The Golden Ratio

Mäezel Metronome Tempi

First Reference Sheet – Exact Figures

Table 1a: 39 source tempi for metric modulation (golden ratio = 1.618/0.618)

A, is to b, what b, is to c…

e.g. 208 ÷ 1.618 = 128.55 ÷ 1.618 = 79.45 ÷ 1.618 = 49.10 ÷ 1.618 = 30.34 etc
e.g. 200 ÷ 1.618 = 123.60 ÷ 1.618 = 76.39 ÷ 1.618 = 47.21 ÷ 1.618 = 29.18 etc

	Mäezel A	**B**	**C**	**D**	**E**	**F**	**G**
39	208	128.55	79.45	49.10	30.34	18.75	11.59
38	200	123.60	76.39	47.21	29.18	18.03	11.14
37	192	118.66	73.34	45.32	28.01	17.31	10.70
36	184	113.72	70.28	43.43	26.84	16.59	10.25
35	176	108.77	67.22	41.55	25.68	15.87	9.80
34	168	103.83	64.17	39.66	24.51	15.15	
33	160	98.88	61.11	37.77	23.34	14.42	
32	152	93.94	58.06	35.88	22.17	13.70	
31	144	88.99	55.00	33.99	21.01	12.98	
30	138	85.29	52.71	32.57	20.13	12.44	
29	132	81.58	50.42	31.16	19.26	11.90	
28	126	77.87	48.12	29.74	18.38	11.36	
27	120	74.16	45.83	28.32	17.50	10.82	
26	116	71.69	44.30	27.38	16.92	10.46	
25	112	69.22	42.78	26.44	16.34	10.10	
24	108	66.74	41.25	25.49	15.75	9.73	
23	104	64.27	39.72	24.55	15.17		
22	100	61.80	38.19	23.60	14.59		
21	96	59.33	36.67	22.66	14.00		
20	92	56.86	35.14	21.71	13.42		
19	88	54.38	33.61	20.77	12.84		
18	84	51.91	32.08	19.83	12.25		
17	80	49.44	30.55	18.88	11.67		
16	76	46.97	29.03	17.94	11.08		
15	72	44.49	27.50	16.99	10.50		
14	69	42.64	26.35	16.28	10.06		
13	66	40.79	25.21	15.58	9.63		
12	63	38.93	24.06	14.87			
11	60	37.08	22.91	14.16			
10	58	35.84	22.15	13.69			
9	56	34.61	21.39	13.22			
8	54	33.37	20.62	12.74			
7	52	32.13	19.86	12.27			
6	50	30.90	19.09	11.80			
5	48	29.66	18.33	11.33			
4	46	28.43	17.57	10.85			
3	44	27.19	16.80	10.38			
2	42	25.95	16.04	9.91			
1	40	24.71	15.27				

The Golden Ratio

Mäezel Metronome Tempi

Second Reference Sheet – Rounded decimal points

Some tempi need multiplying by units of 2, 3 and/or 4, which can be represented through smaller rhythm values within time signatures [e.g. 10 is semi-quaver = 40 and 11 is semi-quaver = 44 in a time signature of 4/16 or 2/8. 64 is dotted crotchet = 192 and 32 is dotted crotchet = 96 in a time signature of 12/8]

Table 1b: 39 source tempi for metric modulation: rounded to closest decimal

Grey cells do not calculate into Mäezel tempi

	Mäezel A	**B**	**C**	**D**	**E**	**F**	**G**
39	208	129	79	49	30	19	12
38	200	124	76	47	29	18	11
37	192	119	73	45	28	17	11
36	184	114	70	43	27	17	10
35	176	109	67	42	26	16	10
34	168	104	64	40	25	15	
33	160	99	61	38	23	14	
32	152	94	58	36	22	14	
31	144	89	55	34	21	13	
30	138	85	53	33	20	12	
29	132	82	50	31	19	12	
28	126	78	48	30	18	11	
27	120	74	46	28	18	11	
26	116	72	44	27	17	10	
25	112	69	43	26	16	10	
24	108	67	41	25	16	10	
23	104	64	40	25	15		
22	100	62	38	24	15		
21	96	59	37	23	14		
20	92	57	35	22	13		
19	88	54	34	21	13		
18	84	52	32	20	12		
17	80	49	31	19	12		
16	76	47	29	18	11		
15	72	44	28	17	11		
14	69	43	26	16	10		
13	66	41	25	16	10		
12	63	39	24	15			
11	60	37	23	14			
10	58	36	22	14			
9	56	35	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	31	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	17	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio

Mäezel Metronome Tempi

Approximated + and - 1

Some tempi need multiplying by units of 2, 3 and/or 4, represented through smaller rhythm values within time signatures [e.g. 10 is semi-quaver = 40 and 11 is semi-quaver = 44 in a time signature of 4/16 or 2/8. 64 is dotted crotchet = 192 and 32 is dotted crotchet = 96 in a time signature of 12/8]

Table 1c: 39 source tempi for metric modulation: moderate approximations: + or – 1

Grey cells do not calculate into Mäezel tempi

	Mäezel A	**B**	**C**	**D**	**E**	**F**	**G**
39	208	129	80*	50*	30	19	12
38	200	124	76	48*	29	18	11
37	192	119	73	46*	28	18*	11
36	184	114	70	44*	27	16*	10
35	176	108*	67	42	26	16	10
34	168	104	64	40	25	15	
33	160	99	61	38	23	14	
32	152	94	58	36	22	14	
31	144	88*	56*	33*	21	13	
30	138	85	52*	33	20	12	
29	132	82	50	32*	19	12	
28	126	78	48	30	18	11	
27	120	74	46	28	18	11	
26	116	72	44	27	16*	10	
25	112	69	42*	26	16	10	
24	108	66*	42*	25	16	10	
23	104	64	40	25	15		
22	100	62	38	24	15		
21	96	60*	36*	23	14		
20	92	56*	36*	22	13		
19	88	54	33*	21	13		
18	84	52	32	20	12		
17	80	50*	30*	19	12		
16	76	46*	29	18	11		
15	72	44	28	16*	11		
14	69	42*	26	16	10		
13	66	40*	25	16	10		
12	63	38*	24	15			
11	60	38*	23	14			
10	58	36	22	14			
9	56	35	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	30*	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	16*	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio

Mäezel Metronome Tempi

Final Reference Sheet

(Approximations to + and – 3)

Some tempi need multiplying by units of 2, 3 and/or 4, represented through smaller rhythm values within time signatures [e.g. 10 is semi-quaver = 40 and 11 is semi-quaver = 44 in a time signature of 4/16 or 2/8. 64 is dotted crotchet = 192 and 32 is dotted crotchet = 96 in a time signature of 12/8]

Table 1d: 39 source tempi for metric modulation: final approximations: + or – 3

*****All tempi now calculate into Mäezel settings*****

	Mäezel A	**B**	**C**	**D**	**E**	**F**	**G**
39	208	126***	80*	50*	30	19	12
38	200	126***	76	48*	29	18	11
37	192	120**	72**	46*	28	18*	11
36	184	112**	69**	44*	27	16*	10
35	176	108*	69**	42	26	16	10
34	168	104	64	40	25	15	
33	160	100**	60**	38	23	14	
32	152	92**	58	36	22	14	
31	144	88*	56*	33*	21	13	
30	138	84**	52*	33	20	12	
29	132	80**	50	32*	19	12	
28	126	76**	48	30	18	11	
27	120	76**	46	28	18	11	
26	116	72	44	27	16*	10	
25	112	69	42*	26	16	10	
24	108	66*	42*	25	16	10	
23	104	64	40	25	15		
22	100	63**	38	24	15		
21	96	60*	36*	23	14		
20	92	56*	36*	22	13		
19	88	54	33*	21	13		
18	84	52	32	20	12		
17	80	50*	30*	19	12		
16	76	46*	29	18	11		
15	72	44	28	16*	11		
14	69	42*	26	16	10		
13	66	40*	25	16	10		
12	63	38*	24	15			
11	60	38*	23	14			
10	58	36	22	14			
9	56	36**	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	30*	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	16*	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio

Mäezel Metronome Tempi

Multiples/Divisions of 2 (Quaver)

Table 2a: 39 source tempi for metric modulation

All multiples of 2 that result in a Mäezel tempo: (half time/double time)

	Mäezel A	**B**	**C**	**D**	**E**	**F**	**G**
39	208	126***	80*	50*	30	19	12
38	200	126***	76	48*	29	18	11
37	192	120**	72**	46*	28	18*	11
36	184	112**	69**	44*	27	16*	10
35	176	108*	69**	42	26	16	10
34	168	104	64	40	25	15	
33	160	100**	60**	38	23	14	
32	152	92**	58	36	22	14	
31	144	88*	56*	33*	21	13	
30	138	84**	52*	33	20	12	
29	132	80**	50	32*	19	12	
28	126	76**	48	30	18	11	
27	120	76**	46	28	18	11	
26	116	72	44	27	16*	10	
25	112	69	42*	26	16	10	
24	108	66*	42*	25	16	10	
23	104	64	40	25	15		
22	100	63**	38	24	15		
21	96	60*	36*	23	14		
20	92	56*	36*	22	13		
19	88	54	33*	21	13		
18	84	52	32	20	12		
17	80	50*	30*	19	12		
16	76	46*	29	18	11		
15	72	44	28	16*	11		
14	69	42*	26	16	10		
13	66	40*	25	16	10		
12	63	38*	24	15			
11	60	38*	23	14			
10	58	36	22	14			
9	56	36**	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	30*	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	16*	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio

