

Making a Bamboo Flute

Much of this information is from

“Simple Flutes”

Mark Shepard

1. Choose a flute size

- See sample flutes: can you cover the holes?
- The G flute will best serve the needs of most players.
- Smaller hands will be better off with an a' or b' flute.

Tube Size Table		
Key	bore 23:1	In si 7
C	25	5
D	23	5
E	21	4
F	19	4
G	17-18	4
a	15-16	3
b	13-14	3
c	12-13	2
d	11-12	2

2. Choose a tube: (sizes in mm)

The Flute Tube

The *length* of the tube is roughly decided by the flute's low note, which is also its "key." The longer the flute, the lower that note. This

measurement is for the flute interior only--in other words, from the open end of the tube, up to the stopper.

The *inside diameter* (I.D.) of the tube--the distance between the tube walls--must vary with the length, for the sake of range and octave tuning. Longer tubes should be wider. For a simple flute, the best ratio of I.D. to length is about 1 to 23, or 4.35%. A wider tube than that will favor low notes, and a narrower tube will favor high notes. This measurement too is shown in the table.

3. Clean the tube up:

- The *wall thickness* of the tube is important mostly because it determines the depth of the fingerholes.
- A thin wall helps volume, tone, range, and octave tuning. Aim at 1/16 inch (1.5mm) to 1/8 inch (3mm) for most materials, and never thicker than 5/32 inch (4 mm).
- Rasp and sand out the inside except near the sound / blowhole. Leave the walls as thick as possible there, just sanding slightly to remove loose material.

4. Make the Mouth / Sound Hole

The mouthhole must be placed at just the right distance from the flute stopper to give the closest octave tuning, as well as a clear tone. A good beginning guess for this measurement is $\frac{2}{3}$ of the flute tube's inside diameter--but you will have to experiment. (The distance is measured from the mouthhole center.)

- A larger mouthhole will improve volume and tone.
- But a smaller mouthhole will improve range and octave tuning.
- A good compromise size is $\frac{7}{16}$ inch (11 mm) or slightly larger. Even better is an oval of about the same area, for an edge better fitted to your blowing. Try 12mm wide by 10mm high.
- Thick tube walls are better: thin tube walls are good for fingerholes, but a deeper mouth-hole produces a more solid tone.
- Burn the hole with a hot iron tool. Then clean it up with a sharp knife to have clean perpendicular edges and be oblong as shown below.

Note 1: we burn holes in bamboo rather than drilling because bamboo splits easily when drilled. When burning a hole, the iron tool should be red hot and generate large amounts of smoke. Try not to breathe the smoke.

Note 2: If you have trouble getting a note, there may be loose material inside the tube; clean it out with a sanding stick. If the mouth hole is so wide that it cuts into the sides of the tube, the mouth hole may not work.

5. Cut to length

Play your flute, and see what note it plays on the tuner. It should be lower (flatter) than what you want for your final tuning.

Now you will cut off small sections of the tube until the note is just a bit flat of what you want.

Check the octave tuning.

Final adjustment can be done by sanding.

6. Tuning

The Fingerholes

- Large fingerholes give better volume, tone, range, and octave tuning.
- Smaller holes are easier to cover, and also to reach, because they wind up closer together.
- A good general hole size is 3/8 inch to 7/16 inch, depending on the flute's size and the player's fingers. But the holes don't need to be all the same size. Individual holes can be made as large as 1/2 inch, as long as you can reach and cover them.

The holes also don't need to be in a straight line. You may want to offset them to make fingering easier. On longer flutes, you could place the bottom hole under your little finger, instead of your ring finger, for better positioning and an easier reach. Tuning The notes of the flute are determined chiefly by the size and placement of the fingerholes.

The pictures below gives a rough guide to where to put the holes for some tuning possibilities. The chart measurements are shown as percentages of distance from the mouthhole or soundhole (from center of the hole for sideblown flutes, the lower edge of the hole for fipple or notch flutes). So carefully measure this distance on your tube and look up the measurement on the charts of hole placement. All measurements are to finger hole centers, not edges. The charts provides a starting point only. From there, you will have to experiment with final placement and hole size, using the tuning techniques we'll now discuss.

