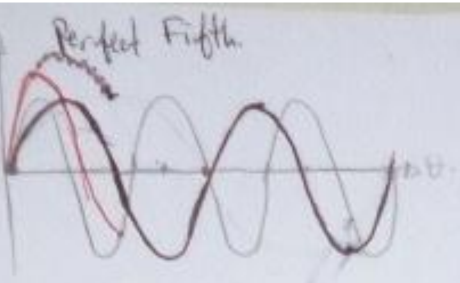


Noise Cancellation Headphones

tsunami show a sudden and dramatic retreat of water which occurs if the tsunami is lead by a trough rather than a peak. If you ever experience this while at the beach immediately head for high ground as this likely means a tsunami is imminent. Although not all underwater earthquakes cause a tsunami if you experience any earthquake while near the shore, head for high ground immediately as a precaution – it could save your life!

•Scientists are still studying and learning about the tsunami's behavior with the hope of providing better warning for their arrival, and thus the safety of those who live in coastal regions.

Sound Waves: In phase:  result: constructive interference, consonant (180°) out of phase:  result: destructive interference,

Phase:

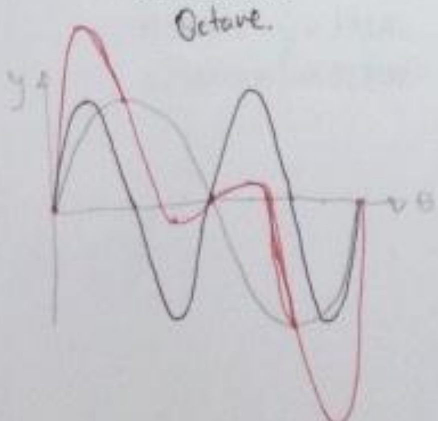
• When tuning a musical instrument a tuning fork can be struck and its pitch compared to that of the instrument. If they are out of tune beats can be heard as the sound waves of the fork and the instrument come in and out of phase – that is to say as constructive and destructive interference occur, or in musical terminology, their pitches are said to be consonant and dissonant respectively. Consonant notes are thought to evoke feelings of happiness and elation, whereas dissonant ones can produce an uneasy feeling or even fear.

* No two notes on an instrument have exactly the same frequencies so we don't get perfect constructive or destructive interference. Instead we

• Any melodic instrument, that is one which is supposed to produce notes of different frequencies, is tuned with a particular set of ratios between notes. This is called the instrument's temperament. Throughout music's history, many different temperaments have been used. One of the classical temperaments is called "Pythagorean tuning", named after Pythagoras who is supposed to have discovered it while investigating the sound produced of two strings of different lengths when plucked together. Playing two or more notes at the same time is called a "chord".

• Pythagoras observed that notes sounded consonant when they were produced by strings whose lengths were related by whole number ratios, i.e. 2:1, 3:2, 4:3, 5:4, 6:5 etc. The ones which sounded most consonant to Pythagoras were the ones with the lowest whole number ratios and thus the Pythagorean tuning is based entirely on frequency ratios of 2:1 (called an octave) and 3:2 (called a perfect fifth). These are the frequency ratios which have the most constructive interference. [Draw up diagrams of such waves]

•Starting from, for example, D on a piano the whole 12-note scale can be created by ascending and descending by a ratio of 3:2. So, starting from D and ascending 3:2, we reach note A. That is, if D has a frequency of 100Hz, A has a frequency of 150Hz. Next, ascending from A, we arrive at E, which has a ratio of 9:4 compared to D. However, we would like to consider all notes in one octave, and since 9:4 = 2.25 is greater than 2, it is customary to divide 9:4 by 2 to bring that E into the same octave as our original D. This can be done since notes which are an octave apart (those which have a frequency ratio of 2:1), are considered to be the same note. Below is a table of the frequency ratios in the octave starting at D.



This note is actually omitted!

∴ This interval is the Pythagorean comma, left badly out of tune and so Eb and G# cannot be played on THIS (D) piano

Note	Formula	Frequency Ratio	Decimal (to 3 places)
Ab	$\left(\frac{2}{3}\right)^6 \times 2^4$	$\frac{1024}{729}$	1.404
Eb	$\left(\frac{2}{3}\right)^5 \times 2^3$	$\frac{256}{243}$	1.053
Bb	$\left(\frac{2}{3}\right)^4 \times 2^3$	$\frac{128}{81}$	1.580
F	$\left(\frac{2}{3}\right)^3 \times 2^2$	$\frac{32}{27}$	1.185
C	$\left(\frac{2}{3}\right)^2 \times 2^2$	$\frac{16}{9}$	1.778
G	$\frac{2}{3} \times 2$	$\frac{4}{3}$	1.333
D	1	1	1
A	$\frac{3}{2}$	$\frac{3}{2}$	1.5
E	$\left(\frac{3}{2}\right)^2 \times \frac{1}{2}$	$\frac{9}{8}$	1.125
B	$\left(\frac{3}{2}\right)^3 \times \frac{1}{2}$	$\frac{27}{16}$	1.688
F#	$\left(\frac{3}{2}\right)^4 \times \left(\frac{1}{2}\right)^2$	$\frac{81}{64}$	1.266
C#	$\left(\frac{3}{2}\right)^5 \times \left(\frac{1}{2}\right)^2$	$\frac{243}{128}$	1.898
G#	$\left(\frac{3}{2}\right)^6 \times \left(\frac{1}{2}\right)^3$	$\frac{729}{512}$	1.424

called $\boxed{\text{Tritone}}$. Banned from music by Church for hundreds of years. Now the basis of heavy metal.

Spain's comment about octave being 8.

$$\left(\frac{3}{2}\right)^n = 2^m$$

As can be seen from the table, the most consonant note which can be played with D is another D (an octave with a pitch ratio of 2:1), followed by A followed by G as these have the lowest pitch ratios. The most dissonant notes which can be played with D are Ab and G# (which are actually held to be the same note in a 12-tone scale). Listen to different combinations of notes played together and you can make your own judgment.

Example If Middle C has a frequency of 256Hz, what is the frequency of a) a perfect fifth above C? b) a perfect fifth below C? c) an octave above C?

a) $256Hz \times \frac{3}{2} = 384Hz$

b) $256Hz \times \frac{2}{3} = 171Hz$

c) $256Hz \times \frac{2}{1} = 512Hz$