What is Music?

Music (from Greek "Art of the Muses") is the art of arranging sounds in time to produce a composition through the elements of melody, harmony, rhythm, and timbre.

(this definition is from "The American Heritage Dictionary")

Nine Muses:
Calliope, Clio, Euterpe, Thalia, Melpomene, Terpsichore, Polyhymnia, Erato, Urania.

- **Both *harmony* (**simultaneously played sounds**) and *melody* (**sequence of sounds**) are based on the use of intervals.**
- **An interval is the difference in pitch between two sounds.**

Mathematics of Intervals

- From *perception point of view*, musical intervals can be typically described as consonant (stable, pleasant) and dissonant (unstable, tense).

- *Scientifically speaking*, the human ear is a sound detector that is sensitive to RATIOS of frequencies (pitches of the sounds) rather than to just *differences* in establishing musical intervals.

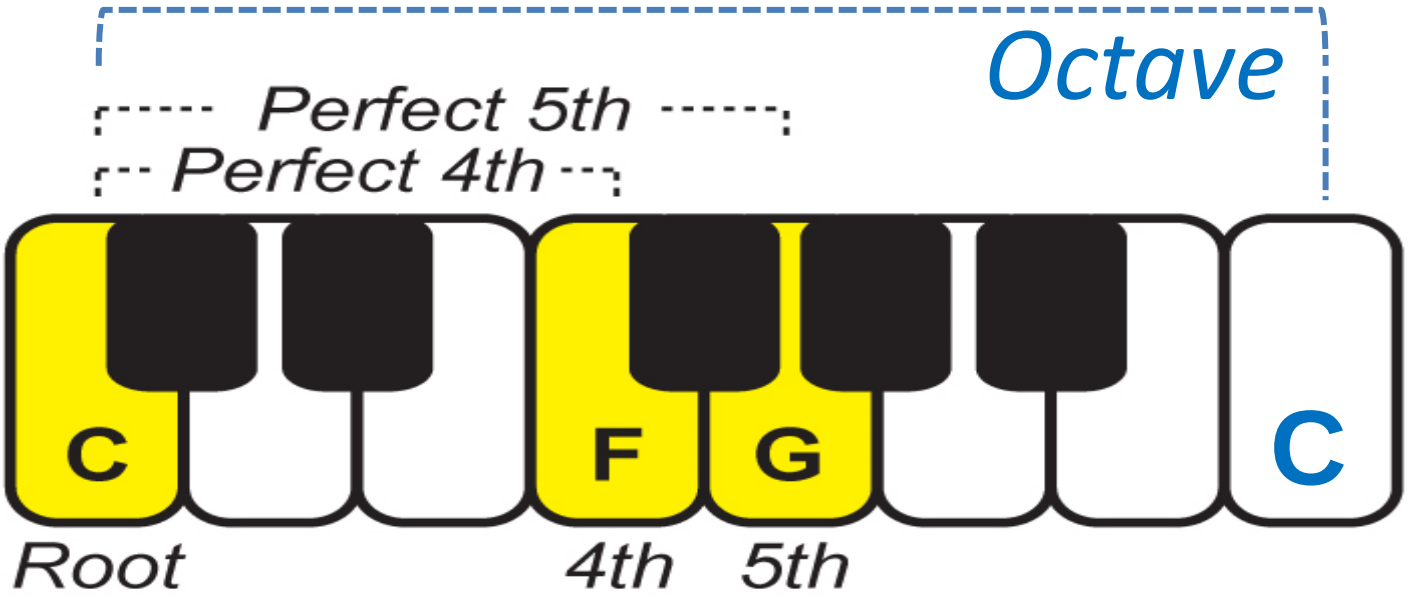
- *Mathematically*, music intervals perceived to be most consonant are composed of small integer ratios of frequency.

(Examples of *small integer ratios*: 1:2, 3:2, 5:4 and so on)

This "mathematical simplicity" is believed to be the very reason for universally "pleasant" sensation of consonant intervals!