Western major scale tuning with the Key starting on the lowest or Root Tone of the tube. This will give the standard *do re mi* tuning (whole step, whole step, half step, whole, whole, whole, then half step from the top hole back to all holes covered and the second octave overblow)

Measure:

- Use the precalculated measurement charts and mark your flute tube carefully.
- Before burning, compare with a finished flute of the type you are making and the images above to be sure that you have not made a major marking error.

For flutes in G and below, I burn the hole with it's lower edge right on the marked line. For flutes above G, I burn the hole centered on the line. The higher the key or root note, the less room there is for error.

Burning:

- Do the bottom 3 holes first and when they are close but still slightly flat, do the top three.
- Burn the holes small to start with, check the tuning and then increase the hole size to bring the hole into tune. I use the burner to increase the size and a knife to clean up the burned part. You can move the center of the hole up or down as needed as you increase the size.

The percentages of the acoustic length are set to be a bit flat to start out. If you go too quickly and make the note sharp, it is very hard to lower the note.

Here are the two most important rules for tuning:

- A hole will give a higher note if it is placed closer to the mouthhole. It will give a lower note if placed farther away.
- A hole will give a higher note if made larger. It will give a lower note if smaller.

These rules mean you can “raise” a note by enlarging the hole *or* by placing the hole closer to the mouthhole. You can “lower” the note by using a smaller hole *or* by placing the hole farther from the mouthhole. It also means you can change the hole size *and* its placement *without* changing the note. A larger hole could be placed farther from the mouthhole, or a smaller hole placed closer to the mouthhole. The tuning of any fingerhole’s note is also affected by:

- The depth of the hole--in other words, the thickness of the tube. The deeper the hole, the lower the note.
- The open fingerholes farther from the mouthhole. The more and larger these fingerholes, the higher the note.
- The size and depth of the mouthhole. The larger the mouth-hole, the higher the note. The deeper the mouthhole, the lower the note.
- The placement of the stopper. The closer to the mouthhole, the higher the note.
- The width of the tube. A wider tube produces a lower note.

Generally, anything that “opens up” the tube wall and allows the air to vibrate more freely will raise the note. Anything that “closes” the wall and resists air vibration will lower it.

How you play the flute will also affect the tuning. When checking the tuning of a note, play at a medium loudness, with your fingers at a medium height over the fingerholes, and without bending over the mouthhole. Try your best not to “bend” the notes into tune, as you would during normal playing.

Also keep in mind that the first note in both the second and third octave is fingered differently from the flute’s low note. Instead of covering all the holes, you should leave the top hole uncovered as a “vent,” as shown below.

The tuning of these two higher notes is affected by both the flute length and the size of the vent hole. Enlarging the vent hole or placing it closer to the mouthhole will sharpen the first note of the second octave. It will *flatten* the first note of the *third* octave. For tuning, the notes of the flute can be compared to the notes of a piano, pitchpipe, or other tuning instrument. Play your own note first, so you aren’t tempted to “bend” your note to match the other. Or you can simply tune the notes of the flute to each other, in the *do-re-mi* pattern, with the low note as *do*. If you tune this way, check each note against the flute’s low note, so you don’t “drift” out of tune.

Whichever way you choose, remember that the notes of the flute aren’t supposed to be *exactly* in tune, but only close enough to “bend” into tune when you play them. This is because simple flutes seldom have perfect octave tuning.

To make sure both the first and the second octave are tuned well enough, the first octave must normally be tuned a little sharp, and the second octave a little flat. You may also have to smooth out differences in “out-of-tuneness” between holes of different sizes. Tuning is the chief art in simple flutemaking. It will become easier, and you’ll get better, the more you do it.

