

I. Preparing your materials

material list

One yard (36 inches) of schedule-40, 1/2 inch PVC sprinkler pipe

Roll of Duct Tape

Eight pennies

PVC pipe cutter (not a hacksaw)

Ruler Pencil Scissors Marker Pen

	<u>Inches</u>	<u>Centimeters</u>	
C	6 1/16	15.4	1
D	5 3/8	13.6	2
E	4 3/4	12.0	3
F	4 7/16	11.2	4
G	3 15/16	9.8	5
A	3 7/16	8.7	6
B ^b	3 1/4	8.1	minor 7
C	2 13/16	7.1	8
optional Major 7th: B natural			
B ⁿ	3	7.6	Major 7

Step 1: Use your ruler and pencil to measure and mark your PVC pipe to the eight lengths on the right, i.e., C, D, E, F, G, A, B^b, C.

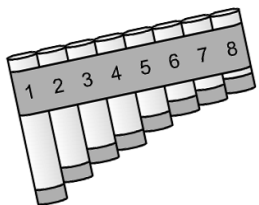
Step 2: With a PVC cutter (not a hacksaw), cut the pipe at each of your marks. Try to make each cut as straight as possible — straight cuts will produce panpipes that are “in-tune.”

Step 3: Cut 2” X 2” square pieces of duct tape. If you’re using the thicker professional grade tape — cut eight squares. If you’re using the thinner inexpensive tape — cut sixteen squares.

Step 4: Arrange your pipes (long to short), your pennies, and your duct tape squares.

Note: Our music will not use Bⁿ (B natural). However, I have also listed it here for those of you who want your instrument to play the Major 7th in the scale.





II. Building your panpipes

Step 5: Place a penny on one end of each pipe and cover with a duct tape square — again, apply two duct tape squares if you're using thinner-grade tape.

Note: Make sure the penny is directly over the center of the tube and the duct tape completely covers the penny. The duct tape must form an air tight seal for the panpipes to play correctly.

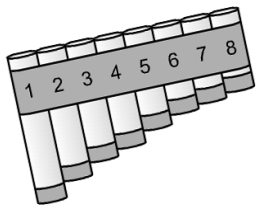
Step 6: Align your tubes (longest to shortest) on an 18-inch strip of duct tape. Notice how the open holes line up with each other evenly. Arrange the tubes so that the open-hole ends are 3/4 of an inch above the duct tape strip.

Step 7: Wrap the tape around your set of panpipes and seal.

Step 8: Mark your tubes 1 through 8, with 1 being the longest and 8 being the shortest.



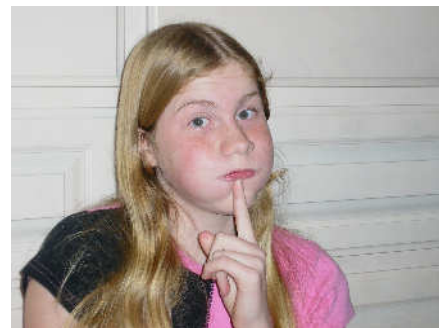
III. How to play your panpipes



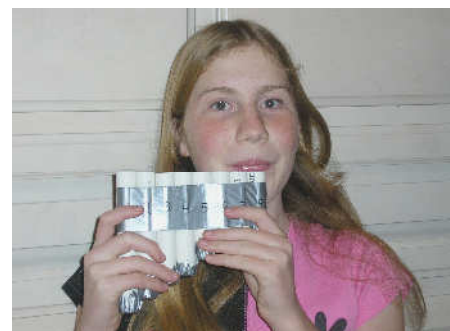
Step 9: Place your index finger on your chin and bottom lip. This is how it feels to play panpipes. When you play your panpipes the tubes should touch your chin and bottom lip. Also, form a hole with your lips and blow air across the top of your finger.



Note: You must keep your cheeks from being puffed. You DO NOT want to puff your cheeks when you play your pan pipes.



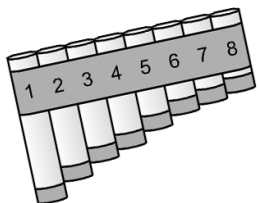
Step 10: Hold you panpipes so they are straight up and down — not tilted left or right. Blow across each tube. It's just like blowing across the top of a soda bottle. Start with the shortest tube — it's the easiest to play.



troubleshooting tips

If you're having problems, try this:

- 1) Check that the pennies are on the middle of each tube and the duct tape is firmly sealed (step 5). Also, if your duct tape is thin, make sure to use two pieces. Each day, before you play your panpipes, check to make sure your duct tape is tightly pushed around the tube and penny — especially if you store your panpipes in a hot area.
- 2) Look in the mirror to see how you're playing. Is your instrument straight up and down? Check your playing technique (step 9) and don't let your cheeks puff out.
- 3) Make sure there is a full 3/4 of an inch (steps 6 & 7) between the top of your panpipes and the duct tape — don't wrap your tape up to the top of the tubes.



IX. 2014 Science Olympiad Addendum



sounds of music event

If you're building an instrument for the 2014 Division B Science Olympiad Competition, the tube lengths on the right will apply to "Instrument 1." We have included all 27 pitches in the "allowable scoring range" between F3 and G5. Additionally, we have highlighted the exact pitches that are required for the "F Major Scale (F4 to F5)."

The tubes are tuned and calibrated to an A-440 at 72 degrees Fahrenheit. The frequencies they produce are precisely based on the "12 tone tempered scale." You will notice that each octave is divided into twelve equal semitones. Since the frequency ratio of the octave is 2, the frequency ratio s of this semitone is given by the equation: $s^{12} = 2$; $s = \sqrt[12]{2} = 1.05946$.

To obtain the best possible sound, we recommend that you glue the pennies (instead of the duct tape method described on page 3) using an all-purpose glue like "Loctite Stick 'n Seal Waterproof Adhesive." Additionally, just for the 8 lowest pitches (F3 to C4), we recommend that you use 3/4-inch schedule-40 pipe (with a quarter on the bottom of each tube), rather than the 1/2-inch pipe (with pennies). Since the pitch of each tube is determined by its length, not its diameter, this change will not affect its tuning.

Intonation can vary depending on the player's breath support and technique. For the absolute best results, we recommend that you use an inexpensive tuner to fine-tune each of your tubes, like the "Korg CA-40 Chromatic Tuner" that sells for approximately \$15.

Pitch Name	Tube Length in Centimeters	Frequency in Hertz
F3	48.0	174.610
F#3	45.3	185.000
G3	42.7	196.000
G#3	40.2	207.650
A3	37.9	220.000
Bb3	35.8	233.080
B3	33.7	246.940
C4	31.8	261.600
C#4	29.9	277.180
D4	28.1	293.670
Eb4	26.5	311.030
E4	25.0	329.630
F4	23.5	349.230
F#4	22.0	369.990
G4	20.8	392.000
G#4	19.5	415.300
A4	18.4	440.000
Bb4	17.3	466.160
B4	16.3	493.880
C5	15.4	523.250
C#5	14.4	554.370
D5	13.6	587.330
Eb5	12.7	622.250
E5	12.0	659.260
F5	11.2	698.460
F#5	10.4	739.990
G5	9.8	783.990