Perfect Musical Intervals

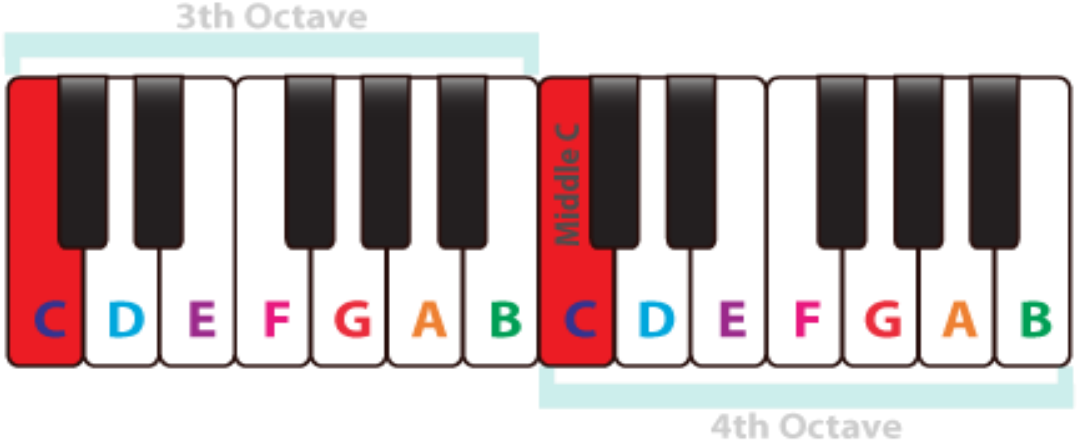
have been considered to be consonant throughout history by essentially all cultures and therefore form the basis for music scales.



Perfect 4th – 5 semitones ("here comes the bride")
Perfect 5th – 7 semitones ("twinkle, twinkle little star")
Octave – 12 semitones ("somewhere over the rainbow")

Frequencies and Ratios

In modern equal temperament scale (*in which an octave is divided into 12 equal semitones to specify musical notes*), frequency ratios for *some* consonant intervals deviate slightly from the exact simple integer ratios, but this deviation is undetectable by most humans.



Note	Frequency, Hz	Note	Frequency, Hz
C3	130.81	C4	261.63
D3	146.83	D4	293.66
E3	164.81	E4	329.63
F3	174.61	F4	349.23
G3	196	G4	392
A3	220	A4	440
B3	246.93	B4	493.88

- **an octave *precisely* corresponds to 2:1** (therefore the higher note of an octave will always have exact double frequency of the lower note)
- **a fifth corresponds to 3:2**
- **a fourth *very closely* corresponds to 4:3**

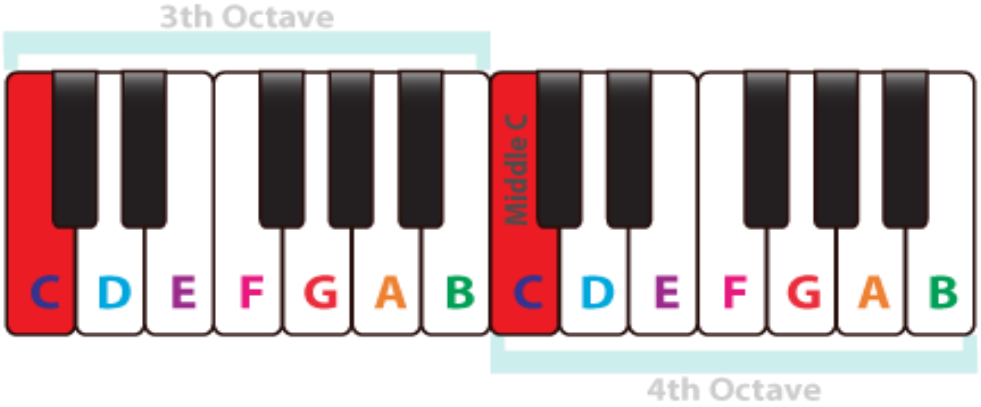
Finding Frequencies using Ratios

Octave: $\frac{F_{top}}{F_{bottom}}$ = 2:1 = 2

G4/G3=392/196=2

A4/A3=440/220=2

G5/G4=2 →
G5=2*G4=2*392=784 Hz



Note	Frequency	Note	Frequency
C3	130.81	C4	261.63
D3	146.83	D4	293.66
E3	164.81	E4	329.63
F3	174.61	F4	349.23
G3	196	G4	392
A3	220	A4	440
B3	246.93	B4	493.88

Fifth: $\frac{F_{top}}{F_{bottom}}$ = 3:2 = 1.5

G3/C3=196/130.81=1.498≈1.5

E4/A3=329.63/220=1.498≈1.5

D3/G2=1.5 →
G2=D3/1.5=146.83/1.5=97.89 Hz

Fourth: $\frac{F_{top}}{F_{bottom}}$ = ~4:3 = 1.33

A4/E4=440/329.63=1.334≈1.33

E5/B4=1.33 →
E5=1.33*B4=1.33*493.88=656.86 Hz