

Journey to the Heart of Music

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Example J *Johannes Brahms - Intermezzo* *Opus 119, No.3*

MUTABLE NUMBER ANALYSIS

The music of Johannes Brahms stands somewhat in contrast to the more exuberant outpourings of the first flush of romanticism and to the more pioneering harmonic developments pursued toward the turn of the nineteenth century. Though his harmonic language is essentially that of the romantic period, in terms of form and compositional rigour he is much more conservative. Brahms (1833-97) was neither reactionary nor revolutionary, he possessed a rare talent which enabled him to convincingly combine the new resources of romantic expression with the formal tradition bequeathed to the nineteenth century by Haydn, Mozart and Beethoven.

The Intermezzo (Op.119, No.3) written quite late in Brahms' career, contains many typical features of the romantic style: a fullness of texture -- great handfuls of notes, the scattering of non-harmonic 'coloring tones' amongst the chords, the chromatic alteration of structural notes such as triads with diminished fifths and the frequent use of seventh, ninth and diminished harmonies plus chords of the added sixth. All of these features present difficulties for the MOS model in that they tend to obscure the core harmonic structure -- that is assuming that there is one. Generally in the music of Brahms there is a strand of more traditional harmonic thought running through the piece. However, for some other composers at the end of the nineteenth century, there is progressively less and less certainty and definition about what actually is, and what is not,

part of a works core traditional harmonic structure: Music theorist at the turn of the nineteenth century struggled to extend their traditional analytical model(s) to account for contemporary musical practice. Indeed these trends, where taken to their logical conclusion, as for example in the more forward looking works of Wagner, produce music which at times defies traditional harmonic analysis and nullifies the potency and relevance of mutable numbers. Essentially the problem theorists faced was that the compositional practice they were seeking to understand and model was largely guided by the rather negative principle of evading and circumventing explicit tonal reference, while at the same time not quite rejecting tonality in toto. The logical end point of this process of loosening of harmonic relationship is to be found in the advent of atonal music, where Arnold Schoenberg and others of the Second Viennese School, forsook the late romantic style of Wagner and Richard Strauss to look for an entirely new path for music. The emancipation of dissonance as Schoenberg termed it. For such music the MOS model is eventually reduced to using one extended fundamental harmonic series to encompass all the twelve chromatic tones: A mildly pointless exercise which has little useful to say about serial music.

In this piece by Brahms the situation is not so difficult, though at some points the mutable numbers have to climb quite high (above five thousand in measure 34) to accommodate the Brahms' harmony and this despite the unit (H1) for the whole composition being set at the low rate of 0.5 hertz. This low unit introduces an immediate point of confusion to be guarded against: the value of a mutable number (the conjunction between adjacent mutable digit sequences) will be roughly twice the frequency measured in hertz.

Page Layout

The presentation of the music follows the standard layout adopted in the examples from *Journey to the Heart of Music*: at the top of the page is the score with Roman Numeral analysis attached, below which, the mutable number analysis is given in factor format 'a la figured bass'. Next the bulk of the page consists of sequences of harmonic series charting the precise evolution of the 'tonal computation' from digit sequence to digit sequence -- from effective chord to chord. Here the simple whole number proportions, additions and subtractions are worked out in detail, with the system being driven, in principle, by the foreground *aggregated series*, which reflect the succession of chords (objective notes circled). The foreground aggregated harmonic series, marked with asterisks, are set against a complementary background of *nested series*. The exact values of the conjunctions (between harmonic series) and nested fundamentals (lower case h1) are marked in hertz, these values are calculated from the ratios of the modulation exchanges and as a consequence of this tend to wander about rather than stick to any fixed pitch scale. (The piece begins at middle C = 256Hz, drifts flat until the staircase figure at measures 50-53 catapults the pitch up beyond its starting level.) The written-out nested/aggregated series are notionally set within a *fundamental series* built upon the unit H1, this series is not shown except for its point of connection with the nested series (eg. C-h1/H32). Below the written-out harmonic series the additions, subtractions and proportions of the modulation exchanges for both the aggregated and nested series are given, the former in black oblique script and the latter in gray upright script. The black/gray color code is similarly applied to the written-out harmonic series, showing how the aggregated series is moving about within the wider confines of nested series. Ultimately, both these series are set within the unwritten fundamental series and all three series, aggregated, nested and fundamental, share the same conjunction(s). However, such an arrangement of dynamical, multiply nested,

harmonic series cannot for long maintain consistent fixed scale degrees. In short the fabric of the system must flex to accommodate the dynamic motion of the aggregated and nested series. This flexibility is registered in the unit value of the factor format mutable numbers and in the variable frequency values of the nested fundamentals (h1/Hnn) and therefore of the conjunctions also.

As the first twelve measures of the Intermezzo are repeated, measures 13 through 24 are given without analysis, however though not shown, the effect of repeating the tonal computation is taken into account in calculating the values ascribed to nested fundamentals and conjunctions from measure 25 onward: The composition is treated as single continuous computation.

Mechanism of Computation

The basic nature of harmony considered as 'tonal computation' is concisely illustrated in the first three measures where the conjunctions between the harmonic series coincide with the top notes of the chords -- the note E. (This coincidence is more the exception than the norm, more usually higher harmonic frequencies form conjunctions.) The chords in the first three measures are: C-major, A-minor and E-minor: with the nested harmonic series which encompass these chords being built of C-h1/H64, F-h1/H42 and C-h1/H32. The upper case 'Hnn' referring to positions in the fundamental series based on C 0.5 hertz, H1, H2, H3,.. H32,.. H42,.. H64, etc. The first harmonic series of the analysis contains the arpeggiated chord of C-major as laid out in measure 1. Due to the position of the E on the bass staff, a series built on C-h1/H64 (32 hertz) is the smallest capable of containing all the objective notes; the difference combination tone generated by this E and the C below would create a perceived non-objective pitch matching the fundamental: C- 32.0 hertz (h1/H64) within the ear. In this first C series the value of the harmonic elements in the series are given in hertz, but in subsequent series this is left out due to space considerations; though these can be easily calculated from the nested fundamentals which have their value in hertz appended below. The second series provides an octave amplification of the first series: It is apparent the processes of aural cognition possess the ability to interpret octave jumps in chords as a 'modulus two' like re-calibration of harmonic coordinates. Within both the first two series the occasional appearance of an A-minor inflection in the C-major harmony is accounted for by a broken line circle around the element A-416.0 hertz. However, at the end of measure 2 the A-minor inflection is treated more seriously, as the harmonic motion moves from C-major, via A-minor to the chord of E-minor in measure 3. The third harmonic series is built on F-h1/H42; effectively the background nested series has been forced to shift its ground within the fundamental series from H64/H32 to H42, in order to accommodate a fully perceived A-minor harmony. By aggregating the elements of this nested series built on F-h1/H42 into groups of five, as shown by the '*R' symbol and asterisks, a minor harmony is able to emerge from the essentially major-like natural harmonic series. The minor third created by the C-natural in the A-minor chord is accommodated in the background nested series (C-h6 and C-h24) while the structurally significant fifth interval (A-h20 and E-h30) lies on the nodes formed by the aggregations of five elements. The same pattern is repeated in the fourth series, where an E-minor harmony is similarly able to emerge from a nested series built on C-h1/H32. These three chords, as laid out upon nested, background harmonic series, share a common upper note E -- a conjunction of different harmonics in their underlying nested series -- h20, h40, h30 and h40 again. (These conjunction frequencies are also objectively present as overtones generated by the chords when the conjunctions lie at a higher pitch than the

written notes, which is most often the case.)