Mäezel Metronome Tempi

Multiples/Divisions of 3 (dotted quaver/triplet)

Table 2b: 39 source tempi for metric modulation

All multiples of 3 that result in a Mäezel tempo: (triple time)

	Mäezel A	**B**	**C**	**D**	**E**	**F**	**G**
39	208	126***	80*	50*	30	19	12
38	200	126***	76	48*	29	18	11
37	192	120**	72**	46*	28	18*	11
36	184	112**	69**	44*	27	16*	10
35	176	108*	69**	42	26	16	10
34	168	104	64	40	25	15	
33	160	100**	60**	38	23	14	
32	152	92**	58	36	22	14	
31	144	88*	56*	33*	21	13	
30	138	84**	52*	33	20	12	
29	132	80**	50	32*	19	12	
28	126	76**	48	30	18	11	
27	120	76**	46	28	18	11	
26	116	72	44	27	16*	10	
25	112	69	42*	26	16	10	
24	108	66*	42*	25	16	10	
23	104	64	40	25	15		
22	100	63**	38	24	15		
21	96	60*	36*	23	14		
20	92	56*	36*	22	13		
19	88	54	33*	21	13		
18	84	52	32	20	12		
17	80	50*	30*	19	12		
16	76	46*	29	18	11		
15	72	44	28	16*	11		
14	69	42*	26	16	10		
13	66	40*	25	16	10		
12	63	38*	24	15			
11	60	38*	23	14			
10	58	36	22	14			
9	56	36**	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	30*	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	16*	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio

Mäezel Metronome Tempi

Multiples/Divisions of 4 (semi-quaver)

Table 2c: 39 tempi for possible metric modulation

All multiples of 4 that result in a Mäezel tempo: (quadruple time)

	Mäezel A	**B**	**C**	**D**	**E**	**F**	**G**
39	208	126***	80*	50*	30	19	12
38	200	126***	76	48*	29	18	11
37	192	120**	72**	46*	28	18*	11
36	184	112**	69**	44*	27	16*	10
35	176	108*	69**	42	26	16	10
34	168	104	64	40	25	15	
33	160	100**	60**	38	23	14	
32	152	92**	58	36	22	14	
31	144	88*	56*	33*	21	13	
30	138	84**	52*	33	20	12	
29	132	80**	50	32*	19	12	
28	126	76**	48	30	18	11	
27	120	76**	46	28	18	11	
26	116	72	44	27	16*	10	
25	112	69	42*	26	16	10	
24	108	66*	42*	25	16	10	
23	104	64	40	25	15		
22	100	63**	38	24	15		
21	96	60*	36*	23	14		
20	92	56*	36*	22	13		
19	88	54	33*	21	13		
18	84	52	32	20	12		
17	80	50*	30*	19	12		
16	76	46*	29	18	11		
15	72	44	28	16*	11		
14	69	42*	26	16	10		
13	66	40*	25	16	10		
12	63	38*	24	15			
11	60	38*	23	14			
10	58	36	22	14			
9	56	36**	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	30*	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	16*	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio

Mäezel Metronome Tempi

Multiples/Divisions of 2, 3 & 4

(Primary Reference Sheet)

Table 2d: 39 source tempi for metric modulation (subdivisions of duration; time signatures)

Light Green = multiples of 2
Dark Green = multiples of 2 & 3
Bright Green = multiples of 2 & 4
Mid Blue = multiples of 2, 3 & 4

Light Yellow = multiples of 3
Bright Yellow = multiples of 3 & 4
Light Blue = multiples of 4

	Mäezel A	B	C	D	E	F	G
39	208	126***	80*	50*	30	19	12
38	200	126***	76	48*	29	18	11
37	192	120**	72**	46*	28	18*	11
36	184	112**	69**	44*	27	16*	10
35	176	108*	69**	42	26	16	10
34	168	104	64	40	25	15	
33	160	100**	60**	38	23	14	
32	152	92**	58	36	22	14	
31	144	88*	56*	33*	21	13	
30	138	84**	52*	33	20	12	
29	132	80**	50	32*	19	12	
28	126	76**	48	30	18	11	
27	120	76**	46	28	18	11	
26	116	72	44	27	16*	10	
25	112	69	42*	26	16	10	
24	108	66*	42*	25	16	10	
23	104	64	40	25	15		
22	100	63**	38	24	15		
21	96	60*	36*	23	14		
20	92	56*	36*	22	13		
19	88	54	33*	21	13		
18	84	52	32	20	12		
17	80	50*	30*	19	12		
16	76	46*	29	18	11		
15	72	44	28	16*	11		
14	69	42*	26	16	10		
13	66	40*	25	16	10		
12	63	38*	24	15			
11	60	38*	23	14			
10	58	36	22	14			
9	56	36**	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	30*	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	16*	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio

Mäezel Metronome Tempi

Multiples/Divisions of 5 (semi-quaver quintuplet)

Table 3a: 39 tempi for possible metric modulation

All multiples of 5 that result in a Mäezel tempo: (Quintuple time)

	Mäezel A	B	C	D	E	F	G
39	208	126***	80*	50*	30	19	12
38	200	126***	76	48*	29	18	11
37	192	120**	72**	46*	28	18*	11
36	184	112**	69**	44*	27	16*	10
35	176	108*	69**	42	26	16	10
34	168	104	64	40	25	15	
33	160	100**	60**	38	23	14	
32	152	92**	58	36	22	14	
31	144	88*	56*	33*	21	13	
30	138	84**	52*	33	20	12	
29	132	80**	50	32*	19	12	
28	126	76**	48	30	18	11	
27	120	76**	46	28	18	11	
26	116	72	44	27	16*	10	
25	112	69	42*	26	16	10	
24	108	66*	42*	25	16	10	
23	104	64	40	25	15		
22	100	63**	38	24	15		
21	96	60*	36*	23	14		
20	92	56*	36*	22	13		
19	88	54	33*	21	13		
18	84	52	32	20	12		
17	80	50*	30*	19	12		
16	76	46*	29	18	11		
15	72	44	28	16*	11		
14	69	42*	26	16	10		
13	66	40*	25	16	10		
12	63	38*	24	15			
11	60	38*	23	14			
10	58	36	22	14			
9	56	36**	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	30*	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	16*	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio

Mäezel Metronome Tempi

Multiple/Divisions of 6 (semi-quaver sextuplet)

Table 3b: 39 tempi for possible metric modulation

All multiples of 6 that result in a Mäezel tempo:

	Mäezel A	B	C	D	E	F	G
39	208	126***	80*	50*	30	19	12
38	200	126***	76	48*	29	18	11
37	192	120**	72**	46*	28	18*	11
36	184	112**	69**	44*	27	16*	10
35	176	108*	69**	42	26	16	10
34	168	104	64	40	25	15	
33	160	100**	60**	38	23	14	
32	152	92**	58	36	22	14	
31	144	88*	56*	33*	21	13	
30	138	84**	52*	33	20	12	
29	132	80**	50	32*	19	12	
28	126	76**	48	30	18	11	
27	120	76**	46	28	18	11	
26	116	72	44	27	16*	10	
25	112	69	42*	26	16	10	
24	108	66*	42*	25	16	10	
23	104	64	40	25	15		
22	100	63**	38	24	15		
21	96	60*	36*	23	14		
20	92	56*	36*	22	13		
19	88	54	33*	21	13		
18	84	52	32	20	12		
17	80	50*	30*	19	12		
16	76	46*	29	18	11		
15	72	44	28	16*	11		
14	69	42*	26	16	10		
13	66	40*	25	16	10		
12	63	38*	24	15			
11	60	38*	23	14			
10	58	36	22	14			
9	56	36**	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	30*	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	16*	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio

Mäezel Metronome Tempi

Multiples/Divisions of 7 (semi-quaver heptuplet)

Table 3c: 39 tempi for possible metric modulation

All multiples of 7 that result in a Mäezel tempo:

	Mäezel A	B	C	D	E	F	G
39	208	126***	80*	50*	30	19	12
38	200	126***	76	48*	29	18	11
37	192	120**	72**	46*	28	18*	11
36	184	112**	69**	44*	27	16*	10
35	176	108*	69**	42	26	16	10
34	168	104	64	40	25	15	
33	160	100**	60**	38	23	14	
32	152	92**	58	36	22	14	
31	144	88*	56*	33*	21	13	
30	138	84**	52*	33	20	12	
29	132	80**	50	32*	19	12	
28	126	76**	48	30	18	11	
27	120	76**	46	28	18	11	
26	116	72	44	27	16*	10	
25	112	69	42*	26	16	10	
24	108	66*	42*	25	16	10	
23	104	64	40	25	15		
22	100	63**	38	24	15		
21	96	60*	36*	23	14		
20	92	56*	36*	22	13		
19	88	54	33*	21	13		
18	84	52	32	20	12		
17	80	50*	30*	19	12		
16	76	46*	29	18	11		
15	72	44	28	16*	11		
14	69	42*	26	16	10		
13	66	40*	25	16	10		
12	63	38*	24	15			
11	60	38*	23	14			
10	58	36	22	14			
9	56	36**	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	30*	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	16*	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio

Mäezel Metronome Tempi

Multiples/Divisions of 8 (demi-semi-quaver)

Table 3d: 39 tempi for possible metric modulation

All multiples of 8 that result in a Mäezel tempo:

	Mäezel A	B	C	D	E	F	G
39	208	126***	80*	50*	30	19	12
38	200	126***	76	48*	29	18	11
37	192	120**	72**	46*	28	18*	11
36	184	112**	69**	44*	27	16*	10
35	176	108*	69**	42	26	16	10
34	168	104	64	40	25	15	
33	160	100**	60**	38	23	14	
32	152	92**	58	36	22	14	
31	144	88*	56*	33*	21	13	
30	138	84**	52*	33	20	12	
29	132	80**	50	32*	19	12	
28	126	76**	48	30	18	11	
27	120	76**	46	28	18	11	
26	116	72	44	27	16*	10	
25	112	69	42*	26	16	10	
24	108	66*	42*	25	16	10	
23	104	64	40	25	15		
22	100	63**	38	24	15		
21	96	60*	36*	23	14		
20	92	56*	36*	22	13		
19	88	54	33*	21	13		
18	84	52	32	20	12		
17	80	50*	30*	19	12		
16	76	46*	29	18	11		
15	72	44	28	16*	11		
14	69	42*	26	16	10		
13	66	40*	25	16	10		
12	63	38*	24	15			
11	60	38*	23	14			
10	58	36	22	14			
9	56	36**	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	30*	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	16*	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio

Mäezel Metronome Tempi

Multiples/Divisions of 9 (demi-semi-quaver triplet; nontuplet)

Table 3e: 39 tempi for possible metric modulation

All multiples of 9 that result in a Mäezel tempo:

	Mäezel A	B	C	D	E	F	G
39	208	126***	80*	50*	30	19	12
38	200	126***	76	48*	29	18	11
37	192	120**	72**	46*	28	18*	11
36	184	112**	69**	44*	27	16*	10
35	176	108*	69**	42	26	16	10
34	168	104	64	40	25	15	
33	160	100**	60**	38	23	14	
32	152	92**	58	36	22	14	
31	144	88*	56*	33*	21	13	
30	138	84**	52*	33	20	12	
29	132	80**	50	32*	19	12	
28	126	76**	48	30	18	11	
27	120	76**	46	28	18	11	
26	116	72	44	27	16*	10	
25	112	69	42*	26	16	10	
24	108	66*	42*	25	16	10	
23	104	64	40	25	15		
22	100	63**	38	24	15		
21	96	60*	36*	23	14		
20	92	56*	36*	22	13		
19	88	54	33*	21	13		
18	84	52	32	20	12		
17	80	50*	30*	19	12		
16	76	46*	29	18	11		
15	72	44	28	16*	11		
14	69	42*	26	16	10		
13	66	40*	25	16	10		
12	63	38*	24	15			
11	60	38*	23	14			
10	58	36	22	14			
9	56	36**	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	30*	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	16*	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio

Mäezel Metronome Tempi

Multiples/Divisions of 5, 6, 7 & 9

(Primary Reference Sheet)

Table 3f: 39 tempi for possible metric modulation (subdivisions of duration/time signature)

Tan = multiples of 5
Light Orange = multiples of 5 & 6
Lilac = multiples of 6
Light Blue = multiples of 6 & 7
Dark Brown = multiples of 5, 6 & 7
Yellow = 5, 6, 7 & 9
Red = multiples of 6 & 9

	Mäezel A	B	C	D	E	F	G
39	208	126***	80*	50*	30	19	12
38	200	126***	76	48*	29	18	11
37	192	120**	72**	46*	28	18*	11
36	184	112**	69**	44*	27	16*	10
35	176	108*	69**	42	26	16	10
34	168	104	64	40	25	15	
33	160	100**	60**	38	23	14	
32	152	92**	58	36	22	14	
31	144	88*	56*	33*	21	13	
30	138	84**	52*	33	20	12	
29	132	80**	50	32*	19	12	
28	126	76**	48	30	18	11	
27	120	76**	46	28	18	11	
26	116	72	44	27	16*	10	
25	112	69	42*	26	16	10	
24	108	66*	42*	25	16	10	
23	104	64	40	25	15		
22	100	63**	38	24	15		
21	96	60*	36*	23	14		
20	92	56*	36*	22	13		
19	88	54	33*	21	13		
18	84	52	32	20	12		
17	80	50*	30*	19	12		
16	76	46*	29	18	11		
15	72	44	28	16*	11		
14	69	42*	26	16	10		
13	66	40*	25	16	10		
12	63	38*	24	15			
11	60	38*	23	14			
10	58	36	22	14			
9	56	36**	21	13			
8	54	33	21	13			
7	52	32	20	12			
6	50	30*	19	12			
5	48	30	18	11			
4	46	28	18	11			
3	44	27	16*	10			
2	42	26	16	10			
1	40	25	15				

The Golden Ratio
Pitch Generation/Compositional Language

Research for pitch generation explored some equidistant theories initially, but realising this produced consecutive octaves. I explored ways of generating pitch material from the golden ratio. Western temperament can be compared to the golden ratio (a, is to b, what b, is to c)

1.618

0.618

1: 0,618

13:8 = 1.62

8:13 = 0.615

8:5 = 1.6

5:8 = 0.625

Fractals:

$$\frac{34}{55} = \frac{55}{34+55} = 0{,}618$$

$$\frac{55}{89} = \frac{89}{55+89} = 0{,}618$$

$$\frac{89}{144} = \frac{144}{89+144} = 0{,}618$$

$$\frac{144}{233} = \frac{233}{144+233} = 0{,}618$$

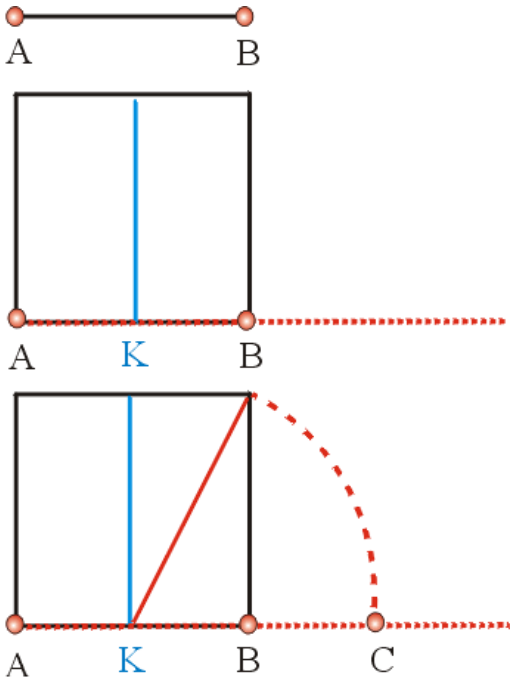
$$\frac{233}{377} = \frac{377}{233+377} = 0{,}618$$

$$\frac{377}{610} = \frac{610}{377+610} = 0{,}618$$

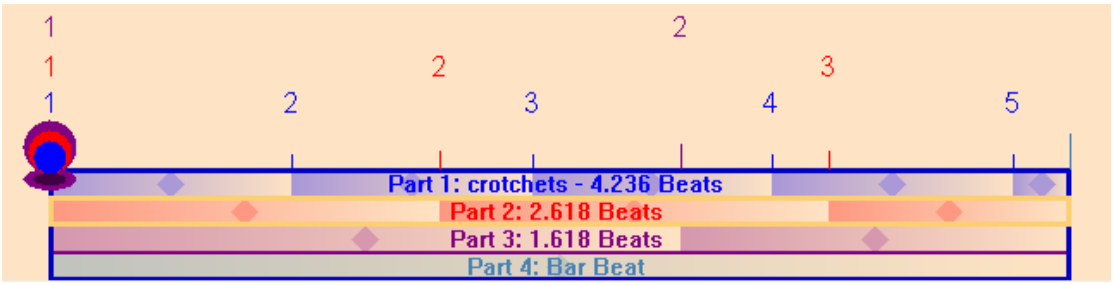
$$\frac{610}{987} = \frac{987}{610+987} = 0{,}618$$

1:0,618

Form and proportion:



Metronome:



Golden Section:

The Golden Ratio

Pitch
(Rounded Figures)

Repetition of pitches basically cycles through the octaves; therefore western equal temperament is comparable to the golden ratio.