Major C														
542	544	546	548	550	552	554	556	558	560	562	564	566	568	570
233.1	233.9	234.8	235.6	236.5	237.4	238.2	239.1	239.9	240.8	241.7	242.5	243.4	244.2	
271.0	272.0	273.0	274.0	275.0	276.0	277.0	278.0	279.0	280.0	281.0	282.0	283.0	284.0	
314.4	315.5	316.7	317.8	319.0	320.2	321.3	322.5	323.6	324.8	326.0	327.1	328.3	329.4	
368.6	369.9	371.3	372.6	374.0	375.4	376.7	378.1	379.4	380.8	382.2	383.5	384.9	386.2	
395.7	397.1	398.6	400.0	401.5	403.0	404.4	405.9	407.3	408.8	410.3	411.7	413.2	414.6	
449.9	451.5	453.2	454.8	456.5	458.2	459.8	461.5	463.1	464.8	466.5	468.1	469.8	471.4	
Major C - D														
512	514	516	518	520	522	524	526	528	530	532	534	536	538	540
220.2	221.02	221.88	222.7	223.6	224.5	225.3	226.2	227.0	227.9	228.8	229.6	230.5	231.3	
256.0	257.0	258.0	259.0	260.0	261.0	262.0	263.0	264.0	265.0	266.0	267.0	268.0	269.0	
297.0	298.1	299.3	300.4	301.6	302.8	303.9	305.1	306.2	307.4	308.6	309.7	310.9	312.0	
348.2	349.5	350.9	352.2	353.6	355.0	356.3	357.7	359.0	360.4	361.8	363.1	364.5	365.8	
373.8	375.2	376.7	378.1	379.6	381.1	382.5	384.0	385.4	386.9	388.4	389.8	391.3	392.7	
425.0	426.6	428.3	429.9	431.6	433.3	434.9	436.6	438.2	439.9	441.6	443.2	444.9	446.5	

Major D														
482	484	486	488	490	492	494	496	498	500	502	504	506	508	510
207.3	208.12	208.98	209.8	210.7	211.6	212.4	213.3	214.1	215.0	215.9	216.7	217.6	218.4	
241.0	242.0	243.0	244.0	245.0	246.0	247.0	248.0	249.0	250.0	251.0	252.0	253.0	254.0	
279.6	280.7	281.9	283.0	284.2	285.4	286.5	287.7	288.8	290.0	291.2	292.3	293.5	294.6	
327.8	329.1	330.5	331.8	333.2	334.6	335.9	337.3	338.6	340.0	341.4	342.7	344.1	345.4	
351.9	353.3	354.8	356.2	357.7	359.2	360.6	362.1	363.5	365.0	366.5	367.9	369.4	370.8	
400.1	401.7	403.4	405.0	406.7	408.4	410.0	411.7	413.3	415.0	416.7	418.3	420.0	421.6	