Below the written-out series are the whole number modulation exchanges which show how the relative movements of the aggregated and nested series (within a broader fundamental series) can be understood in terms of simple ratios or proportions. For example, between the second and third written-out series the aggregated series representing the perceived harmonies of C-major and A-minor, moves from ten groups (of four) to six groups (of five), a proportion of 5/3 between the roots C-64.0 hertz and A-106.666... hertz -- elements marked by '*R'. At the same time the background nested series out of which these aggregates are formed, moves by the proportion of 4/3, through the execution of a decanary or tenfold sesquitertia 3:4 modulation exchange from a series built on C-16.0 hertz to a series built on F-21.333... hertz. Both the motions of the series hinge upon the selfsame harmonic conjunction between E-h40 of the second series and E-h30 of the third written-out series, though individually the ratios of exchange are different. And essentially the same process is involved in every harmonic step from measure 1 to measure 70, sometimes the aggregated and nested series will move in union but for the most part they will differ in their proportions of exchange. So from start to finish, by following the exchanges step by step, the whole composition can be construed as effectively the execution of a computation or calculation. These mathematical manipulations carried out through the language of tonal progression are summarised in the factor format mutable numbers, where the rearrangement of their digit sequences, representing a common value, the conjunction value, encapsulate the succession of harmonies. Thus for example the harmonic progression discussed above, from C-major to A-minor to E-minor, can be re-interpreted as three different mutable number digit sequences which all represent the single magnitude one-thousand two-hundred and eighty.

| | | | |
|-----------------------|--|--|--|
| <u>Harmony:</u> | C-major chord | ---> A-minor chord | ---> E-minor chord |
| <u>Factor Format:</u> | 10 x 4 x 32 x 1 = 1280 | ---> 6 x 5 x 42 x 1.016 = 1280 | ---> 8 x 5 x 32 x 1 = 1280 |
| <u>Subscript Fmt:</u> | MBN 10 ₄ 0 ₃₂ 0 ₁ | ---> MBN 6 ₅ 0 ₄₂ 0 ₁ | ---> MBN 8 ₅ 0 ₃₂ 0 ₁ |

(The factor format unit value 1.016, above, is a rounded approximation.) It is the common ground of the frequency of the conjunctions (E-h20, E-h30, E-h40 = 640 hertz) which allows the ear to connect together the succession of objective sounds into a commensurable harmonic progressions.

Parallel Motion

There are two passages in the Intermezzo where 'parallel motion' rather than 'tonal computation' is the primary organising principle, measures 35-37 and 52-55. In the former a two measure sequence of descending bare octaves is interposed between the free flowing tonal harmony. The octaves form a 'break figure' which the MOS analysis manages to digest by the allowing the background nested series to approximate a diminished fifth interval to the ratio 7:10. Also at this point the conjunction has to leaping up an octave to encompass the high G. However the whole two measures, considered as harmonic interpolation, could be bridged by a 5:4 modulation exchange direct from measure 34 to measure 37.5.

(24 groups of 5) --5:4--> (30 groups of 4)
 F-minor chord -----> Dflat-major chord

The 'staircase' sequence beginning at measure 52 presents greater difficulties as its organising principle is thoroughly parallel -- moving in semitone steps -- and of greater length. In the later romantic period, as composers moved further and further away from the more or less exclusive use of small whole numbered proportions of tonal harmony eg. 2:3, 3:4, 4:5, etc., one of the natural non-tonal organisational techniques that came to hand was that of parallel motion. Most often this parallelism involved repeated patterns moving in semitone steps; which might be seen as an extension of embedded chromaticism (within tonal harmony) to a thoroughly explicit chromaticism used as a structural principle. In this pervasive form chromaticism tends to nullify tonality. Also the technique could be viewed as a new type of symmetry: the use of a continuous 'glissando' type symmetry as opposed to tonal harmony's dependence on the discrete symmetry of rational numbers. Whichever way, it poses something of a problem for a MOS analysis in that parallelism is rather alien to the natural character of whole mutable numbers. In the analysis this difficulty is flagged by the foreground aggregated series and the background nested series locking step through measures 52-55, in a sequence of semitone 15:16 modulation exchanges (8 x sixteen -15:16-> 8 x fifteen) using the matching conjunctions at h80 -> h75. These are somewhat irregular mutable number digit sequence exchanges in that the note letter designation of the conjunction h75 actually occurs at element h76. Practically over these measures the aggregated series in groups of five is simply 'hoisted', semitone by semitone up an augmented fourth, in its enfolding nested series. In a similar manner to measures 34 through 37.5, a bridge could be formed across these troubled waters, from measure 51 (24 groups of 8) to measure 55.6 (24 groups of 4) using the conjunction D-h192 --> D-h96.

Thus by one means or another the MOS analysis is able to accommodate the chromatic parallel principle within a broader tonal architecture. However, the model accommodates them with some degree of discomfort. The semitone steps in measures 50-51 provide another example. Indeed when the late romantic harmonic style developed to a position where chromaticism became the norm and tonal organisation (defined as mutable number computation) the exception, clearly, the MOS model and mutable number analysis will no longer constitute a particularly sensible or fruitful approach. Overall though, this Intermezzo appears to fall well within the scope of mutable number analysis, nevertheless the signs of the MOS model's limits are present and no doubt these limitations will loom ever larger in the works of Brahms' contemporaries: Richard Wagner and Richard Strauss.

J.6 - INTERMEZZO, J. BRAHMS

Grazioso e Giocosso

CM: I

vi iii vi⁷ IV⁷

| | | | | | | | | |
|----------|------------------|--------|--------|--------|--------|--------|--------|--------|
| Value: | 1280-E (decimal) | 1280-E | 1280-E | 1280-E | 2560-E | 2560-E | 1664-A | 1664-A |
| Mutable | 10 | 10 | 6 | 8 | 16 | 24 | 16 | 10 |
| Digit | 2 | 4 | 5 | 5 | 5 | 5 | 5 | 4 |
| Sequence | 64 | 32 | 42 | 32 | 32 | 21 | 21 | 42 |
| | 1 | 1 | 1.016 | 1 | 1 | 1.016 | 0.990 | 0.990 |

