A BRIEF DESCRIPTION OF THREE TUNING SYSTEMS

EQUAL TEMPERAMENT

With equal temperament, all intervals are equally out of tune. It is often argued that equal temperament can be offensive to musicians with keen ears. The space of an octave is divided into twelve equal parts called semitones or half steps, with each tone equal distance from the next (octave equivalence). These tones do not exactly agree with the frequencies of pitch found in the overtone series. The tones are tempered or adjusted; the tuning system is called equal temperament, since the twelve half steps are equal in size. The intervals in equal temperament are fixed as a piano keyboard.

PYTHAGOREAN SCALE

Pythagoras, a Greek mathematician and philosopher (582-500 B.C.), is thought to have made certain acoustic experiments with a vibrating string called the monochord. By using two monochords, he performed an experiment in which the string of one monochord was successively shortened by one-half (raising the pitch an octave), and the string of the other was shortened each time by two-thirds (raising the pitch a fifth). After seven octaves and twelve fifths, Pythagoras discovered that the B# from the second monochord was not exactly the same as the C produced by the first monochord, but slightly higher. This small discrepancy is called the Pythagorean comma. The tuning systems differ in the manner in which this comma is handled.

The Pythagorean scale derives all tones from the interval of the pure fifth (3/2) as it occurs in the overtone series. This tuning system produces a sharper, brighter sound and is particularly good for barbershop harmony.

JUST INTONATION

This system attempts to improve upon the deficiencies of the Pythagorean scale by basing the calculations on both pure fifths (3/2) and pure thirds (5/4). The just intonation scale multiplies its difficulties as soon as chromatic tones are introduced. Sharps are actually lower in pitch than the flats. Some musicians love just temperament dearly. One musician had a harmonium just tuned in the key of C. It sounded excellent in C, but dreadful when played in any other key.

COMPARISON OF SELECTED FREQUENCIES USING THREE TUNING SYSTEMS

Scale Tone	Interval From Root	Equal-Temperament Scale		Pythagorean Scale			Just Intonation (Overtone Series) Zarbino Scale		
		Log Cents	Freq. Hz	Log Cents	Ratio	Freq. Hz	Log Cents	Ratio	Freq. Hz
A	Unison	0	220.000	0	1:1	220.000	0	1:1	220.000
A# / Bb	Min. 2	100	233.082	90	256:243	231.7695	112	16:15	234.667
B	Maj. 2	200	246.942	204	9:8	247.500	204	9:8	247.500
C'	Min. 3	300	261.626	294	32:27	260.7407	315	6:5	264.000
C# / Db	Maj. 3	400	277.183	408	81:64	278.4375	385	5:4	275.000
D	Perf. 4	500	293.665	498	4:3	293.333	498	4:3	293.333
D# / Eb	Aug. 4 / Dim. 5	600 600	311.127 311.127	612 588	729:512 1024:729	313.242 309.026	590 610	45:32 64:45	309.375 312.889
E	Perf. 5	700	329.628	702	3:2	330.000	702	3:2	330.000
F	Min. 6	800	349.228	792	128:81	347.6543	814	8:5	352.000
F# / Gb	Maj. 6	900	369.994	906	27:16	371.250	884	5:3	366.667
G	Min. 7	1000	391.995	996	16:9	391.111	996	16:9	391.111
G# / Ab	Maj. 7	1100	415.305	1110	243:128	417.6562	1088	15:8	412.500
A	Octave	1200	440.000	1200	2:1	440.000	1200	2:1	440.000