Major C													
542	544	546	548	550	552	554	556	558	560	562	564	566	568
233.1	233.9	234.8	235.6	236.5	237.4	238.2	239.1	239.9	240.8	241.7	242.5	243.4	244.2
271.0	272.0	273.0	274.0	275.0	276.0	277.0	278.0	279.0	280.0	281.0	282.0	283.0	284.0
314.4	315.5	316.7	317.8	319.0	320.2	321.3	322.5	323.6	324.8	326.0	327.1	328.3	329.4
368.6	369.9	371.3	372.6	374.0	375.4	376.7	378.1	379.4	380.8	382.2	383.5	384.9	386.2
395.7	397.1	398.6	400.0	401.5	403.0	404.4	405.9	407.3	408.8	410.3	411.7	413.2	414.6
449.9	451.5	453.2	454.8	456.5	458.2	459.8	461.5	463.1	464.8	466.5	468.1	469.8	471.4
Major D													
482	484	486	488	490	492	494	496	498	500	502	504	506	508
207.3	208.12	208.98	209.8	210.7	211.6	212.4	213.3	214.1	215.0	215.9	216.7	217.6	218.4
241.0	242.0	243.0	244.0	245.0	246.0	247.0	248.0	249.0	250.0	251.0	252.0	253.0	254.0
279.6	280.7	281.9	283.0	284.2	285.4	286.5	287.7	288.8	290.0	291.2	292.3	293.5	294.6
327.8	329.1	330.5	331.8	333.2	334.6	335.9	337.3	338.6	340.0	341.4	342.7	344.1	345.4
351.9	353.3	354.8	356.2	357.7	359.2	360.6	362.1	363.5	365.0	366.5	367.9	369.4	370.8
400.1	401.7	403.4	405.0	406.7	408.4	410.0	411.7	413.3	415.0	416.7	418.3	420.0	421.6
Major E													
452	454	456	458	460	462	464	466	468	470	472	474	476	478
194.4	195.2	196.1	196.9	197.8	198.7	199.5	200.4	201.2	202.1	203.0	203.8	204.7	205.5
226.0	227.0	228.0	229.0	230.0	231.0	232.0	233.0	234.0	235.0	236.0	237.0	238.0	239.0
262.2	263.3	264.5	265.6	266.8	268.0	269.1	270.3	271.4	272.6	273.8	274.9	276.1	277.2
307.4	308.7	310.1	311.4	312.8	314.2	315.5	316.9	318.2	319.6	321.0	322.3	323.7	325.0
330.0	331.4	332.9	334.3	335.8	337.3	338.7	340.2	341.6	343.1	344.6	346.0	347.5	348.9
375.2	376.8	378.5	380.1	381.8	383.5	385.1	386.8	388.4	390.1	391.8	393.4	395.1	396.7
Major F 1													
430	432	434	436	438	440	442	444	446	448	450	452	454	456
184.9	185.8	186.6	187.5	188.3	189.2	190.1	190.9	191.8	192.6	193.5	194.4	195.2	196.1
215.0	216.0	217.0	218.0	219.0	220.0	221.0	222.0	223.0	224.0	225.0	226.0	227.0	228.0
249.4	250.6	251.7	252.9	254.0	255.2	256.4	257.5	258.7	259.8	261.0	262.2	263.3	264.5
292.4	293.8	295.1	296.5	297.8	299.2	300.6	301.9	303.3	304.6	306.0	307.4	308.7	310.1
313.9	315.4	316.8	318.3	319.7	321.2	322.7	324.1	325.6	327.0	328.5	330.0	331.4	332.9
356.9	358.6	360.2	361.9	363.5	365.2	366.9	368.5	370.2	371.8	373.5	375.2	376.8	378.5
Major F G													
400	402	404	406	408	410	412	414	416	418	420	422	424	426
172.0	172.9	173.7	174.6	175.4	176.3	177.2	178.0	178.9	179.7	180.6	181.5	182.3	183.2
200.0	201.0	202.0	203.0	204.0	205.0	206.0	207.0	208.0	209.0	210.0	211.0	212.0	213.0
232.0	233.2	234.3	235.5	236.6	237.8	239.0	240.1	241.3	242.4	243.6	244.8	245.9	247.1
272.0	273.4	274.7	276.1	277.4	278.8	280.2	281.5	282.9	284.2	285.6	287.0	288.3	289.7
292.0	293.5	294.9	296.4	297.8	299.3	300.8	302.2	303.7	305.1	306.6	308.1	309.5	311.0
332.0	333.7	335.3	337.0	338.6	340.3	342.0	343.6	345.3	346.9	348.6	350.3	351.9	353.6
Major G													
370	372	374	376	378	380	382	384	386	388	390	392	394	396
159.1	160.0	160.8	161.7	162.5	163.4	164.3	165.1	166.0	166.8	167.7	168.6	169.4	170.3
185.0	186.0	187.0	188.0	189.0	190.0	191.0	192.0	193.0	194.0	195.0	196.0	197.0	198.0
214.6	215.8	216.9	218.1	219.2	220.4	221.6	222.7	223.9	225.0	226.2	227.4	228.5	229.7
251.6	253.0	254.3	255.7	257.0	258.4	259.8	261.1	262.5	263.8	265.2	266.6	267.9	269.3
270.1	271.6	273.0	274.5	275.9	277.4	278.9	280.3	281.8	283.2	284.7	286.2	287.6	289.1
307.1	308.8	310.4	312.1	313.7	315.4	317.1	318.7	320.4	322.0	323.7	325.4	327.0	328.7