Tonal Center C

C-H1 = 0.5Hz

| | | | | | | |
|-------------|------------------|------------------|------------|------------|----------|------------|
| 1280.0Hz | E1280.0(h80)* | E1280.0(h80)* | E-h60* | E-h80*> | 1280.0Hz | E-h120* |
| Conjunction | (E)-640.0(h20)*> | (E)-640.0(h40)*> | (E)-h30*> | (E)-h40*> | 640.0Hz | (E)-h60* |
| | D#608.0(h19) | D-576.0(h36)* | D#h28 | - h35* | | - h55* |
| | D-576.0(h18)* | (C)-512.0(h32)* | D-h26 | (B)-h30* | | C-h50* |
| | C#544.0(h17) | A#448.0(h28)* | C#h25* | A#h28 | | (C)-h48 |
| | (C)-512.0(h16)* | (A)-416.0(h26) | (C)-h24 | - h27 | | - h45* |
| | B-480.0(h15) | (G)-384.0(h24)* | - h23 | A-h26 | | A-h40* |
| | A#448.0(h14)* | - 368.0(h23) | B-h22 | G#h25* | | - h35* |
| | (A)-416.0(h13) | F#352.0(h22) | A#h21 | (G)-h24 | | E-h30* |
| | (G)-384.0(h12)* | F-336.0(h21) | (A)-h20* | - h23 | | C#h25* |
| | F#352.0(h11) | (E)-320.0(h20)* | G#h19 | F#h22 | | C-h24 |
| | (E)-320.0(h10)* | D#304.0(h19) | G-h18 | F-h21 | | - h23 |
| | D-288.0(h9) | D-288.0(h18) | F#h17 | (E)-h20* | | B-h22 |
| | (C)-256.0(h8)* | C#272.0(h17) | F-h16 | D#h19 | | A#h21 |
| | A#224.0(h7) | (C)-256.0(h16)* | E-h15* | D-h18 | | A-h20* |
| | G-192.0(h6)* | B-240.0(h15) | D#h14 | C#h17 | | G#h19 |
| | (E)-160.0(h5) | A#224.0(h14) | D-h13 | C-h16 | | G-h18 |
| | (C)-128.0(h4)* | A-208.0(h13) | C-h12 | B-h15* | | F#h17 |
| | G- 96.0(h3) | G-192.0(h12)* | B-h11 | A#h14 | | F-h16 |
| | (C)- 64.0(h2)*R | F#176.0(h11) | A-h10* | A-h13 | | E-h15* |
| | C- 32.0(h1/H64) | (E)-160.0(h10) | G- h9 | (C)-h12 | | D#h14 |
| | ----- | D-144.0(h9) | F- h8 | F#h11 | | D-h13 |
| | C- 0.5Hz (H1) | (C)-128.0(h8)* | D# h7 | (E)-h10* | | (C)-h12 |
| | | A#112.0(h7) | (C)- h6 | D- h9 | | B-h11 |
| | | G- 96.0(h6) | A- h5*R | C- h8 | | (A)-h10* |
| | | E- 80.0(h5) | F- h4 | A# h7 | | G- h9 |
| | | (C)- 64.0(h4)*R | C- h3 | G- h6 | | F- h8 |
| | | G- 48.0(h3) | F- h2 | (E)- h5*R | | D# h7 |
| | | C- 32.0(h2) | F- h1/H42 | C- h4 | | C- h6 |
| | | C- 16.0(h1/H32) | (21.333Hz) | G- h3 | | (A)- h5*R |
| | | | | C- h2 | | F- h4 |
| | | | | C-h1/H32 | | C- h3 |
| | | | | (16.000Hz) | | F- h2 |
| | | | | | | F- h1/H21 |
| | | | | | | (10.666Hz) |

Objective
Notes: ○
Aggregates: *
Mid.C=256Hz
Conjunction:>
Root: R

Aggregated (16 groups of 5) -----3:2-----> (24 groups of 5)
Series: (10 groups of 2) -1:1-> (10 groups of 4) -3:5-> (6 grps of 5) -4:3-> (8 groups of 5) ---3:2----> (12 groups of 5) (+4 groups of 5)
Nested (16 groups of 5) 5:8 (10 grps 4)
Series: (20 x one) ---2:1---> (20 x two)(10 x four) -3:4-> (10 x three) 4:3 (10 x four)(20 x two) ---3:2----> (20 x three) --9:10--> (+20 x one)
(20 x four) --1:2--> (10 x four) (4 x ten) --10:9-->

J.8 - INTERMEZZO, J. BRAHMS

| | | | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1408F# | 1280-E | 1280-E | 1280-E | 1280-E | 1280-E | 1280-E | 1280-E | 1280-E | 1280-E |
| 9 | 8 | 12 | 8 | 6 | 8 | 6 | 9 | 6 | 6 |
| 4 | 4 | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 5 |
| 40 | 40 | 36 | 40 | 52 | 40 | 52 | 48 | 52 | 42 |
| 0.978 | 1 | 0.988 | 1 | 1.026 | 1 | 1.026 | 0.988 | 1.026 | 1.016 |

702.3Hz F#h36*

- h35
- F-h34
- h33

| | | | | | | | | | |
|---------|-------------------|--------------------|-------------------|-------------------|-------------------|-------------------|---------------|-------------------|-------------------|
| 624.3Hz | E-h32*> | E-h36**> | E-h32*> | E-h24*> | E-h32*> | E-h24*> | E-h27* | E-h24*> | E-h30*> |
| | - h31 | - h35 | - h31 | - h23 | - h31 | - h23 | - h26 | - h23 | - h29 |
| | D#h30 | D#h34 | D#h30 | D#h22 | D#h30 | D#h22 | D#h25 | D#h22 | D#h28 |
| | - h29 | - h33* | - h29 | D-h21 | - h29 | D-h21 | D-h24* | D-h21 | - h27 |
| | D-h28* | D-h32 | D-h28* | C#h20* | D-h28* | C#h20* | - h23 | C#h20* | D-h26 |
| | - h27 | C#h30** | - h27 | C-h19 | - h27 | C-h19 | C#h22 | C-h19 | C#h25* |
| | C#h26 | C-h28 | C#h26 | B-h18 | C#h26 | B-h18 | C-h21* | B-h18 | C-h24 |
| | C-h25 | - h27* | C-h25 | A#h17 | C-h25 | A#h17 | B-h20 | A#h17 | - h23 |
| | B-h24* | B-h26 | B-h24* | A-h16* | B-h24* | A-h16* | A#h19 | A-h16* | B-h22 |
| | - h23 | A#h25 | - h23 | G#h15 | - h23 | G#h15 | A-h18* | G#h15 | A#h21 |
| | A#h22 | A-h24** | A#h22 | G-h14 | A#h22 | G-h14 | G#h17 | G-h14 | A-h20* |
| | A-h21 | - h23 | A-h21 | F#h13 | A-h21 | F#h13 | G-h16 | F#h13 | G#h19 |
| | G#h20* | G#h22 | G#h20* | E-h12* | G#h20* | E-h12* | F#h15* | E-h12* | G-h18 |
| | G-h19 | G-h21* | G-h19 | D#h11 | G-h19 | D#h11 | F-h14 | D#h11 | F#h17 |
| | F#h18 | F#h20 | F#h18 | C#h10 | F#h18 | C#h10 | E-h13 | C#h10 | F-h16 |
| | F-h17 | F-h19 | F-h17 | B- h9 | F-h17 | B- h9 | D-h12* | B- h9 | E-h15* |
| | E-h16* | E-h18** | E-h16* | A- h8* | E-h16* | A- h8* | C#h11 | A- h8* | D#h14 |
| | D#h15 | D#h17 | D#h15 | G- h7 | D#h15 | G- h7 | B-h10 | G- h7 | D-h13 |
| | D-h14 | D-h16 | D-h14 | E- h6 | D-h14 | E- h6 | A- h9* | E- h6 | C-h12 |
| | C#h13 | C#h15* | C#h13 | C# h5 | C#h13 | C# h5 | G- h8 | C# h5 | B-h11 |
| | B-h12* | C-h14 | B-h12* | A- h4*R | B-h12* | A- h4*R | F- h7 | A- h4*R | A-h10* |
| | A#h11 | B-h13 | A#h11 | E- h3 | A#h11 | E- h3 | D- h6* | E- h3 | G- h9 |
| | G#h10 | A-h12** | G#h10 | A- h2 | G#h10 | A- h2 | B- h5 | A- h2 | F- h8 |
| | F# h9 | G#h11 | F# h9 | A- h1/H52 | F# h9 | A- h1/H52 | G- h4 | A- h1/H52 | D# h7 |
| | E- h8* | F#h10 | E- h8* | (26.012Hz) | E- h8* | (26.012Hz) | D- h3*R | (26.012Hz) | C- h6 |
| | D- h7 | E- h9* | D- h7 | | D- h7 | | G- h2 | | A- h5*R |
| | B- h6 | D- h8 | B- h6 | | B- h6 | | G-h1/H48 | | F- h4 |
| | G# h5 | C- h7 | G# h5 | | G# h5 | | (23.122Hz) | | C- h3 |
| | E- h4*R | A- h6** | E- h4*R | | E- h4*R | | | | F- h2 |
| | B- h3 | F# h5 | B- h3 | | B- h3 | | | | F- h1/H42 |
| | E- h2 | D- h4 | E- h2 | | E- h2 | | | | (20.810Hz) |
| | E- h1/H40 | A- h3*R | E- h1/H40 | | E- h1/H40 | | | | |
| | (19.509Hz) | D- h2 | (19.509Hz) | | (19.509Hz) | | | | |
| | | D- h1/H36 | | | | | | | |
| | | (17.342Hz) | | | | | | | |