Table 4a: Using 'C' as zero I assigned numbers 0-87 to the 12 chromatic notes representing the 88 pitches of the piano/orchestra:

C	0	12	24	36	48	60	72	84
C#	1	13	25	37	49	61	73	85
D	2	14	26	38	50	62	74	86
D#	3	15	27	39	51	63	75	87
E	4	16	28	40	52	64	76	
F	5	17	29	41	53	65	77	
F#	6	18	30	42	54	66	78	
G	7	19	31	43	55	67	79	
G#	8	20	32	44	56	68	80	
A	9	21	33	45	57	69	81	
B♭	10	22	34	46	58	70	82	
B	11	23	35	47	59	71	83	

Table 4b: I transposed to 'A' as zero, directly associating each number 0-87 to the 12 chromatic notes representing the 88 pitches of the piano/orchestra

A	0	12	24	36	48	60	72	84
B♭	1	13	25	37	49	61	73	85
B	2	14	26	38	50	62	74	86
C	3	15	27	39	51	63	75	87
C#	4	16	28	40	52	64	76	
D	5	17	29	41	53	65	77	
D#	6	18	30	42	54	66	78	
E	7	19	31	43	55	67	79	
F	8	20	32	44	56	68	80	
F#	9	21	33	45	57	69	81	
G	10	22	34	46	58	70	82	
G#	11	23	35	47	59	71	83	

Table 4c: I gave each of the 88 notes a specific number (0-87) in relation to exact register:

0	**A0**	12	**A1**	24	**A2**	36	**A3**	48	**A4**	60	**A5**	72	**A6**	84	**A7**
1	**B♭0**	13	**B♭1**	25	**B♭2**	37	**B♭3**	49	**B♭4**	61	**B♭5**	73	**B♭6**	85	**B♭7**
2	**B0**	14	**B1**	26	**B2**	38	**B3**	50	**B4**	62	**B5**	74	**B6**	86	**B7**
3	**C1**	15	**C2**	27	**C3**	39	**C4**	51	**C5**	63	**C6**	75	**C7**	87	**C8**
4	**C#1**	16	**C#2**	28	**C#3**	40	**C#4**	52	**C#5**	64	**C#6**	76	**C#7**		
5	**D1**	17	**D2**	29	**D3**	41	**D4**	53	**D5**	65	**D6**	77	**D7**		
6	**D#1**	18	**D#2**	30	**D#3**	42	**D#4**	54	**D#5**	66	**D#6**	78	**D#7**		
7	**E1**	19	**E2**	31	**E3**	43	**E4**	55	**E5**	67	**E6**	79	**E7**		
8	**F1**	20	**F2**	32	**F3**	44	**F4**	56	**F5**	68	**F6**	80	**F7**		
9	**F#1**	21	**F#2**	33	**F#3**	45	**F#4**	57	**F#5**	69	**F#6**	81	**F#7**		
10	**G1**	22	**G2**	34	**G3**	46	**G4**	58	**G5**	70	**G6**	82	**G7**		
11	**G#1**	23	**G#2**	35	**G#3**	47	**G#4**	59	**G#5**	71	**G#6**	83	**G#7**		

The Golden Ratio

88 Pitches Converted to Pitch Frequencies

Pitch frequencies below middle 'C'

I then converted each note into a frequency number and applied the golden ratio:

Table 5a: 39 pitches excluding middle 'C': 40 pitches in total.

e.g. a ÷ 1.618 = b ÷ 1.618 = c ÷ 1.618 = d ÷ 1.618 = e etc

No.	Pitch	Freq.	a	b	c	d	e	f	g	h	i	j	k
0	A0	27.500	27 28										
1	B♭0	29.135	29										
2	B0	30.868	31										
3	C1	32.703	33										
4	C#1	34.648	35										
5	D1	36.708	37										
6	D#1	38.891	39										
7	E1	41.203	41										
8	F1	43.654	44	27									
9	F#1	46.249	46	28									
10	G1	48.999	49	30.2									
11	G#1	51.913	52	32.1									
12	A1	55.000	55	34									
13	B♭1	58.270	58	36									
14	B1	61.735	62	38									
15	C2	65.406	65	40									
16	C#2	69.296	69	43									
17	D2	73.416	73	45	28								
18	D#2	77.782	78	48	30								
19	E2	82.407	82	51	31								
20	F2	87.307	87	54	33								
21	F#2	92.499	92	57	35								
22	G2	97.999	98	61	37								
23	G#2	103.83	104	64	40								
24	A2	110.00	110	68	42								
25	B♭2	116.54	117	72	45	28							
26	B2	123.47	123	76	47	29							
27	C3	130.81	131	81	50	31							
28	C#3	138.59	139	86	53	33							
29	D3	146.83	147	91	56	35							
30	D#3	155.56	156	96	60	37							
31	E3	164.81	165	102	63	39							
32	F3	174.61	175	108	67	41							
33	F#3	185.00	185	114	71	44	27						
34	G3	196.00	196	121	75	46	29						
35	G#3	207.65	208	129	79	49	30						
36	A3	220.00	220	136	84	52	32						
37	B♭3	233.08	233	144	89	55	34						
38	B3	246.94	247	153	94	58	36						
39	C4	261.60	262	162	100	62	38						

88 Pitches Converted to Pitch Frequencies

Pitch frequencies above middle 'C'

Table 5b: 48 pitches excluding middle 'C': 49 pitches in total.

No.	Pitch	Freq.	a	b	c	d	e	f	g	h	i	j	k
39	C4	261.60	262	162	100	62	38						
40	C#4	277.18	277	171	106	65	40						
41	D4	293.67	294	182	112	70	43	27					
42	D#4	311.13	311	192	119	73	45	28					
43	E4	329.63	330	204	126	78	48	30					
44	F4	349.23	349	216	133	83	51	32					
45	F#4	369.99	370	229	141	87	54	33					
46	G4	392.00	392	242	150	92	57	35					
47	G#4	415.30	415	256	159	98	61	37					
48	A4	440.00	440	272	168	104	64	40					
49	B♭4	466.16	466	288	178	110	68	42					
50	B4	493.88	494	305	189	116	72	44	28				
51	C5	523.25	523	323	200	123	76	47	29				
52	C#5	554.37	554	342	212	131	81	50	31				
53	D5	587.33	587	363	224	139	86	53	33				
54	D#5	622.25	622	384	238	147	91	56	35				
55	E5	659.26	659	407	252	155	96	59	37				
56	F5	698.46	698	431	267	165	102	63	39				
57	F#5	739.99	740	457	283	175	108	67	41				
58	G5	783.99	784	485	299	185	114	71	44	27			
59	G#5	830.61	831	514	317	196	121	75	46	29			
60	A5	880.00	880	544	336	208	128	79	49	30			
61	B♭5	932.33	932	576	356	220	136	84	52	32			
62	B5	987.77	988	611	377	233	144	89	55	34			
63	C6	1046.5	1046	646	400	247	153	94	58	36			
64	C#6	1108.7	1109	685	424	262	162	100	62	38			
65	D6	1174.7	1175	726	449	277	172	106	66	40			
66	D#6	1244.5	1244	769	475	294	181	112	69	43	27		
67	E6	1318.5	1318	815	504	311	192	119	74	45	28		
68	F6	1396.9	1397	863	534	330	204	126	78	48	30		
69	F#6	1480.0	1480	915	565	349	216	133	83	51	32		
70	G6	1568.0	1568	969	599	370	229	141	87	54	33		
71	G#6	1661.2	1661	1027	634	392	242	150	92	57	35		
72	A6	1760.0	1760	1088	672	416	257	159	98	61	37		
73	B♭6	1864.7	1865	1153	712	440	272	168	104	64	40		
74	B6	1975.5	1975	1221	754	466	288	178	110	68	42		
75	C7	2093.0	2093	1294	799	494	305	189	116	72	44	28	
76	C#7	2217.5	2217	1370	847	523	324	200	124	76	47	29	
77	D7	2349.3	2349	1452	897	555	343	212	131	81	50	31	
78	D#7	2489.0	2489	1538	951	587	363	224	139	86	53	33	
79	E7	2637.0	2637	1630	1007	623	385	238	147	91	56	35	
80	F7	2793.8	2794	1727	1067	660	408	252	156	96	60	37	
81	F#7	2960.0	2960	1829	1131	699	432	267	165	102	63	39	
82	G7	3136.0	3136	1938	1198	740	458	283	175	108	67	41	
83	G#7	3322.4	3322	2053	1269	784	485	299	185	114	71	44	27
84	A7	3520.0	3520	2175	1345	831	514	317	196	121	75	46	29
85	B♭7	3729.3	3729	2305	1424	880	544	336	208	128	79	49	30
86	B7	3951.1	3951	2442	1509	933	576	356	220	136	84	52	32
87	C8	4186.0	4186	2587	1599	988	611	377	233	144	89	55	34

The Golden Ratio

Frequency Numbers Converted to Closest Pitch

Pitches below middle 'C'

I then translated the list of frequency numbers into the nearest concert pitch:

Table 6a: 39 pitches excluding middle 'C': 40 pitches in total.

e.g. a ÷ 1.618 = b ÷ 1.618 = c ÷ 1.618 = d ÷ 1.618 = e etc

No.	Pitch	Freq.	a	b	c	d	e	f	g	h	i	j	k
0	A0	27.500	A0										
1	B♭0	29.135	B♭0										
2	B0	30.868	B0										
3	C1	32.703	C1										
4	C#1	34.648	C#1										
5	D1	36.708	D1										
6	D#1	38.891	D#1										
7	E1	41.203	E1										
8	F1	43.654	F1	A0									
9	F#1	46.249	F#1	A0									
10	G1	48.999	G1	B0									
11	G#1	51.913	G#1	C1									
12	A1	55.000	A1	C#1									
13	B♭1	58.270	B♭1	D1									
14	B1	61.735	B1	D#1									
15	C2	65.406	C2	E1									
16	C#2	69.296	C#2	F1									
17	D2	73.416	D2	F#1	A0								
18	D#2	77.782	D#2	G1	B♭0								
19	E2	82.407	E2	G#1	B0								
20	F2	87.307	F2	A1	C1								
21	F#2	92.499	F#2	B♭1	C#1								
22	G2	97.999	G2	B1	D1								
23	G#2	103.83	G#2	C2	D#1								
24	A2	110.00	A2	C#2	E1								
25	B♭2	116.54	B♭2	D2	F1	A0							
26	B2	123.47	B2	D#2	F#1	B♭0							
27	C3	130.81	C3	E2	G1	B0							
28	C#3	138.59	C#3	F2	G#1	C1							
29	D3	146.83	D3	F#2	A1	C#1							
30	D#3	155.56	D#3	G2	B♭1	D1							
31	E3	164.81	E3	G#2	B1	D#1							
32	F3	174.61	F3	A2	C2	E1							
33	F#3	185.00	F#3	B♭2	C#2	F1	A0						
34	G3	196.00	G3	B2	D2	F#1	B♭0						
35	G#3	207.65	G#3	C3	D#2	G1	B0						
36	A3	220.00	A3	C#3	E2	G#1	C1						
37	B♭3	233.08	B♭3	E3	F2	A1	C#1						
38	B3	246.94	B3	D#3	F#2	B♭1	D1						
39	C4	261.60	C4	E3	G2	B1	D#1						

