



# I. Preparing your materials

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## material list

- 12 feet (3.66 meters) of 2-inch diameter ABS pipe
- 1 Plastic container of Baby Wipes - 80 count box (recommend: \* Walmart "Equate Pop-Ups")
- 1 tube of Loctite Stik 'n Seal glue - 1 fl oz. (30 ml)
- 2 small sheets of general purpose sandpaper - medium grit, 100
- 4 pair of disposable latex gloves 10 paper napkins
- Duct Tape Ruler Pencil Scissors Marker Pen Newspaper
- Large PVC pipe cutter (cuts 2-inch pipe), or Hacksaw
- \* (All items in the material list, except the ABS pipe, can be purchased at Walmart.)



	<u>Inches</u>	<u>Centimeters</u>	
C	24 5/8	62.6	1
D	21 5/8	55.0	2
E	19	48.2	3
F	17 13/16	45.2	4
G	15 7/8	40.3	5
A	14 1/8	35.9	6
B <sup>b</sup>	13 5/16	33.9	minor 7
C	11 7/8	30.2	8
optional Major 7th: B natural			
B <sup>n</sup>	12 9/16	32.0	Major 7

**Step 1:** Use a ruler and pencil to measure and mark your ABS pipe to the eight lengths on the right, i.e., C, D, E, F, G, A, B<sup>b</sup>, C.

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

**Step 2:** With a large PVC cutter or hacksaw, cut the pipe at each mark. Try to make each cut as straight as possible — straight cuts will produce tubes that are “in-tune.”



**Step 3:** Lightly sand the ends of the tubes to remove any rough edges. Then, using your baby wipes, clean the outside of the tubes and set aside to let dry.



**Step 4:** Rinse plastic baby wipe container in warm water for 2 minutes and remove any labels.



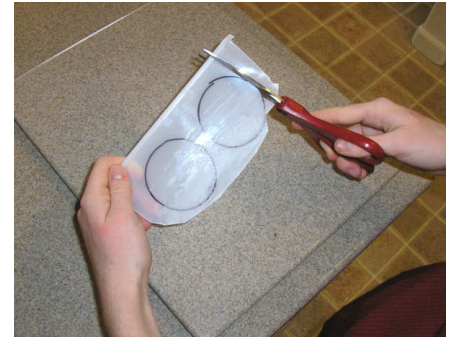


## II. Building your Melodic Tube Drums

**Step 5:** Using one of your ABS pipes and a marker pen, draw eight 2-inch circles on your baby wipe container — the Walmart “Equate Pop-Ups” container actually allows for nine: 1 on the top lid, 2 on the bottom, and 6 around the sides.



**Step 6:** Using your scissors, cut out eight circles based on your markings. Check that your plastic circles match the size of your tubes — not larger or smaller.



**Step 7:** Lightly sand both sides of each plastic circle.



**Step 8:** Working in a well ventilated area, and wearing latex gloves, apply glue to one end of a tube.



**Step 9:** Carefully place a plastic circle on top of the glued end of the tube.



**Step 10:** Using your index finger, press down lightly in the middle of the plastic circle, and turn/twist the plastic circle a quarter-turn — this will help to spread the glue evenly.



**Step 11:** Hold the tube in one hand, and a paper napkin in the other. Gently turn/twist the tube to remove excess glue from the side of the tube.



**Step 12:** Place the tube (glued end down) on a flat piece newspaper or a napkin. Allow glue to set for 1-2 hours, depending on temperature and humidity. Repeat the same procedure (steps 8-12) for all remaining tubes.



**Step 13:** After your glue has set, place a 40-inch (1 meter) strip of duct tape (sticky side up) on top of a flat piece of newspaper. Arrange tubes 1-4 as shown — the longest tube (number 1) is on the far right. Position the tops of the tubes (plastic circles) 4 inches (10 cm) from the duct tape strip. Check that the tubes make contact with the tape (underneath) and are tightly pressed together (side to side).



**Step 14:** Apply a drop of glue between each tube — in line with the duct tape strip. Press the tubes together (side to side) to ensure that the glue makes contact with each tube.





### III. Playing your Melodic Tube Drums



**Step 15:** On tubes 1-4, apply drops of glue (in line with the duct tape) where tubes 5-8 will make contact. Carefully place tubes 5-8 on top of tubes 1-4. Position tubes 5-8 to be 1-inch (3 centimeters) higher than tubes 1-4. Also notice that the shortest tube (number 8) is on the far left.



**Step 16:** Apply drops of glue between tubes 5-8. Then, tightly wrap the duct tape around the 8-tube set. Check that all of the tubes are lined up straight and tightly pressed together. Allow the glue to dry overnight.



**Step 17:** After the glue is completely dry, lightly sand the drum heads (plastic circles) to remove any glued-on newspaper or napkin, then mark your drum heads 1-8 with your marker pen. Again, tube 1 is the longest, and tube 8 is the shortest.

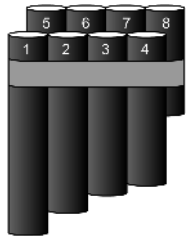


**Step 18:** After the glue is completely dry, hold the instrument under your left arm and play with your right hand. Quickly strike/tap the drum heads (plastic circles) near the center to produce the best sound.



**Step 19:** Make sure not to place your left hand around the tube openings, as this will change their vibrating length and their corresponding pitch.





# 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 2." We have included all 27 pitches in the "allowable scoring range" between C2 and D4. Additionally, we have highlighted the exact pitches that are required for the "C Major Scale (C3-C4)."

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:  $s^{12} = 2$ ;  $s = \sqrt[12]{2} = 1.05946$ .

Intonation can vary if the tube cuts are not straight, or the plastic circle drum heads are not completely glued-on to provide an air-tight seal. Therefore, to obtain 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
C2	146.2	65.406
C#2	135.7	69.296
D2	125.9	73.416
Eb2	116.8	77.782
E2	108.4	82.407
F2	102.0	87.307
F#2	96.0	92.499
G2	90.3	98.000
G#3	85.1	103.830
A2	80.2	110.000
Bb2	75.6	116.540
B2	71.2	123.470
<b>C3</b>	<b>67.1</b>	<b>130.810</b>
C#3	63.5	138.590
<b>D3</b>	<b>60.0</b>	<b>146.830</b>
Eb3	56.2	155.560
<b>E3</b>	<b>52.6</b>	<b>164.810</b>
<b>F3</b>	<b>49.4</b>	<b>174.610</b>
F#3	46.6	185.000
<b>G3</b>	<b>43.9</b>	<b>196.000</b>
G#3	41.3	207.650
<b>A3</b>	<b>38.8</b>	<b>220.000</b>
Bb3	36.6	233.080
<b>B3</b>	<b>34.4</b>	<b>246.940</b>
<b>C4</b>	<b>32.5</b>	<b>261.600</b>
C#4	30.6	277.180
D4	28.9	293.670