(8 groups of 4) 2:3 (12 grps 3) 3:2 (8 grps 4) 3:4 (6 grps 4) 4:3 (8 grps 4) 3:4 (6 grps 4) 4:3 (8 grps 3) 3:4 (6 grps 4) 1:1 (6 grps 5)

-9:10-> (9 x four)

(-4 x one)

(4 x eight) -9:8-> (4 x nine) -8:9-> (4 x eight)

(8 x four) -3:4-> (8 x three) 4:3 (8 x four) 3:4 (8 x three)

(3 x eight) 9:8 (3 x nine) 8:9 (3 x eight)

(6 x four) 5:4 (6 x five)

--1:1-->

[(10 x three)]

J.9 - INTERMEZZO, J. BRAHMS

1280-E

10
6
21
1.016

1280-E

10
4
32
1

(10 groups of 6) -----1:1-----> (10 groups of 4)

2:1-> (30 x two)

(20 x three) -----2:3-----> (20 x two)

1280-E

6
4
52
1.026

1280-E

6
5
42
1.016

1280-E

8
4
40
1

(6 groups of 4) -1:1-> (6 grps 5) 4:3 (8 grps 4)

(6 x four) -5:4-> (6 x five)

(2 x fifteen)16:15(2 x sixteen)

(16 x two)->

J.11 - INTERMEZZO, J. BRAHMS

| | | | | | | | | |
|--------|-------|-------|-------|--------|--------|--------|--------|--------|
| 1600G# | 800G# | 800G# | 800G# | 1344-F | 1344-F | 1344-F | 2048-C | 2048-C |
| 24 | 12 | 9 | 12 | 20 | 12 | 20 | 30 | 24 |
| 4 | 4 | 4 | 4 | 4 | 5 | 4 | 4 | 5 |
| 17 | 17 | 22 | 17 | 17 | 22 | 17 | 17 | 17 |
| 0.980 | 0.980 | 1.010 | 0.980 | 0.988 | 1.018 | 0.988 | 1.004 | 1.004 |

| | | | | | |
|-----------|------------|-----------|------------|-----------|-----------|
| C#h128* | C#h96* | C#h128* | C#h96* | C#h128* | C#h128* |
| 761.2Hz | | | | 951.5Hz | |
| G#h96* | G#h72* | G#h96* | G#h72* | G#h96* | G#h96 |
| G-h88* | F-h60* | G-h88* | - h66* | G-h88* | F-h80* |
| F-h80* | C#h48* | F-h80*> | F-h60*> | F-h80* | C#h64 |
| D#h72* | A#h40* | D#h72* | D-h50* | C#h64* | C#h64* |
| C-h60* | A-h38 | C-h60* | C#h48 | A#h52* | A-h50* |
| G#h48*> | G#h36*> | G#h48* | - h45* | G#h48* | G#h48 |
| F-h40* | F#h32* | F-h40* | A#h40* | F-h40* | F-h40* |
| D#h36* | F-h30 | D#h36* | - h35* | D#h36* | - h35* |
| C#h32* | - h29 | C#h32* | E#h32 | C#h32* | C#h32 |
| - h31 | E-h28* | - h31 | F-h30* | - h31 | - h31 |
| C-h30 | - h27 | C-h30 | - h29 | C-h30 | C-h30* |
| - h29 | D#h26 | - h29 | E-h28 | - h29 | - h29 |
| B-h28* | D-h25 | B-h28* | - h27* | B-h28* | B-h28 |
| - h27 | C#h24* | - h27 | D#h26 | - h27 | - h27 |
| A#h26 | - h23 | A#h26 | D-h25* | A#h26 | A#h26 |
| A-h25 | C-h22 | A-h25 | C#h24 | A-h25 | A-h25* |
| G#h24* | B-h21 | G#h24* | - h23 | G#h24* | G#h24 |
| - h23 | A#h20* | - h23 | C-h22 | - h23 | - h23 |
| G-h22 | A-h19 | G-h22 | B-h21 | G-h22 | G-h22 |
| F#h21 | G#h18 | F#h21 | A#h20* | F#h21 | F#h21 |
| F-h20* | G-h17 | F-h20* | A-h19 | F-h20* | F-h20* |
| E-h19 | F#h16* | E-h19 | G#h18 | E-h19 | E-h19 |
| D#h18 | F-h15 | D#h18 | G-h17 | D#h18 | D#h18 |
| D-h17 | E-h14 | D-h17 | F#h16 | D-h17 | D-h17 |
| C#h16* | D#h13 | C#h16* | F-h15* | C#h16* | C#h16 |
| C-h15 | C#h12* | C-h15 | E-h14 | C-h15 | C-h15* |
| B-h14 | C-h11 | B-h14 | D#h13 | B-h14 | B-h14 |
| A#h13 | A#h10 | A#h13 | C#h12 | A#h13 | A#h13 |
| G#h12* | G# h9 | G#h12* | C-h11 | G#h12* | G#h12 |
| G-h11 | F# h8* | G-h11 | A#h10* | G-h11 | G-h11 |
| F-h10 | E- h7 | F-h10 | G# h9 | F-h10 | F-h10* |
| D# h9 | C# h6 | D# h9 | F# h8 | D# h9 | D# h9 |
| C# h8* | A# h5 | C# h8* | E- h7 | C# h8* | C# h8 |
| B- h7 | F# h4*R | B- h7 | C# h6 | B- h7 | B- h7 |
| G# h6 | C# h3 | G# h6 | A# h5*R | G# h6 | G# h6 |
| F- h5 | F# h2 | F- h5 | F# h4 | F- h5 | F- h5*R |
| C# h4*R | F# h1/H22 | C# h4*R | C# h3 | C# h4*R | C# h4 |
| G# h3 | (10.572Hz) | G# h3 | F# h2 | G# h3 | G# h3 |
| C# h2 | | C# h2 | F# h1/H22 | C# h2 | C# h2 |
| C# h1/H17 | | C# h1/H17 | (10.572Hz) | C# h1/H17 | C# h1/H17 |
| (7.929Hz) | | (7.929Hz) | | (7.929Hz) | (7.929Hz) |