Frequency Numbers Converted to Closest Pitch

Pitches above middle 'C'

Table 6b: 48 pitches excluding middle 'C': 49 pitches in total

No.	Pitch	Freq.	a	b	c	d	e	f	g	h	i	j	k
39	C4	261.60	C4	E3	G2	B1	D#1						
40	C#4	277.18	C#4	F3	G#2	C2	E1						
41	D4	293.67	D4	F#3	A2	C#2	F1	A0					
42	D#4	311.13	D#4	G3	B♭2	D2	F#1	B♭0					
43	E4	329.63	E4	G#3	B2	D#2	G1	B0					
44	F4	349.23	F4	A3	C3	E2	G#1	C1					
45	F#4	369.99	F#4	B♭3	C#3	F2	A1	C#1					
46	G4	392.00	G4	B3	D3	F#2	B♭1	D1					
47	G#4	415.30	G#4	C4	D#3	G2	B1	D#1					
48	A4	440.00	A4	C#4	E3	G#2	C2	E1					
49	B♭4	466.16	B♭4	D4	F3	A2	C#2	F1					
50	B4	493.88	B4	D#4	F#3	B♭2	D2	F#1	A0				
51	C5	523.25	C5	E4	G3	B2	D#2	G1	B♭0				
52	C#5	554.37	C#5	F4	G#3	C3	E2	G#1	B0				
53	D5	587.33	D5	F#4	A3	C#3	F2	A1	C1				
54	D#5	622.25	D#5	G4	B♭3	D3	F#2	B♭1	C#1				
55	E5	659.26	E5	G#4	B3	D#3	G2	B1	D1				
56	F5	698.46	F5	A4	C4	E3	G#2	C2	D#1				
57	F#5	739.99	F#5	B♭4	C#4	F3	A2	C#2	E1				
58	G5	783.99	G5	B4	D4	F#3	B♭2	D2	F1	A0			
59	G#5	830.61	G#5	C5	D#4	G3	B2	D#2	F#1	B♭0			
60	A5	880.00	A5	C#5	E4	G#3	C3	E2	G1	B0			
61	B♭5	932.33	B♭5	D5	F4	A3	C#3	F2	G#1	C1			
62	B5	987.77	B5	D#5	F#4	B♭3	D3	F#2	A1	C#1			
63	C6	1046.5	C6	E5	G4	B3	D#3	G2	B♭1	D1			
64	C#6	1108.7	C#6	F5	G#4	C4	E3	G#2	B1	D#1			
65	D6	1174.7	D6	F#5	A4	C#4	F3	A2	C2	E1			
66	D#6	1244.5	D#6	G5	B♭4	D4	F#3	B♭2	C#2	F1	A0		
67	E6	1318.5	E6	G#5	B4	D#4	G3	B2	D2	F#1	B♭0		
68	F6	1396.9	F6	A5	C5	E4	G#3	C3	D#2	G1	B0		
69	F#6	1480.0	F#6	B♭5	C#5	F4	A3	C#3	E2	G#1	C1		
70	G6	1568.0	G6	B5	D5	F#4	B♭3	D3	F2	A1	C#1		
71	G#6	1661.2	G#6	C6	D#5	G4	B3	D#3	F#2	B♭1	D1		
72	A6	1760.0	A6	C#6	E5	G#4	C4	E3	G2	B1	D#1		
73	B♭6	1864.7	B♭6	D6	F5	A4	C#4	F3	G#2	C2	E1		
74	B6	1975.5	B6	D#6	F#5	B♭4	D4	F#3	A2	C#2	F1		
75	C7	2093.0	C7	E6	G5	B4	D#4	G3	B♭2	D2	F#1	A0	
76	C#7	2217.5	C#7	F6	G#5	C5	E4	G#3	B2	D#2	G1	B♭0	
77	D7	2349.3	D7	F#6	A5	C#5	F4	A3	C3	E2	G#1	B0	
78	D#7	2489.0	D#7	G6	B♭5	D5	F#4	B♭3	C#3	F2	A1	C1	
79	E7	2637.0	E7	G#6	B5	D#5	G4	B3	D3	F#2	B♭1	C#1	
80	F7	2793.8	F7	A6	C6	E5	G#4	C4	D#3	G2	B1	D1	
81	F#7	2960.0	F#7	B♭6	C#6	F5	A4	C#4	E3	G#2	C2	D#1	
82	G7	3136.0	G7	B6	D6	F#5	B♭4	D4	F3	A2	C#2	E1	
83	G#7	3322.4	G#7	C7	D#6	G5	B4	D#4	F#3	B♭2	D2	F1	A0
84	A7	3520.0	A7	C#7	E6	G#5	C5	E4	G3	B2	D#2	F#1	B♭0
85	B♭7	3729.3	B♭7	D7	F6	A5	C#5	F4	G#3	C3	E2	G1	B0
86	B7	3951.1	B7	D#7	F#6	B♭5	D5	F#4	A3	C#3	F2	G#1	C1
87	C8	4186.0	C8	E7	G6	B5	D#5	G4	B♭3	D3	F#2	A1	C#1

The Golden Ratio

Closest Pitch Translation to Pitch Number

Pitches below middle 'C'

I then converted the list of concert pitches to their designated number from Table 4c:

Table 7a: 39 pitches excluding middle 'C': 40 pitches in total (see Table 8a & 8b)

e.g. a ÷ 1.618 = b ÷ 1.618 = c ÷ 1.618 = d ÷ 1.618 = e etc

No.	Pitch	Freq.	a	b	c	d	e	f	g	h	i	j	k
0	A0	27.500	0										
1	B♭0	29.135	1										
2	B0	30.868	2										
3	C1	32.703	3										
4	C#1	34.648	4										
5	D1	36.708	5										
6	D#1	38.891	6										
7	E1	41.203	7										
8	F1	43.654	8	0									
9	F#1	46.249	9	1									
10	G1	48.999	10	2									
11	G#1	51.913	11	3									
12	A1	55.000	12	4									
13	B♭1	58.270	13	5									
14	B1	61.735	14	6									
15	C2	65.406	15	7									
16	C#2	69.296	16	8									
17	D2	73.416	17	9	0								
18	D#2	77.782	18	10	1								
19	E2	82.407	19	11	2								
20	F2	87.307	20	12	3								
21	F#2	92.499	21	13	4								
22	G2	97.999	22	14	5								
23	G#2	103.83	23	15	6								
24	A2	110.00	24	16	7								
25	B♭2	116.54	25	17	8	0							
26	B2	123.47	26	18	9	1							
27	C3	130.81	27	19	10	2							
28	C#3	138.59	28	20	11	3							
29	D3	146.83	29	21	12	4							
30	D#3	155.56	30	22	13	5							
31	E3	164.81	31	23	14	6							
32	F3	174.61	32	24	15	7							
33	F#3	185.00	33	25	16	8	0						
34	G3	196.00	34	26	17	9	1						
35	G#3	207.65	35	27	18	10	2						
36	A3	220.00	36	28	19	11	3						
37	B♭3	233.08	37	29	20	12	4						
38	B3	246.94	38	30	21	13	5						
39	C4	261.60	39	31	22	14	6						

Closest Pitch Translation to Pitch Number

Pitches above middle 'C'

Table 7b: 48 pitches excluding middle 'C': 49 pitches in total (see Table 8a & 8b)

