HSI2013 Midterms Brief Cheatsheet

Science of Music (National University of Singapore)

Period inverse to frequency, ie T (secs, period) = 1/f (Hz, frequency) OR f = 1/T

1 octave higher = frequency of lower note x 2

If P1's sound power is 10 times more powerful than P2's sound power, P1's sound power is higher than P2's power level by 10dB.

If increase power by 10 times, ADD another 10dB. Usually, softest sound level = dB, loudest sound level is 120dB

Frequency vs length:

1st string: length l and freq f, 2nd string: length 0.5l and freq 2f, 3rd string: length 0.33l and freq 3f. therefore f proportional to 1/l, f inversely proportional to l.

Antinode: top of the string vibration, node: sides

Therefore 2nd harmonic: freq double, 3rd harmonic: freq triple fundamental freq

Therefore freq of a 5th = 3/2 fundamental freq

Go down by a 5th = 2/3 fundamental freq

Scales:

Pentatonic: derived from all the 5ths

Pythagorean scale: derived from 5ths, divide by 2/4 where necessary to bring it down to the scale. C:1, D: 9/8, E: 81/64, F: 4/3, G: 3/2, A: 27/16, B: 243/128, C: 2/1

- Accurate fifths from any note to 5 notes above and below, imperfect thirds and sixths. Only 1 type of whole tone, 9/8

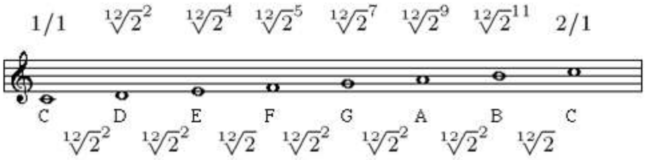
Chinese pentatonic: 1, 9/8, 81.64, 3/2, 27/16, 2 (up and down)

Just scale: A and B are derived from Just Third (up from F and G), rest are the same. C: 1, D: 9/8, E: 5/4, F: 4/3, G: 3/2, A: 5/3, B: 15/8, C: 2/1. Just third: 5/4

- Problems with Just scale: some intervals don't give expected ratios eg less than 3/2, 2 kinds of whole tone

Tetrachord: lower tetrachord – lower 4 notes, upper tetrachord – upper 4 notes. Modulate to a scale such that lower tetrachord becomes upper tetrachord.

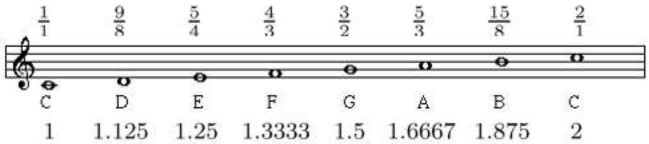
Note	D	E	F	G	A	B
mult/div C by	mult $\left(\sqrt[12]{2^7}\right)^2$	mult $\left((\sqrt[12]{2})^7\right)^4$	div $\left((\sqrt[12]{2})^7\right)^1$	mult $\left((\sqrt[12]{2})^7\right)^1$	mult $\left((\sqrt[12]{2})^7\right)^3$	mult $\left((\sqrt[12]{2})^7\right)^5$
Ratio	$(\sqrt[12]{2})^{14}$	$(\sqrt[12]{2})^{28}$	$(\sqrt[12]{2})^{-7}$	$(\sqrt[12]{2})^{7}$	$(\sqrt[12]{2})^{21}$	$(\sqrt[12]{2})^{35}$
Mult/div by	div 2	div 4	mult 2	div 1	div 2	div 4
Temp ratio	$(\sqrt[12]{2})^2$	$(\sqrt[12]{2})^4$	$(\sqrt[12]{2})^5$	$(\sqrt[12]{2})^7$	$(\sqrt[12]{2})^9$	$(\sqrt[12]{2})^{11}$
Pyth ratio	$\frac{9}{8}$	$\frac{81}{64}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{27}{16}$	$\frac{243}{128}$



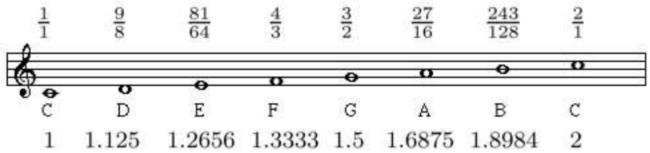
We notice that all the intervals are powers of $\sqrt[12]{2}$, and the tones are all $(\sqrt[12]{2})^2$ and semitones are $\sqrt[12]{2}$ which is exactly half of $(\sqrt[12]{2})^2$.