(24 grps 4)
 (-12 grps 4)
 (12 grps 4) 3:4 (9 grps 4) 4:3 (12 grps 4)
 (+8 grps 4)
 (20 grps 4) 6:10 (12 grps 5) ---10:6---> (20 groups of 4)
 (+10 groups of 4)
 (12 x four) 3:4 (12 x three) 4:3 (12 x four)
 (+32 x one)
 (20 x four) 3:4 (20 x three) ----4:3----> (20 x four)
 (+40 x one)
 (30 x four) -----1:1----->

J.13 - INTERMEZZO, J. BRAHMS

| | | |
|-------|--------|--------|
| 896A# | 1024-C | 1024-C |
| 14 | 16 | 12 |
| 4 | 4 | 5 |
| 16 | 16 | 17 |
| 1 | 1 | 1.004 |

| | | |
|--------|--------|--------|
| 1024-C | 1024-C | 1280-E |
| 10 | 12 | 15 |
| 4 | 5 | 5 |
| 25 | 17 | 17 |
| 1.024 | 1.004 | 1.004 |

| | | | | | | |
|----------------|-----------|---------|------------|-----------|---------|---------|
| C-h64*> | C-h60*> | 491.0Hz | C-h40*> | C-h60* | E-h75*> | 613.7Hz |
| A#h56* 429.6Hz | G#h48* | | A#h36* | A-h50* | | |
| G-h48* | F-h40* | | G#h32* | G#h48 | | |
| E-h40* | D#h36* | | - h31 | F-h40* | | |
| C-h32* | D-h34 | | G-h30 | - h35* | | |
| B-h30 | C#h32* | | - h29 | C#h32 | | |
| A#h28* | - h31 | | F#h28* | - h31 | | |
| - h27 | C-h30 | | - h27 | C-h30* | | |
| A-h26 | - h29 | | F-h26 | - h29 | | |
| G#h25 | B-h28* | | E-h25 | B-h28 | | |
| G-h24* | - h27 | | D#h24* | - h27 | | |
| - h23 | A#h26 | | - h23 | A#h26 | | |
| F#h22 | A-h25 | | D-h22 | A-h25* | | |
| F-h21 | C#h24* | | C#h21 | C#h24 | | |
| E-h20* | - h23 | | C-h20* | - h23 | | |
| D#h19 | G-h22 | | B-h19 | G-h22 | | |
| D-h18 | F#h21 | | A#h18 | F#h21 | | |
| C#h17 | F-h20* | | A-h17 | F-h20* | | |
| C-h16* | E-h19 | | G#h16* | E-h19 | | |
| B-h15 | D#h18 | | G-h15 | D#h18 | | |
| A#h14 | D-h17 | | F#h14 | D-h17 | | |
| A-h13 | C#h16* | | F-h13 | C#h16 | | |
| G-h12* | C-h15 | | D#h12* | C-h15* | | |
| F#h11 | B-h14 | | D-h11 | B-h14 | | |
| E-h10 | A#h13 | | C-h10 | A#h13 | | |
| D- h9 | G#h12* | | A# h9 | G#h12 | | |
| C- h8* | G-h11 | | G# h8* | G-h11 | | |
| A# h7 | F-h10 | | F# h7 | F-h10* | | |
| G- h6 | D# h9 | | D# h6 | D# h9 | | |
| E- h5 | C# h8* | | C- h5 | C# h8 | | |
| C- h4*R | B- h7 | | G# h4*R | B- h7 | | |
| G- h3 | G# h6 | | D# h3 | G# h6 | | |
| C- h2 | F- h5 | | G# h2 | F- h5*R | | |
| C-h1/H16 | C# h4*R | | G# h1/H25 | C# h4 | | |
| (7.671Hz) | G# h3 | | (12.274Hz) | G# h3 | | |
| | C# h2 | | | C# h2 | | |
| | C# h1/H17 | | | C# h1/H17 | | |
| | (8.183Hz) | | | (8.183Hz) | | |

7:8 (14 grps 4)
 (+2 grps 4)
 (16 grps 4) -15:16-//-> (15 grps 4) -----2:3-----> (10 groups of 4) 6:5 (12 groups of 5)
 (+3 group of 5)
 (15 groups of 5) -----2:3----->

7:8 (8 x seven)
 (+8 x one)
 (4 x sixteen) 15:16 (4 x fifteen)
 (20 x three) -----2:3-----> (20 x two) -3:2-> (20 x three)
 (+15 x one)
 (15 x five) -----4:5----->

J.15 - INTERMEZZO, J. BRAHMS

| | | | | | | | |
|--------|--------|--------|----------|----------|---------|----------|---------|
| 1920-B | 1920-B | 1920-B | 36 | 36 | 32 | 24 | 16 |
| 15 | 15 | 18 | 8 | 9 | 9 | 12 | 12 |
| 8 | 8 | 8 | 13 | 12 | 12 | 12 | 12 |
| 16 | 16 | 16 | 1.026 | 0.988 | 0.963 | 0.961 | 1 |
| 1 | 1 | 1 | B-h288*> | 1841.2Hz | B-h324* | A-h288*> | A-h288* |