No.	Pitch	Freq.	a	b	c	d	e	f	g	h	i	j	k
39	C4	261.60	39	31	22	14	6						
40	C#4	277.18	40	32	23	15	7						
41	D4	293.67	41	33	24	16	8	0					
42	D#4	311.13	42	34	25	17	9	1					
43	E4	329.63	43	35	26	18	10	2					
44	F4	349.23	44	36	27	19	11	3					
45	F#4	369.99	45	37	28	20	12	4					
46	G4	392.00	46	38	29	21	13	5					
47	G#4	415.30	47	39	30	22	14	6					
48	A4	440.00	48	40	31	23	15	7					
49	B♭4	466.16	49	41	32	24	16	8					
50	B4	493.88	50	42	33	25	17	9	0				
51	C5	523.25	51	43	34	26	18	10	1				
52	C#5	554.37	52	44	35	27	19	11	2				
53	D5	587.33	53	45	36	28	20	12	3				
54	D#5	622.25	54	46	37	29	21	13	4				
55	E5	659.26	55	47	38	30	22	14	5				
56	F5	698.46	56	48	39	31	23	15	6				
57	F#5	739.99	57	49	40	32	24	16	7				
58	G5	783.99	58	50	41	33	25	17	8	0			
59	G#5	830.61	59	51	42	34	26	18	9	1			
60	A5	880.00	60	52	43	35	27	19	10	2			
61	B♭5	932.33	61	53	44	36	28	20	11	3			
62	B5	987.77	62	54	45	37	29	21	12	4			
63	C6	1046.5	63	55	46	38	30	22	13	5			
64	C#6	1108.7	64	56	47	39	31	23	14	6			
65	D6	1174.7	65	57	48	40	32	24	15	7			
66	D#6	1244.5	66	58	49	41	33	25	16	8	0		
67	E6	1318.5	67	59	50	42	34	26	17	9	1		
68	F6	1396.9	68	60	51	43	35	27	18	10	2		
69	F#6	1480.0	69	61	52	44	36	28	19	11	3		
70	G6	1568.0	70	62	53	45	37	29	20	12	4		
71	G#6	1661.2	71	63	54	46	38	30	21	13	5		
72	A6	1760.0	72	64	55	47	39	31	22	14	6		
73	B♭6	1864.7	73	65	56	48	40	32	23	15	7		
74	B6	1975.5	74	66	57	49	41	33	24	16	8		
75	C7	2093.0	75	67	58	50	42	34	25	17	9	0	
76	C#7	2217.5	76	68	59	51	43	35	26	18	10	1	
77	D7	2349.3	77	69	60	52	44	36	27	19	11	2	
78	D#7	2489.0	78	70	61	53	45	37	28	20	12	3	
79	E7	2637.0	79	71	62	54	46	38	29	21	13	4	
80	F7	2793.8	80	72	63	55	47	39	30	22	14	5	
81	F#7	2960.0	81	73	64	56	48	40	31	23	15	6	
82	G7	3136.0	82	74	65	57	49	41	32	24	16	7	
83	G#7	3322.4	83	75	66	58	50	42	33	25	17	8	0
84	A7	3520.0	84	76	67	59	51	43	34	26	18	9	1
85	B♭7	3729.3	85	77	68	60	52	44	35	27	19	10	2
86	B7	3951.1	86	78	69	61	53	45	36	28	20	11	3
87	C8	4186.0	87	79	70	62	54	46	37	29	21	12	4

The Golden Ratio

Pitch Generation – Number Sequences (see Table 7a & 7b)

Possible units for extended melody technique: E3 [164 Hz] is important as 162 = Phi

i] I have only used figures which produce a distinct row from the preceding calculation

ii] Using rounded figure calculations produced too much direct repetition, so I adapted the Fibonacci principle to extend some of the sequences [blue figures].

Table 8a: Number sequences produced by Tables 7a and 7b:

1st octave			
1 – 0 – 0			
2 – 1 – 0			
3 – 2 – 1	3 – 2 – 1 – 0		
5 – 3 – 2	5 – 3 – 2 – 1	5 – 3 – 2 – 1 – 0	
7 – 4 – 3	7 – 4 – 3 – 1		
10 – 6 – 4	10 – 6 – 4 – 2		
12 – 7 – 5	12 – 7 – 5 – 2		
2nd octave			
15 – 9 – 6	15 – 9 – 6 – 3		
18 – 11 – 7	18 – 11 – 7 – 4	18 – 11 – 7 – 4 – 3	18 – 11 – 7 – 4 – 3 – 1
20 – 12 – 8	20 – 12 – 8 – 4		
23 – 14 – 9	23 – 14 – 9 – 5	23 – 14 – 9 – 5 – 4	23 – 14 – 9 – 5 – 4 – 1
3rd octave			
26 – 16 – 10	26 – 16 – 10 – 6	26 – 16 – 10 – 6 – 4	26 – 16 – 10 – 6 – 4 – 2
28 – 17 – 11	28 – 17 – 11 – 6	28 – 17 – 11 – 6 – 5	28 – 17 – 11 – 6 – 5 – 1
31 – 19 – 12	31 – 19 – 12 – 7	31 – 19 – 12 – 7 – 5	31 – 19 – 12 – 7 – 5 – 2
33 – 20 – 13	33 – 20 – 13 – 7	33 – 20 – 13 – 7 – 6	33 – 20 – 13 – 7 – 6 – 1
36 – 22 – 14	36 – 22 – 14 – 8	36 – 22 – 14 – 8 – 6	36 – 22 – 14 – 8 – 6 – 2
4th octave			
38 – 23 – 15	38 – 23 – 15 – 8	38 – 23 – 15 – 8 – 7	38 – 23 – 15 – 8 – 7 – 1
41 – 25 – 16	41 – 25 – 16 – 9	41 – 25 – 16 – 9 – 7	41 – 25 – 16 – 9 – 7 – 2
44 – 27 – 17	44 – 27 – 17 – 10	44 – 27 – 17 – 10 – 7	44 – 27 – 17 – 10 – 7 – 3
46 – 28 – 18	46 – 28 – 18 – 10	46 – 28 – 18 – 10 – 8	46 – 28 – 18 – 10 – 8 – 2
5th octave			
49 – 30 – 19	49 – 30 – 19 – 11	49 – 30 – 19 – 11 – 8	49 – 30 – 19 – 11 – 8 – 3
52 – 32 – 20	52 – 32 – 20 – 12	52 – 32 – 20 – 12 – 8	52 – 32 – 20 – 12 – 8 – 4
54 – 33 – 21	54 – 33 – 21 – 12	54 – 33 – 21 – 12 – 9	54 – 33 – 21 – 12 – 9 – 3
57 – 35 – 22	57 – 35 – 22 – 13	57 – 35 – 22 – 13 – 9	57 – 35 – 22 – 13 – 9 – 4
59 – 36 – 23	59 – 36 – 23 – 13	59 – 36 – 23 – 13 – 10	59 – 36 – 23 – 13 – 10 – 3
6th octave			
62 – 38 – 24	62 – 38 – 24 – 14	62 – 38 – 24 – 14 – 10	62 – 38 – 24 – 14 – 10 – 4
65 – 40 – 25	65 – 40 – 25 – 15	65 – 40 – 25 – 15 – 10	65 – 40 – 25 – 15 – 10 – 5
67 – 41 – 26	67 – 41 – 26 – 15	67 – 41 – 26 – 15 – 11	67 – 41 – 26 – 15 – 11 – 4
70 – 43 – 27	70 – 43 – 27 – 16	70 – 43 – 27 – 16 – 11	70 – 43 – 27 – 16 – 11 – 5
72 – 44 – 28	72 – 44 – 28 – 16	72 – 44 – 28 – 16 – 12	72 – 44 – 28 – 16 – 12 – 4
7th octave			
75 – 46 – 29	75 – 46 – 29 – 17	75 – 46 – 29 – 17 – 12	75 – 46 – 29 – 17 – 12 – 5
78 – 48 – 30	78 – 48 – 30 – 18	78 – 48 – 30 – 18 – 12	78 – 48 – 30 – 18 – 12 – 6
80 – 49 – 31	80 – 49 – 31 – 18	80 – 49 – 31 – 18 – 13	80 – 49 – 31 – 18 – 13 – 5
83 – 51 – 32	83 – 51 – 32 - 19	83 – 51 – 32 – 19 – 13	83 – 51 – 32 – 19 – 13 – 6
8th octave			
86 – 53 – 33	86 – 53 – 33 – 20	86 – 53 – 33 – 20 – 13	86 – 53 – 33 – 20 – 13 – 7 – 6 – 1

The Golden Ratio

Pitch Generation – Number Sequences Translation to Pitch Register (Table 7a & 7b)

Possible units for extended melody technique: E3 [164 Hz] is important as 162 = Phi

i] I have only used figures which produce a distinct row from the preceding calculation

ii] Using rounded figure calculations produced too much direct repetition, so I adapted the Fibonacci principle to extend some of the sequences [blue figures].

Table 8b: Translation of table 8a (7a & 7b) into orchestral pitch and register (A0 = 0)