Comparison of scale ratios

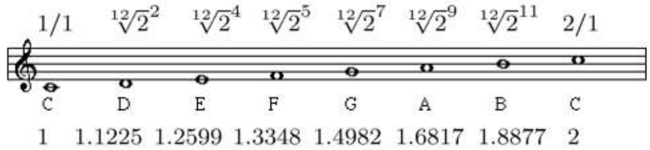
In the Just scale the intervals are perfect, but the fifth from D to A is too small.



In the Pythagorean scale all the fifths are perfect, but the thirds are too large.



In the Equal-tempered scale the fifths are almost perfect, and the thirds are better than the Pythagorean scale.

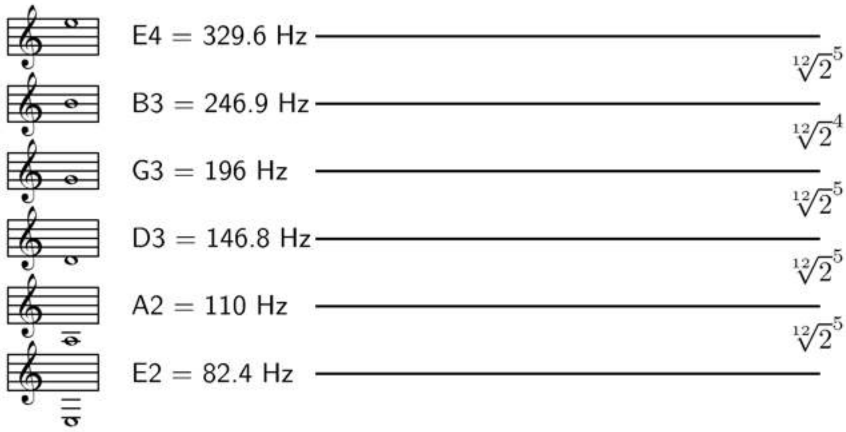


Note names:

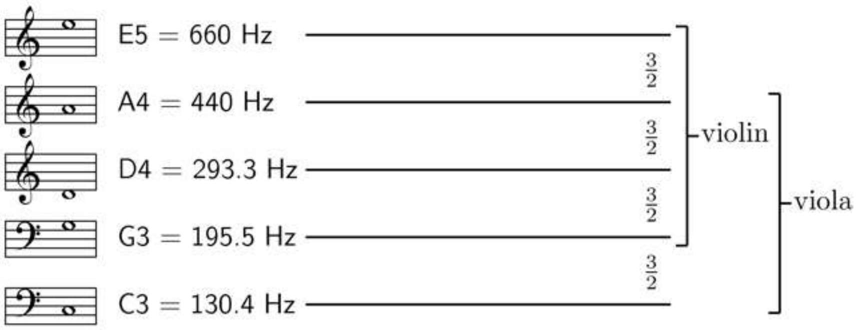
Low numbers to high numbers. C2 is low low C on the piano, C4 is middle C, C5 is 1 octave higher

Instruments and frequencies:

Equal-tempered guitar (notation 1 octave higher than actual pitch):

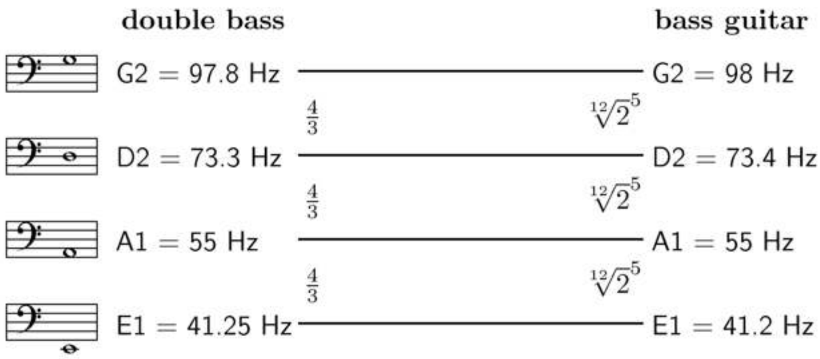


Violin, Viola, Cello:

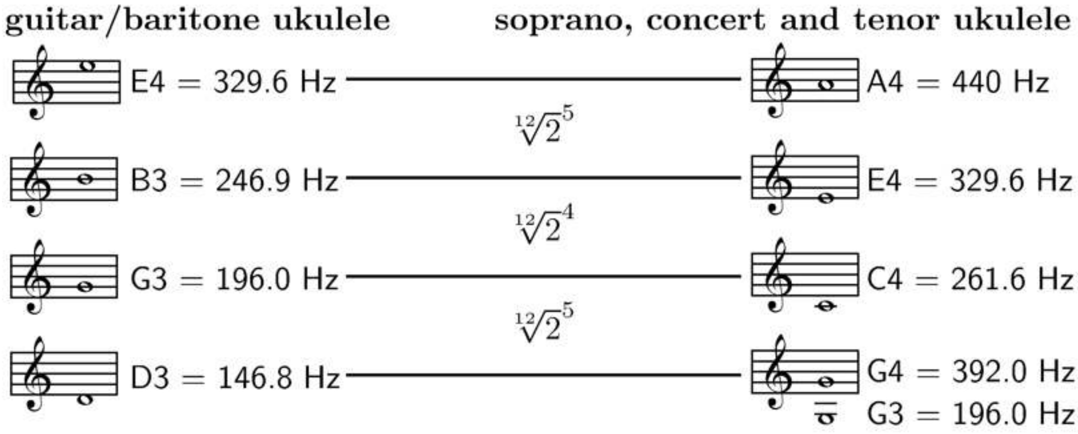


Cello 1 octave lower than viola.

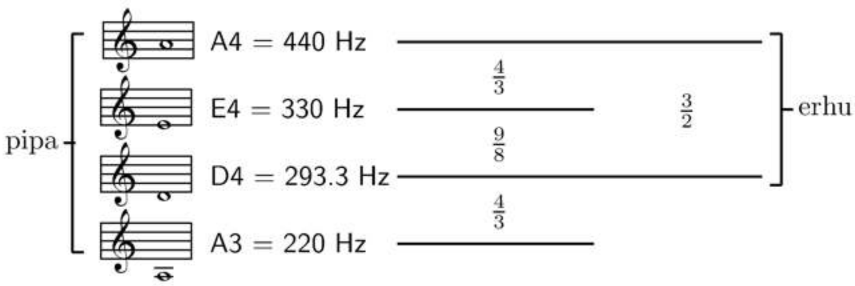
Double bass and bass guitar



Guitar, Baritone ukulele, soprano concert and tenor ukulele

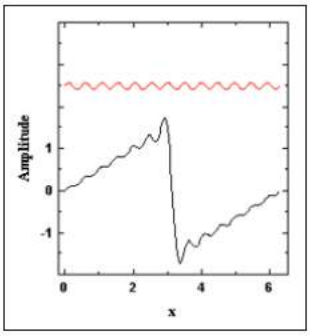


Erhu and pipa

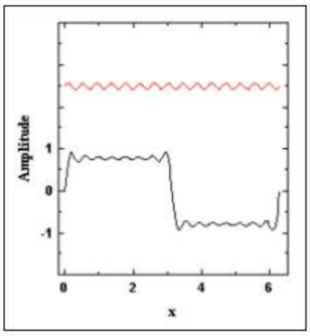


Science stuff:

Frequency spectrum: length of line is amplitude of the sine wave, its position shows u the frequency. Shows u each harmonic in the waveform



Sawtooth waveform:



Square wave:

Standing wave: wave vibrates in a fixed or standing position, diff parts of the string move up and down tgt at the same time

Travelling wave: diff parts of the string move up and down a little later/earlier than its neighbours (velocity, wavelength etc apply)

Transverse waves: particles and waves move perpendicular to each other

Longitudinal waves: particles travelling in a direction parallel to the wave's overall direction

Types of wave motion: lecture 11

Closed and open pipes: lecture 11

- Open pipe
- Closed pipe
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