| | | | | | | | | |
|------------------|-----------|----------|----------|----------|-----------|-----------|-------------------|----------|
| B-h120*> 920.6Hz | B-h120*> | B-h144* | B-h288*> | 1841.2Hz | B-h324* | A-h288*> | A-h288* | 1636.6Hz |
| (E-h80* | (E-h80* | A-h136* | C-h152* | D-h189* | (C-h180* | C-h180* | D-h192*> 1091.1Hz | |
| (C-h64* | (C-h64* | A-h128* | C-h152* | (C-h180* | B-h162* | C-h168* | C-h180* | |
| B-h60* | B-h60* | G-h120* | (A-h52 | (G-h112* | A-h144* | B-h156* | (A-h144* | |
| (A-h52 | (A-h52 | F-h104* | (A-h52 | (G-h112* | G-h135* | G-h132* | G-h132* | |
| (G-h48* | (G-h48* | (E-h96* | (A-h52 | (G-h112* | (G-h126* | G-h126* | G-h126* | |
| F-h44* | F-h44* | D-h88* | (A-h52 | (G-h112* | F-h120 | F-h120* | F-h120* | |
| (E-h40* | (E-h40* | (E-h88* | (A-h52 | (G-h112* | F-h117* | F-h117* | F-h117* | |
| (C-h32* | (C-h32* | (C-h80* | (A-h52 | (G-h112* | (E-h108* | (E-h108* | (E-h108* | |
| B-h30 | B-h30 | B-h72* | (A-h52 | (G-h112* | D-h99* | D-h99* | D-h99* | |
| A-h28* | A-h28* | A-h64* | (A-h52 | (G-h112* | (C-h90* | (C-h90* | (C-h90* | |
| - h27 | - h27 | (G-h56* | (A-h52 | (G-h112* | B-h81* | B-h81* | B-h81* | |
| A-h26 | A-h26 | (E-h48* | (A-h52 | (G-h112* | A-h72* | A-h72* | A-h72* | |
| G-h25 | G-h25 | C-h40* | (A-h52 | (G-h112* | G-h63* | G-h63* | G-h63* | |
| G-h24* | G-h24* | B-h36* | (A-h52 | (G-h112* | F-h56 | F-h56 | F-h56 | |
| - h23 | - h23 | (A-h32* | (A-h52 | (G-h112* | E-h54* | E-h54* | E-h54* | |
| F-h22 | F-h22 | G-h28* | (A-h52 | (G-h112* | D-h48 | D-h48 | D-h48 | |
| F-h21 | F-h21 | F-h25 | (A-h52 | (G-h112* | C-h45* | C-h45* | C-h45* | |
| (E-h20* | (E-h20* | (E-h24* | (A-h52 | (G-h112* | A-h36* | A-h36* | A-h36* | |
| D-h19 | D-h19 | - h23 | (A-h52 | (G-h112* | G-h32 | G-h32 | G-h32 | |
| D-h18 | D-h18 | D-h22 | (A-h52 | (G-h112* | E-h27* | E-h27* | E-h27* | |
| C-h17 | C-h17 | D-h21 | (A-h52 | (G-h112* | D-h24 | D-h24 | D-h24 | |
| (C-h16* | (C-h16* | (C-h20* | (A-h52 | (G-h112* | - h23 | - h23 | - h23 | |
| B-h15 | B-h15 | C-h19 | (A-h52 | (G-h112* | C-h22 | C-h22 | C-h22 | |
| A-h14 | (A-h14 | B-h18 | (A-h52 | (G-h112* | C-h21 | C-h21 | C-h21 | |
| A-h13 | A-h13 | A-h17 | (A-h52 | (G-h112* | B-h20 | B-h20 | B-h20 | |
| G-h12* | G-h12* | (A-h16* | (A-h52 | (G-h112* | A-h19 | A-h19 | A-h19 | |
| F-h11 | F-h11 | G-h15 | (A-h52 | (G-h112* | A-h18* | A-h18* | A-h18* | |
| E-h10 | E-h10 | G-h14 | (A-h52 | (G-h112* | G-h17 | G-h17 | G-h17 | |
| D-h9 | D-h9 | F-h13 | (A-h52 | (G-h112* | G-h16 | G-h16 | G-h16 | |
| (C-h8* | (C-h8* | E-h12* | (A-h52 | (G-h112* | F-h15 | F-h15 | F-h15 | |
| A-h7 | (A-h7 | D-h11 | (A-h52 | (G-h112* | F-h14 | F-h14 | F-h14 | |
| G-h6 | G-h6 | C-h10 | (A-h52 | (G-h112* | E-h13 | E-h13 | E-h13 | |
| E-h5 | E-h5 | B-h9 | (A-h52 | (G-h112* | D-h12 | D-h12 | D-h12 | |
| C-h4*R | C-h4*R | (A-h8* | (A-h52 | (G-h112* | C-h11 | C-h11 | C-h11 | |
| G-h3 | G-h3 | G-h7 | (A-h52 | (G-h112* | B-h10 | B-h10 | B-h10 | |
| C-h2 | C-h2 | E-h6 | (A-h52 | (G-h112* | A-h9*R | A-h9 | A-h9 | |
| C-h1/H16 | C-h1/H16 | A-h4*R | (A-h52 | (G-h112* | G-h8 | G-h8 | G-h8 | |
| (7.671Hz) | (7.671Hz) | E-h3 | (A-h52 | (G-h112* | (F-h7 | F-h7 | F-h7 | |
| | | A-h2 | (A-h52 | (G-h112* | D-h6 | D-h6 | D-h6 | |
| | | A-h1/H13 | (A-h52 | (G-h112* | B-h5 | B-h5 | B-h5 | |
| | | | (A-h52 | (G-h112* | G-h4 | G-h4 | G-h4 | |
| | | | (A-h52 | (G-h112* | D-h3 | D-h3 | D-h3 | |
| | | | (A-h52 | (G-h112* | G-h2 | G-h2 | G-h2 | |
| | | | (A-h52 | (G-h112* | G-h1/H12 | G-h1/H12 | G-h1/H12 | |
| | | | (A-h52 | (G-h112* | (5.682Hz) | (5.682Hz) | (5.682Hz) | |

3:2 (30 groups of 4)
 ---1:2-->
 (15 groups of 8) -----6:5-----> (18 groups of 8)
 (+18 groups of 8)
 (36 groups of 8) -----9:8-----> (36 groups of 9)
 (-4 groups of 9)
 (32 groups of 9) -3:4-> (24 groups of 12)
 (-8 groups of 12)

-3:2-> (30 x four) -----1:1-----> (24 x five) -----6:5-----> (24 x six)
 (+144 x one)
 (36 x eight) -----9:8-----> (36 x nine)
 (-36 x one)
 (32 x nine) -> (-96 x one) -> (48 x four) ->

J.17 - INTERMEZZO, J. BRAHMS

| | | | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1664-A | 1792A# | 1792A# | 2816F# | 2816F# | 3072-G | 3072-G | 3072-G | 3072-G | 3072-G |
| 16 | 16 | 15 | 24 | 30 | 32 | 32 | 24 | 16 | 12 |
| 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 22 | 22 | 24 | 24 | 24 | 24 | 24 | 32 | 48 | 64 |
| 0.945 | 1.018 | 0.996 | 0.978 | 0.978 | 1 | 1 | 1 | 1 | 1 |