Major															
344	346	348	350	352	354	356	358	360	361	362	363	364	365	366	367
147.9	148.8	149.6	150.5	151.4	152.2	153.1	153.9	154.8	155.2	155.7	156.1	156.5	157.0	157.4	157.8
172.0	173.0	174.0	175.0	176.0	177.0	178.0	179.0	180.0	180.5	181.0	181.5	182.0	182.5	183.0	183.5
199.5	200.7	201.8	203.0	204.2	205.3	206.5	207.6	208.8	209.4	210.0	210.5	211.1	211.7	212.3	212.9
233.9	235.3	236.6	238.0	239.4	240.7	242.1	243.4	244.8	245.5	246.2	246.8	247.5	248.2	248.9	249.6
251.1	252.6	254.0	255.5	257.0	258.4	259.9	261.3	262.8	263.5	264.3	265.0	265.7	266.5	267.2	267.9
285.5	287.2	288.8	290.5	292.2	293.8	295.5	297.1	298.8	299.6	300.5	301.3	302.1	303.0	303.8	304.6
Major															
318	319	320	321	322	323	324	325	327	329	331	333	335	337	339	341
136.7	137.2	137.6	138.0	138.5	138.9	139.3	139.8	140.6	141.5	142.3	143.2	144.1	144.9	145.8	146.6
159.0	159.5	160.0	160.5	161.0	161.5	162.0	162.5	163.5	164.5	165.5	166.5	167.5	168.5	169.5	170.5
184.4	185.0	185.6	186.2	186.8	187.3	187.9	188.5	189.7	190.8	192.0	193.1	194.3	195.5	196.6	197.8
216.2	216.9	217.6	218.3	219.0	219.6	220.3	221.0	222.4	223.7	225.1	226.4	227.8	229.2	230.5	231.9
232.1	232.9	233.6	234.3	235.1	235.8	236.5	237.3	238.7	240.2	241.6	243.1	244.6	246.0	247.5	248.9
263.9	264.8	265.6	266.4	267.3	268.1	268.9	269.8	271.4	273.1	274.7	276.4	278.1	279.7	281.4	283.0
Major															
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316
129.4	129.9	130.3	130.7	131.2	131.6	132.0	132.4	132.9	133.3	133.7	134.2	134.6	135.0	135.5	135.9
150.5	151.0	151.5	152.0	152.5	153.0	153.5	154.0	154.5	155.0	155.5	156.0	156.5	157.0	157.5	158.0
174.6	175.2	175.7	176.3	176.9	177.5	178.1	178.6	179.2	179.8	180.4	181.0	181.5	182.1	182.7	183.3
204.7	205.4	206.0	206.7	207.4	208.1	208.8	209.4	210.1	210.8	211.5	212.2	212.8	213.5	214.2	214.9
219.7	220.5	221.2	221.9	222.7	223.4	224.1	224.8	225.6	226.3	227.0	227.8	228.5	229.2	230.0	230.7
249.8	250.7	251.5	252.3	253.2	254.0	254.8	255.6	256.5	257.3	258.1	259.0	259.8	260.6	261.5	262.3
Major															
284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299
122.1	122.6	123.0	123.4	123.8	124.3	124.7	125.1	125.6	126.0	126.4	126.9	127.3	127.7	128.1	128.6
142.0	142.5	143.0	143.5	144.0	144.5	145.0	145.5	146.0	146.5	147.0	147.5	148.0	148.5	149.0	149.5
164.7	165.3	165.9	166.5	167.0	167.6	168.2	168.8	169.4	169.9	170.5	171.1	171.7	172.3	172.8	173.4
193.1	193.8	194.5	195.2	195.8	196.5	197.2	197.9	198.6	199.2	199.9	200.6	201.3	202.0	202.6	203.3
207.3	208.1	208.8	209.5	210.2	211.0	211.7	212.4	213.2	213.9	214.6	215.4	216.1	216.8	217.5	218.3
235.7	236.6	237.4	238.2	239.0	239.9	240.7	241.5	242.4	243.2	244.0	244.9	245.7	246.5	247.3	248.2
Major															
267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282
114.8	115.2	115.7	116.1	116.5	117.0	117.4	117.8	118.3	118.7	119.1	119.5	120.0	120.4	120.8	121.3
133.5	134.0	134.5	135.0	135.5	136.0	136.5	137.0	137.5	138.0	138.5	139.0	139.5	140.0	140.5	141.0
154.9	155.4	156.0	156.6	157.2	157.8	158.3	158.9	159.5	160.1	160.7	161.2	161.8	162.4	163.0	163.6
181.6	182.2	182.9	183.6	184.3	185.0	185.6	186.3	187.0	187.7	188.4	189.0	189.7	190.4	191.1	191.8
194.9	195.6	196.4	197.1	197.8	198.6	199.3	200.0	200.8	201.5	202.2	202.9	203.7	204.4	205.1	205.9
221.6	222.4	223.3	224.1	224.9	225.8	226.6	227.4	228.3	229.1	229.9	230.7	231.6	232.4	233.2	234.1