1st octave			
B♭0: A0: A0 B0: B♭0: A0 C1: B0: B♭0 D1: C1: B0 E1: C#1: C1 G1: D#1: C#1 A1: E1: D1	C1: B0: B♭0: A0 D1: C1: B0: B♭0 E1: C#1: C1: B♭0 G1: D#1: C#1: B0 A1: E1: D1: B0	D1: C1: B0: B♭0: A0	
2nd octave			
C2: F#1: D#1 D#2: G#1: E1 F2: A1: F1 G#2: B1: F#1	C2: F#1: D#1: C1 D#2: G#1: E1: C#1 F2: A1: F1: C#1 G#2: B1: F#1: D1	D#2: G#1: E1: C#1: C1 G#2: B1: F#1: D1: D♭1	D#2: G#1: E1: C#1: C1: B♭0 G#2: B1: F#1: D1: D♭1: B♭0
3rd octave			
B2: C#2: G1 C#3: D2: G#1 E3: E2: A1 F#3: F2: B♭1 A3: G2: B1	B2: C#2: G1: D#1 C#3: D2: G#1: D#1 E3: E2: A1: E1 F#3: F2: B♭1: E1 A3: G2: B1: F1	B2: C#2: G1: D#1: C#1 C#3: D2: G#1: D#1: D1 E3: E2: A1: E1: D1 F#3: F2: B♭1: E1: E♭1 A3: G2: B1: F1: D#1	B2: C#2: G1: D#1: C#1: B0 C#3: D2: G#1: D#1: D1: B♭0 E3: E2: A1: E1: D1: B0 F#3: F2: B♭1: E1: E♭1: B♭0 A3: G2: B1: F1: D#1: B0
4th octave			
B3: G#2: C2 D4: A#2: C#2 F4: C3: D2 G4: C#3: D#2	B3: G#2: C2: F1 D4: A#2: C#2: F#1 F4: C3: D2: G1 G4: C#3: D#2: G1	B3: G#2: C2: F1: E1 D4: A#2: C#2: F#1: E1 F4: C3: D2: G1: E1 G4: C#3: D#2: G1: F1	B3: G#2: C2: F1: E1: B♭0 D4: A#2: C#2: F#1: E1: B0 F4: C3: D2: G1: E1: C1 G4: C#3: D#2: G1: F1: B0
5th octave			
B♭4: D#3: E2 C#5: F3: F2 D#5: F#3: F#2 F#5: G#3: G2 G#5: A3: G#2	B♭4: D#3: E2: G#1 C#5: F3: F2: A1 D#5: F#3: F#2: A1 F#5: G#3: G2: B♭1 G#5: A3: G#2: A#1	B♭4: D#3: E2: G#1: F1 C#5: F3: F2: A1: F1 D#5: F#3: F#2: A1: F#1 F#5: G#3: G2: B♭1: F#1 G#5: A3: G#2: A#1: G1	B♭4: D#3: E2: G#1: F1: C1 C#5: F3: F2: A1: F1: C#1 D#5: F#3: F#2: A1: F#1: C1 F#5: G#3: G2: B♭1: F#1: C#1 G#5: A3: G#2: A#1: G1: C1
6th octave			
B5: B3: A2 D6: D♭4: B♭2 E6: D4: B2 G6: E4: C3 A6: F4: C#3	B5: B3: A2: B1 D6: D♭4: B♭2: C2 E6: D4: B2: C2 G6: E4: C3: C#2 A6: F4: C#3: C#2	B5: B3: A2: B1: G1 D6: D♭4: B♭2: C2: G1 E6: D4: B2: C2: G#1 G6: E4: C3: C#2: G#1 A6: F4: C#3: C#2: A1	B5: B3: A2: B1: G1: C#1 D6: D♭4: B♭2: C2: G1: D1 E6: D4: B2: C2: G#1: C#1 G6: E4: C3: C#2: G#1: D1 A6: F4: C#3: C#2: A1: C#1
7th octave			
C7: G4: D3 E♭7: A4: E♭3 F7: B♭4: E3 G#7: C5: F3	C7: G4: D3: D2 E♭7: A4: E♭3: E♭2 F7: B♭4: E3: E♭2 G#7: C5: F3: E2	C7: G4: D3: D2: A1 E♭7: A4: E♭3: E♭2: A1 F7: B♭4: E3: E♭2: B♭1 G#7: C5: F3: E2: B♭1	C7: G4: D3: D2: A1: D1 E♭7: A4: E♭3: E♭2: A1: E♭1 F7: B♭4: E3: E♭2: B♭1: D1 G#7: C5: F3: E2: B♭1: E♭1
8th octave			
B7: D5: F#3	B7: D5: F#3: F2	B7: D5: F#3: F2: B♭1	B7:D5:F#3:F2:B♭1:E1:E♭1:B♭0

The Golden Ratio

Pitch Number Translation Converted within an Octave

Pitches below middle 'C'

I then converted the list of concert pitches to a number within an octave span:

Table 9a: 39 pitches excluding middle 'C': 40 pitches in total (see Table 10a)

e.g. a ÷ 1.618 = b ÷ 1.618 = c ÷ 1.618 = d ÷ 1.618 = e etc

No.	Pitch	Freq.	a	b	c	d	e	f	g	h	i	j	k
0	A0	27.500	0										
1	B♭0	29.135	1										
2	B0	30.868	2										
3	C1	32.703	3										
4	C#1	34.648	4										
5	D1	36.708	5										
6	D#1	38.891	6										
7	E1	41.203	7										
8	F1	43.654	8	0									
9	F#1	46.249	9	1									
10	G1	48.999	10	2									
11	G#1	51.913	11	3									
12	A1	55.000	0	4									
13	B♭1	58.270	1	5									
14	B1	61.735	2	6									
15	C2	65.406	3	7									
16	C#2	69.296	4	8									
17	D2	73.416	5	9	0								
18	D#2	77.782	6	10	1								
19	E2	82.407	7	11	2								
20	F2	87.307	8	0	3								
21	F#2	92.499	9	1	4								
22	G2	97.999	10	2	5								
23	G#2	103.83	11	3	6								
24	A2	110.00	0	4	7								
25	B♭2	116.54	1	5	8	0							
26	B2	123.47	2	6	9	1							
27	C3	130.81	3	7	10	2							
28	C#3	138.59	4	8	11	3							
29	D3	146.83	5	9	0	4							
30	D#3	155.56	6	10	1	5							
31	E3	164.81	7	11	2	6							
32	F3	174.61	8	0	3	7							
33	F#3	185.00	9	1	4	8	0						
34	G3	196.00	10	2	5	9	1						
35	G#3	207.65	11	3	6	10	2						
36	A3	220.00	0	4	7	11	3						
37	B♭3	233.08	1	5	8	0	4						
38	B3	246.94	2	6	9	1	5						
39	C4	261.60	3	7	10	2	6						

Pitch Number Translation Converted within an Octave

Pitches above middle 'C'

Table 9b: 48 pitches excluding middle 'C': 49 pitches in total (see Table 10a)

No.	Pitch	Freq.	a	b	c	d	e	f	g	h	i	j	k
39	C4	261.60	3	7	10	2	6						
40	C#4	277.18	4	8	11	3	7						
41	D4	293.67	5	9	0	4	8	0					
42	D#4	311.13	6	10	1	5	9	1					
43	E4	329.63	7	11	2	6	10	2					
44	F4	349.23	8	0	3	7	11	3					
45	F#4	369.99	9	1	4	8	0	4					
46	G4	392.00	10	2	5	9	1	5					
47	G#4	415.30	11	3	6	10	2	6					
48	A4	440.00	0	4	7	11	3	7					
49	B♭4	466.16	1	5	8	0	4	8					
50	B4	493.88	2	6	9	1	5	9	0				
51	C5	523.25	3	7	10	2	6	10	1				
52	C#5	554.37	4	8	11	3	7	11	2				
53	D5	587.33	5	9	0	4	8	0	3				
54	D#5	622.25	6	10	1	5	9	1	4				
55	E5	659.26	7	11	2	6	10	2	5				
56	F5	698.46	8	0	3	7	11	3	6				
57	F#5	739.99	9	1	4	8	0	4	7				
58	G5	783.99	10	2	5	9	1	5	8	0			
59	G#5	830.61	11	3	6	10	2	6	9	1			
60	A5	880.00	0	4	7	11	3	7	10	2			
61	B♭5	932.33	1	5	8	0	4	8	11	3			
62	B5	987.77	2	6	9	1	5	9	0	4			
63	C6	1046.5	3	7	10	2	6	10	1	5			
64	C#6	1108.7	4	8	11	3	7	11	2	6			
65	D6	1174.7	5	9	0	4	8	0	3	7			
66	D#6	1244.5	6	10	1	5	9	1	4	8	0		
67	E6	1318.5	7	11	2	6	10	2	5	9	1		
68	F6	1396.9	8	0	3	7	11	3	6	10	2		
69	F#6	1480.0	9	1	4	8	0	4	7	11	3		
70	G6	1568.0	10	2	5	9	1	5	8	0	4		
71	G#6	1661.2	11	3	6	10	2	6	9	1	5		
72	A6	1760.0	0	4	7	11	3	7	10	2	6		
73	B♭6	1864.7	1	5	8	0	4	8	11	3	7		
74	B6	1975.5	2	6	9	1	5	9	0	4	8		
75	C7	2093.0	3	7	10	2	6	10	1	5	9	0	
76	C#7	2217.5	4	8	11	3	7	11	2	6	10	1	
77	D7	2349.3	5	9	0	4	8	0	3	7	11	2	
78	D#7	2489.0	6	10	1	5	9	1	4	8	0	3	
79	E7	2637.0	7	11	2	6	10	2	5	9	1	4	
80	F7	2793.8	8	0	3	7	11	3	6	10	2	5	
81	F#7	2960.0	9	1	4	8	0	4	7	11	3	6	
82	G7	3136.0	10	2	5	9	1	5	8	0	4	7	
83	G#7	3322.4	11	3	6	10	2	6	9	1	5	8	0
84	A7	3520.0	0	4	7	11	3	7	10	2	6	9	1
85	B♭7	3729.3	1	5	8	0	4	8	11	3	7	10	2
86	B7	3951.1	2	6	9	1	5	9	0	4	8	11	3
87	C8	4186.0	3	7	10	2	6	10	1	5	9	0	4

The Golden Ratio

Pitch Generation – Pitch Number Sequenced within an Octave

Possible units for extended melody technique: E3 [164 Hz] is important as 162 = Phi

i] I have only used figures which produce a distinct row from the preceding calculation

ii] Using rounded figure calculations produced too much direct repetition, so I adapted the Fibonacci principle to extend some of the sequences [blue figures].