| | | | | | | | | | |
|------------|------------|------------|------------|------------|------------|------------|------------|----------|------------|
| | | | | 1548.0Hz | | | | | |
| | | 1451.2Hz | | G-h128*> | G-h128*> | G-h96* | G-h64*> | 1548.0Hz | G-h48*> |
| | 907.0Hz | F#h120*> | F#h120* | F-h112* | E-h104* | E-h80* | F-h56* | | F#h44* |
| 850.3Hz | A#h80*> | A#h75* | E-h104* | D-h96* | E-h104* | C-h64* | D-h48* | | E-h40* |
| A-h80*> | A-h75* | - h70* | D-h96* | C-h84* | D-h96* | B-h60* | C-h42* | | C-h32* |
| G#h75* | - h70* | C-h64 | C-h84* | C-h84* | C-h84* | A-h52 | B-h40* | | B-h30 |
| - h70* | G-h68 | F#h60* | B-h80* | B-h80* | B-h80* | G-h48* | G-h32* | | A#h28* |
| F-h64 | F-h60* | F-h56 | A-h72* | A-h72* | A-h72* | F#h44* | F-h28* | | - h27 |
| E-h60* | E-h56 | D#h50* | G-h64* | G-h64* | G-h64* | E-h40* | D#h25 | | A-h26 |
| C#h50* | D-h50* | D-h48 | F-h56* | F-h56* | F-h56* | C-h32* | D-h24* | | G#h25 |
| C-h48 | C#h48 | B-h40* | D-h48* | D-h48* | D-h48* | B-h30 | C#h22 | | G-h24* |
| A-h40* | A#h40* | - h35* | B-h40* | B-h40* | B-h40* | A#h28* | C-h21 | | - h23 |
| - h35* | G-h34 | C-h32 | A-h36* | A-h36* | A-h36* | - h27 | B-h20* | | F#h22 |
| E-h30* | F-h30* | F#h30* | G-h32* | G-h32* | G-h32* | A-h26 | A#h19 | | F-h21 |
| C#h25* | D-h25* | D#h25* | F-h28* | F-h28* | F-h28* | G#h25 | A-h18 | | E-h20* |
| C-h24 | C#h24 | D-h24 | D#h25 | D#h25 | D#h25 | G-h24* | G#h17 | | D#h19 |
| - h23 | - h23 | C#h22 | D-h24* | D-h24* | D-h24* | - h23 | G-h16* | | D-h18 |
| B-h22 | C-h22 | C-h21 | C#h22 | C#h22 | C#h22 | F#h22 | F#h15 | | C#h17 |
| A#h21 | B-h21 | B-h20* | C-h21 | C-h21 | C-h21 | F-h21 | F-h14 | | C-h16* |
| A-h20* | A#h20* | A#h19 | B-h20* | B-h20* | B-h20* | E-h20* | E-h13 | | B-h15 |
| G#h19 | A-h19 | A-h18 | A#h19 | A#h19 | A#h19 | D#h19 | D-h12* | | A#h14 |
| G-h18 | G#h18 | G#h17 | A-h18 | A-h18 | A-h18 | D-h18 | C#h11 | | A-h13 |
| F#h17 | G-h17 | G-h16 | G#h17 | G#h17 | G#h17 | C#h17 | B-h10 | | G-h12* |
| F-h16 | F#h16 | F#h15* | G-h16* | G-h16* | G-h16* | C-h16* | A-h9 | | F#h11 |
| E-h15* | F-h15* | F-h14 | F#h15 | F#h15 | F#h15 | B-h15 | G-h8* | | E-h10 |
| D#h14 | E-h14 | E-h13 | F-h14 | F-h14 | F-h14 | A#h14 | F-h7 | | D-h9 |
| D-h13 | D#h13 | D-h12 | E-h13 | E-h13 | E-h13 | A-h13 | D-h6 | | C-h8* |
| C-h12 | C#h12 | C#h11 | D-h12* | D-h12* | D-h12* | G-h12* | B-h5 | | A#h7 |
| B-h11 | C-h11 | B-h10* | C#h11 | C#h11 | C#h11 | F#h11 | G-h4*R | | G-h6 |
| A-h10* | A#h10* | A-h9 | B-h10 | B-h10 | B-h10 | E-h10 | D-h3 | | E-h5 |
| G-h9 | G#h9 | G-h8 | A-h9 | A-h9 | A-h9 | D-h9 | G-h2 | | C-h4*R |
| F-h8 | F#h8 | F-h7 | G-h8* | G-h8* | G-h8* | C-h8* | G-h1/H48 | | G-h3 |
| D#h7 | E-h7 | D-h6 | F-h7 | F-h7 | F-h7 | A#h7 | (24.078Hz) | | C-h2 |
| C-h6 | C#h6 | B-h5*R | D-h6 | D-h6 | D-h6 | G-h6 | | | C-h1/H64 |
| A-h5*R | A#h5*R | G-h4 | B-h5 | B-h5 | B-h5 | E-h5 | | | (32.104Hz) |
| F-h4 | F#h4 | D-h3 | G-h4*R | G-h4*R | G-h4*R | C-h4*R | | | |
| C-h3 | C#h3 | G-h2 | D-h3 | D-h3 | D-h3 | G-h3 | | | |
| F-h2 | F#h2 | G-h1/H24 | G-h2 | G-h2 | G-h2 | C-h2 | | | |
| F-h1/H21 | F#h1/H22 | (12.039Hz) | G-h1/H24 | G-h1/H24 | G-h1/H24 | C-h1/H32 | | | |
| (10.581Hz) | (11.286Hz) | | (12.039Hz) | (12.039Hz) | (12.039Hz) | (16.052Hz) | | | |

.....(16 grps 5) 15:16 (15 groups of 5)
 (+9 groups of 5)
 (24 groups of 5) -5:4-> (30 groups of 4)
 (+2 groups of 4)
 (32 groups of 4) -----3:4--> (24 grps 4) 2:3 (16 grps 4) -3:4-> (12 grps 4)

.....simile.....(5 x sixteen) 15:16 (5 x fifteen) -> (+45, +8 x one) -1:1-> (32 x four) -3:4-> (24 x four) 2:3 (16 x four) --3:4-> (12 x four)

J.18 - INTERMEZZO, J. BRAHMS

| | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|
| 3072-G | 3072-G | 3072-G | 3328-A | 3328-A | 2560-E | 2560-E |
| 16 | 12 | 16 | 18 | 16 | 12 | 10 |
| 4 | 4 | 4 | 4 | 5 | 5 | 4 |
| 48 | 64 | 48 | 48 | 42 | 42 | 64 |
| 1 | 1 | 1 | 0.963 | 0.990 | 1.016 | 1 |