Major Keys

Tuning Chart:

Root	3	5	6	8
A	B	C#	D	E
B	C#	D#	E	F#
C	D	E	F	G
D	E	F#	G	A
E	F#	G#	A	B
F	G	A	A#	C
G	A	B	C	D

Hole Placement for none standard tunings:

Decimal fractions of acoustic length to allow hole placement for any tuning you want using the Western 12 step scale. If you know the notes of the scale, you can calculate where to place the holes using these percentages. The holes are numbered by how many half steps they are up from the base note of the tube.

Example: Key of C

7. Cleaning and Finishing

Bamboo needs only a light sanding, to remove dirt. A bottle brush will clean the inside. You can decorate the flute by burning in an insignia, or running a torch over it to darken it, or even by inlaying.

A bamboo flute will crack and split when the inside of the tube expands much more rapidly than the outside. This can happen when you take a flute outside on a cold day and blow your warm breath into it. It can also happen anytime the flute absorbs moisture from your breath too quickly. To resist moisture and guard against cracking, bamboo requires finishes inside and out.

Finishes

You have many choices. Wooden orchestra instruments are finished with bore oil, which is nothing but light mineral oil. Be careful not to use too much on the outside of your flute, because it never dries! Almond oil is used by many flutemakers. Buy it at a natural foods store. If you prefer an oil that dries, you can use walnut oil.

Avoid using commercial finishes from hardware stores on the outside of your flute, because they almost always have toxic additives. However, they work well *inside*, sealing against moisture better than most natural finishes. One way to apply a finish inside only is to seal the flute holes with masking tape and pour in the finish.

Other options for the outside include shellac and petroleum jelly. Organic wood finishes are sometimes advertised in fine wood-working magazines.

Binding.

You should also bind the flute, at least once below the mouth-hole and once at the open end. See the illustration following. You can't pull the cord tight enough with your fingers alone, so use one or more dowels, sticks, or extra bamboo pieces for wrapping, pulling, and levering. The finished binding must be tight enough that the end loops don't spread out when you nudge them with a finger.

You can find a wide variety of cords for binding at hardware stores and craft shops. Your cord must be strong, not slippery, and attractive. One favorite is waxed flax (linen). Another is waxed nylon, available from leather supply and shoe repair shops. Synthetic cords become tighter and stronger when the air is dry. Natural cords become tighter and stronger when the air is humid--but hot, humid weather also shortens their life. Waxed cords aren't as affected by changes in humidity, and last longer. Among natural fibers, cotton and jute are too weak. You can make your bindings even stronger by coating them with epoxy or melted wax.

Binding a Flute

(from "Simple Flutes" by Mark Shepard)

Tools:

Step 1:

sample flutes to test for ability to cover holes.

Step 2: No tools: need precut and sorted flute tubes.

Step 3:

round rasps and rat-tail files (these can be hard to find)

sanding sticks: use contact cement to glue pieces of sandpaper around the ends of sticks. Glue heavy grade paper on one end, finer grade on the other for finish sanding. Be sure to use the contact cement properly (apply it to the stick and sandpaper in a thin layer, and let it dry 15 minutes before sticking the paper onto the stick. I use large rubber bands to hold the paper in place while the glue finishes setting).

Step 4:

Metric ruler in millimeters

pencil

thin stick (to find the exact depth of the tube stopper to place the mouth hole properly)

burning tool: I use double headed nails driven into a wooden
power handle (a piece of old broomstick will do), and then cut the top head off with a
hacksaw.

gas camp stove

sharp knife

Step 5:

cheap electronic instrument tuner: I am using a and a
hacksaw with 10" blade and 10 teeth / inch (rotate the tube as you cut to keep from knocking
splinters out of the bottom edge of the tube)

Step 6:

measuring chart

good metric yardstick in millimeters

burning tool

gas camp stove

sharp knife

electronic instrument tuner (or a good set of ears)

Step 7:

damp cloth

fine sandpaper

hemp twine

beeswax

natural furniture polish or oil (olive, walnut, orange)