Table 10a: Ratio sequences sequenced within an octave (see Table 9a & 9b): 12 tone theory

1st octave			
1 – 0 – 0			
2 – 1 – 0			
3 – 2 – 1	3 – 2 – 1 – 0		
5 – 3 – 2	5 – 3 – 2 – 1	5 – 3 – 2 – 1 – 0	
7 – 4 – 3	7 – 4 – 3 – 1		
10 – 6 – 4	10 – 6 – 4 – 2		
0 – 7 – 5	0 – 7 – 5 – 2		
2nd octave			
3 – 9 – 6	3 – 9 – 6 – 3		
6 – 11 – 7	6 – 11 – 7 – 4	6 – 11 – 7 – 4 – 3	6 – 11 – 7 – 4 – 3 – 1
8 – 0 – 8	8 – 0 – 8 – 4		
11 – 2 – 9	11 – 2 – 9 – 5	11 – 2 – 9 – 5 – 4	11 – 2 – 9 – 5 – 4 – 1
3rd octave			
2 – 4 – 10	2 – 4 – 10 – 6	2 – 4 – 10 – 6 – 4	2 – 4 – 10 – 6 – 4 – 2
4 – 5 – 11	4 – 5 – 11 – 6	4 – 5 – 11 – 6 – 5	4 – 5 – 11 – 6 – 5 – 1
7 – 7 – 0	7 – 7 – 0 – 7	7 – 7 – 0 – 7 – 5	7 – 7 – 0 – 7 – 5 – 2
9 – 8 – 1	9 – 8 – 1 – 7	9 – 8 – 1 – 7 – 6	9 – 8 – 1 – 7 – 6 – 1
0 – 10 – 2	0 – 10 – 2 – 8	0 – 10 – 2 – 8 – 6	0 – 10 – 2 – 8 – 6 – 2
4th octave			
2 – 11 – 3	2 – 11 – 3 – 8	2 – 11 – 3 – 8 – 7	2 – 11 – 3 – 8 – 7 – 1
5 – 1 – 4	5 – 1 – 4 – 9	5 – 1 – 4 – 9 – 7	5 – 1 – 4 – 9 – 7 – 2
8 – 3 – 5	8 – 3 – 5 – 10	8 – 3 – 5 – 10 – 7	8 – 3 – 5 – 10 – 7 – 3
10 – 4 – 6	10 – 4 – 6 – 10	10 – 4 – 6 – 10 – 8	10 – 4 – 6 – 10 – 8 – 2
5th octave			
1 – 6 – 7	1 – 6 – 7 – 11	1 – 6 – 7 – 11 – 8	1 – 6 – 7 – 11 – 8 – 3
4 – 8 – 8	4 – 8 – 8 – 0	4 – 8 – 8 – 0 – 8	4 – 8 – 8 – 0 – 8 – 4
6 – 9 – 9	6 – 9 – 9 – 0	6 – 9 – 9 – 0 – 9	6 – 9 – 9 – 0 – 9 – 3
9 – 11 – 10	9 – 11 – 10 – 1	9 – 11 – 10 – 1 – 9	9 – 11 – 10 – 1 – 9 – 4
11 – 0 – 11	11 – 0 – 11 – 1	11 – 0 – 11 – 1 – 10	11 – 0 – 11 – 1 – 10 – 3
6th octave			
2 – 2 – 0	2 – 2 – 0 – 2	2 – 2 – 0 – 2 – 10	2 – 2 – 0 – 2 – 10 – 4
5 – 4 – 1	5 – 4 – 1 – 3	5 – 4 – 1 – 3 – 10	5 – 4 – 1 – 3 – 10 – 5
7 – 5 – 2	7 – 5 – 2 – 3	7 – 5 – 2 – 3 – 11	7 – 5 – 2 – 3 – 11 – 4
10 – 7 – 3	10 – 7 – 3 – 4	10 – 7 – 3 – 4 – 11	10 – 7 – 3 – 4 – 11 – 5
0 – 8 – 4	0 – 8 – 4 – 4	0 – 8 – 4 – 4 – 0	0 – 8 – 4 – 4 – 0 – 4
7th octave			
3 – 10 – 5	3 – 10 – 5 – 5	3 – 10 – 5 – 5 – 0	3 – 10 – 5 – 5 – 0 – 5
6 – 0 – 6	6 – 0 – 6 – 6	6 – 0 – 6 – 6 – 0	6 – 0 – 6 – 6 – 0 – 6
8 – 1 – 7	8 – 1 – 7 – 6	8 – 1 – 7 – 6 – 1	8 – 1 – 7 – 6 – 1 – 5
11 – 3 – 8	11 – 3 – 8 – 7	11 – 3 – 8 – 7 – 1	11 – 3 – 8 – 7 – 1 – 6
8th octave			
2 – 5 – 9	2 – 5 – 9 – 8	2 – 5 – 9 – 8 – 1	2 – 5 – 9 – 8 – 1 – 7 – 6 – 1

The Golden Ratio

Pitch Generation – Symmetrical Interval Classes

Possible units for extended melody technique: E3 [164 Hz] is important as 162 = Phi

i] I have only used figures which produce a distinct row from the preceding calculation

ii] Using rounded figure calculations produced too much direct repetition, so I adapted the Fibonacci principle to extend some of the sequences [blue figures].

Table 10b: Symmetrical interval classes: method treats A as 0 (academic): set theory

1st octave			
1 – 0 – 0			
2 – 1 – 0			
3 – 2 – 1	3 – 2 – 1 – 0		
5 – 3 – 2	5 – 3 – 2 – 1	5 – 3 – 2 – 1 – 0	
5 – 4 – 3	5 – 4 – 3 – 1		
2 – 6 – 4	2 – 6 – 4 – 2		
0 – 5 – 5	0 – 5 – 5 – 2		
2nd octave			
3 – 3 – 6	3 – 3 – 6 – 3		
6 – 1 – 5	6 – 1 – 5 – 4	6 – 1 – 5 – 4 – 3	6 – 1 – 5 – 4 – 3 – 1
4 – 0 – 4	4 – 0 – 4 – 4		
1 – 2 – 3	1 – 2 – 3 – 5	1 – 2 – 3 – 5 – 4	1 – 2 – 3 – 5 – 4 – 1
3rd octave			
2 – 4 – 2	2 – 4 – 2 – 6	2 – 4 – 2 – 6 – 4	2 – 4 – 2 – 6 – 4 – 2
4 – 5 – 1	4 – 5 – 1 – 6	4 – 5 – 1 – 6 – 5	4 – 5 – 1 – 6 – 5 – 1
5 – 5 – 0	5 – 5 – 0 – 5	5 – 5 – 0 – 5 – 5	5 – 5 – 0 – 5 – 5 – 2
3 – 4 – 1	3 – 4 – 1 – 5	3 – 4 – 1 – 5 – 6	3 – 4 – 1 – 5 – 6 – 1
0 – 2 – 2	0 – 2 – 2 – 4	0 – 2 – 2 – 4 – 6	0 – 2 – 2 – 4 – 6 – 2
4th octave			
2 – 1 – 3	2 – 1 – 3 – 4	2 – 1 – 3 – 4 – 5	2 – 1 – 3 – 4 – 5 – 1
5 – 1 – 4	5 – 1 – 4 – 3	5 – 1 – 4 – 3 – 5	5 – 1 – 4 – 3 – 5 – 2
4 – 3 – 5	4 – 3 – 5 – 2	4 – 3 – 5 – 2 – 5	4 – 3 – 5 – 2 – 5 – 3
2 – 4 – 6	2 – 4 – 6 – 2	2 – 4 – 6 – 2 – 4	2 – 4 – 6 – 2 – 4 – 2
5th octave			
1 – 6 – 5	1 – 6 – 5 – 1	1 – 6 – 5 – 1 – 4	1 – 6 – 5 – 1 – 4 – 3
4 – 4 – 4	4 – 4 – 4 – 0	4 – 4 – 4 – 0 – 4	4 – 4 – 4 – 0 – 4 – 4
6 – 3 – 3	6 – 3 – 3 – 0	6 – 3 – 3 – 0 – 3	6 – 3 – 3 – 0 – 3 – 3
3 – 1 – 2	3 – 1 – 2 – 1	3 – 1 – 2 – 1 – 3	3 – 1 – 2 – 1 – 3 – 4
1 – 0 – 1	1 – 0 – 1 – 1	1 – 0 – 1 – 1 – 2	1 – 0 – 1 – 1 – 2 – 3
6th octave			
2 – 2 – 0	2 – 2 – 0 – 2	2 – 2 – 0 – 2 – 2	2 – 2 – 0 – 2 – 2 – 4
5 – 4 – 1	5 – 4 – 1 – 3	5 – 4 – 1 – 3 – 2	5 – 4 – 1 – 3 – 2 – 5
5 – 5 – 2	5 – 5 – 2 – 3	5 – 5 – 2 – 3 – 1	5 – 5 – 2 – 3 – 1 – 4
2 – 5 – 3	2 – 5 – 3 – 4	2 – 5 – 3 – 4 – 11	2 – 5 – 3 – 4 – 1 – 5
0 – 4 – 4	0 – 4 – 4 – 4	0 – 4 – 4 – 4 – 0	0 – 4 – 4 – 4 – 0 – 4
7th octave			
3 – 2 – 5	3 – 2 – 5 – 5	3 – 2 – 5 – 5 – 0	3 – 2 – 5 – 5 – 0 – 5
6 – 0 – 6	6 – 0 – 6 – 6	6 – 0 – 6 – 6 – 0	6 – 0 – 6 – 6 – 0 – 6
4 – 1 – 5	4 – 1 – 5 – 6	4 – 1 – 5 – 6 – 1	4 – 1 – 5 – 6 – 1 – 5
1 – 3 – 4	1 – 3 – 4 – 5	1 – 3 – 4 – 5 – 1	1 – 3 – 4 – 5 – 1 – 6
8th octave			
2 – 5 – 3	2 – 5 – 3 – 4	2 – 5 – 3 – 4 – 1	2 – 5 – 3 – 4 – 1 – 5 – 6 – 1