| | | | | | | |
|------------|------------|------------|------------|------------|------------|------------|
| G-h64*> | 1541.0Hz | G-h48*> | A-h72*> | A-h80* | 1733.6Hz | E-h40*> |
| F-h56* | F#h44* | F-h56* | F-h64* | F-h70* | F-h64 | C-h32* |
| D-h48* | E-h40* | D-h48* | E-h60*> | E-h60*> | 1300.2Hz | B-h30 |
| C-h42 | C-h32* | C-h42 | C-h50* | C-h50* | C-h48 | A#h28* |
| B-h40* | B-h30 | B-h40* | C-h48 | A-h40* | A-h40* | - h27 |
| A-h36* | A#h28* | G-h32* | A-h40* | - h35* | - h35* | A-h26 |
| F-h28* | - h27 | F-h28* | E-h30* | E-h30* | E-h30* | G#h25 |
| D#h25 | A-h26 | D#h25 | D-h24* | C-h25* | C-h25* | G-h24* |
| D-h24* | G#h25 | D-h24* | C-h22 | C-h24 | C-h24 | - h23 |
| C#h22 | G-h24* | C-h22 | C-h21 | - h23 | - h23 | F#h22 |
| C-h21 | - h23 | C-h21 | B-h20* | B-h22 | B-h22 | F-h21 |
| B-h20* | F#h22 | B-h20* | A#h19 | A#h21 | A#h21 | E-h20* |
| A#h19 | F-h21 | A#h19 | A-h18 | A-h20* | A-h20* | D#h19 |
| A-h18 | E-h20* | A-h18 | G#h17 | G#h19 | G#h19 | D-h18 |
| G#h17 | D#h19 | G#h17 | G-h16* | G-h18 | G-h18 | C#h17 |
| G-h16* | D-h18 | G-h16* | F#h15 | F#h17 | F#h17 | C-h16* |
| F#h15 | C#h17 | F#h15 | F-h16 | F-h16 | F-h16 | B-h15 |
| F-h14 | C-h16* | F-h14 | E-h15* | E-h15* | E-h15* | A#h14 |
| E-h13 | B-h15 | E-h13 | D#h14 | D#h14 | D#h14 | A-h13 |
| D-h12* | A#h14 | D-h12* | D-h13 | D-h13 | D-h13 | C-h12* |
| C#h11 | A-h13 | C#h11 | C-h12 | C-h12 | C-h12 | F#h11 |
| B-h10 | C-h12* | B-h10 | B-h11 | B-h11 | B-h11 | E-h10 |
| A-h9 | F#h11 | A-h9 | A-h10* | A-h10* | A-h10* | D-h9 |
| C-h8* | E-h10 | C-h8* | G-h9 | G-h9 | G-h9 | C-h8* |
| F-h7 | D-h9 | F-h7 | F-h8 | F-h8 | F-h8 | A#h7 |
| D-h6 | C-h8* | D-h6 | D#h7 | D#h7 | D#h7 | C-h6 |
| B-h5 | A#h7 | B-h5 | C-h6 | C-h6 | C-h6 | E-h5 |
| C-h4*R | G-h6 | G-h4*R | A-h5*R | A-h5*R | A-h5*R | C-h4*R |
| D-h3 | E-h5 | D-h3 | F-h4 | F-h4 | F-h4 | G-h3 |
| G-h2 | C-h4*R | G-h2 | C-h3 | C-h3 | C-h3 | C-h2 |
| G-h1/H48 | G-h3 | G-h1/H48 | F-h2 | F-h2 | F-h2 | C-h1/H64 |
| (24.078Hz) | C-h2 | (24.078Hz) | F-h1/H42 | F-h1/H42 | F-h1/H42 | (32.506Hz) |
| | C-h1/H64 | | (21.671Hz) | (21.671Hz) | (21.671Hz) | |
| | (32.105Hz) | | | | | |

4:3-> (16 groups of 4) -----3:4-----> (12 grps 4) 4:3 (16 grps 4)
 (+2 grps 4)
 (18 grps 4) 8:9 (16 groups of 5
 (-4 groups of 5)
 (12 groups of 5) -----5:6-----> (10 groups of 4)

4:3-> (16 x four) -----3:4-----> (16 x three) 4:3 (16 x four)
 (+8 x one)
 (8 x nine) 10:9 (8 x ten)
 (-20 x one)
 (20 x three) -----2:3-----> (20 x two)

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|---------------|----|--------|---------------|----|--------|---------------|--------|
| 2560-E 3072-G | | 3072-G | 3072-G 2304-D | | 2304-D | 2304-D 3072-G | 3072-G |
| 10 | 12 | 24 | 16 | 12 | 16 | 12 | 16 |
| 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 |
| 64 | 64 | 32 | 48 | 48 | 48 | 48 | 48 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| | | | | | |
|-------------------|----------|------------|------------|------------|-----------------|
| (G)-h48*> | G-h96*> | 1560.3Hz | G-h64* | G-h64*> | G-h64*>1560.3Hz |
| F#h44* | E-h80* | | F-h56* | F-h56* | (F)-h56* |
| (E)-h40* 1300.2Hz | C-h64* | 1170.2Hz | D-h48*> | D-h48* | D-h48* |
| C-h32* | B-h60* | (32.506Hz) | C-h42 | C-h42* | C-h42 |
| B-h30 | (A)-h52 | | B-h40* | A-h36* | B-h40* |
| A#h28* | (G)-h48* | | G-h32* | F#h30* | (G)-h32* |
| - h27 | F#h44* | | F-h28* | - h27* | (F)-h28* |
| A-h26 | (E)-h40* | | D#h25 | D-h24* | D#h25 |
| G#h25 | (C)-h32* | | D-h24* | - h23 | (D)-h24* |
| (G)-h24* | B-h30 | | C#h22 | C#h22 | C#h22 |
| - h23 | A#h28* | | C-h21 | C-h21* | C-h21 |
| F#h22 | - h27 | | B-h20* | B-h20 | (B)-h20* |
| F-h21 | (A)-h26 | | A#h19 | A#h19 | A#h19 |
| (E)-h20* | G#h25 | | A-h18 | (A)-h18* | A-h18 |
| D#h19 | (G)-h24* | | G#h17 | G#h17 | G#h17 |
| D-h18 | - h23 | | G-h16* | G-h16 | (G)-h16* |
| C#h17 | F#h22 | | F#h15 | F#h15* | F#h15 |
| C-h16* | F-h21 | | F-h14 | (F)-h14 | (F)-h14 |
| B-h15 | (E)-h20* | | E-h13 | E-h13 | E-h13 |
| A#h14 | D#h19 | | D-h12* | (D)-h12* | D-h12* |
| A-h13 | D-h18 | | C#h11 | C#h11 | C#h11 |
| G-h12* | C#h17 | | (B)-h10 | B-h10 | (B)-h10 |
| F#h11 | (C)-h16* | | A- h9 | (A)- h9* | A- h9 |
| (E)-h10 | B-h15 | | G- h8* | G- h8 | (G)- h8* |
| D- h9 | A#h14 | | (F)- h7 | F- h7 | (F)- h7 |
| (C)- h8* | (A)-h13 | | (D)- h6 | D- h6* | (D)- h6 |
| A# h7 | (G)-h12* | | B- h5 | B- h5 | B- h5 |
| (G)- h6 | F#h11 | | (G)- h4*R | G- h4 | (G)- h4*R |
| (E)- h5 | (E)-h10 | | D- h3 | D- h3*R | D- h3 |
| (C)- h4*R | D- h9 | | G- h2 | G- h2 | G- h2 |
| (G)- h3 | (C)- h8* | | G-h1/H48 | G-h1/H48 | G-h1/H48 |
| C- h2 | A# h7 | | (24.379Hz) | (24.379Hz) | (24.379Hz) |
| C-h1/H64 | G- h6 | | | | |
| (32.506Hz) | E- h5 | | | | |
| | C- h4*R | | | | |
| | G- h3 | | | | |
| | C- h2 | | | | |
| | C-h1/H32 | | | | |

(10 groups of 4) (12 groups of 4) 4:3 (16 grps 3) 3:4 (12 grps 4)
 (+2 groups of 4) (-4 groups of 4) (+4 grps 4)
 (12 groups of 4) ----2:1----> (24 groups of four) -----2:3-----> (16 groups of 4) (16 grps 4) ----->

(20 x two) (24 x two) -----1:1-----> (24 x two)
 (+8 x one) (-8 x one) (+8 x one)
 (48 x one) -----2:1-----> (48 x two) -----2:3-----> (32 x two) ----->

