length of the tube})$

#### How do I build it?

Materials: PVC pipe, Optional – Acetone (nail polish remover works) and paint for plastic to decorate the pipes, or Optional - Different color tape to decorate the pipes

Tools: You will need a pvc pipe cutter or else a hack saw and possibly a mitre box to cut the different lengths of the tubes.

Assembly: Cut the palm pipes to the desired length. A suggested scheme is shown in the table below. It is a good idea to decorate the pipes so that they can be told apart. Wrap different color tape on each pipe or else clean the pipes with acetone (the active ingredient in nail polish remover is acetone) and then spray paint them with paint designed for plastic. A suggested color scheme is given in the table as well.

Note	Frequency	Wavelength (cm)	Length of Tube (cm)	Suggested color
C <sub>4</sub>	261.63	131.1	32.8	White
D <sub>4</sub>	293.66	116.8	29.2	Red
E <sub>4</sub>	329.63	104.1	26.0	Orange
F <sub>4</sub>	349.23	98.2	24.6	Yellow
G <sub>4</sub>	392	87.5	21.9	Green
A <sub>4</sub>	440	78.0	19.5	Blue
B <sub>4</sub>	493.88	69.5	17.4	Purple
C <sub>5</sub>	523.25	65.6	16.4	Black or white

#### Enrichment

Have students measure the length of each pipe and then take the ratio of successive lengths to see if they can determine a pattern. Have the students research the equally tempered scale and see if they can explain the pattern they discover. Palm pipes and boom whackers complement each other as palm pipes are closed on one end and boom whackers are open at both ends.