

TOMMASO ROSATI  
SOUND ART

THE  
BOOK IS  
NOW  
AVAILABLE!

SOUND2 FREQUENCY

# PLAY WITH SOUND

MANUAL FOR ELECTRONIC  
MUSICIANS AND OTHER SOUND  
EXPLORERS



TOMMASO ROSATI  
TIMOTHY HSU

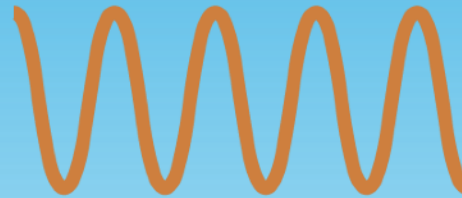
A Focal Press Book

R

SOURCE



WAVE



AUDITORY  
SYSTEM



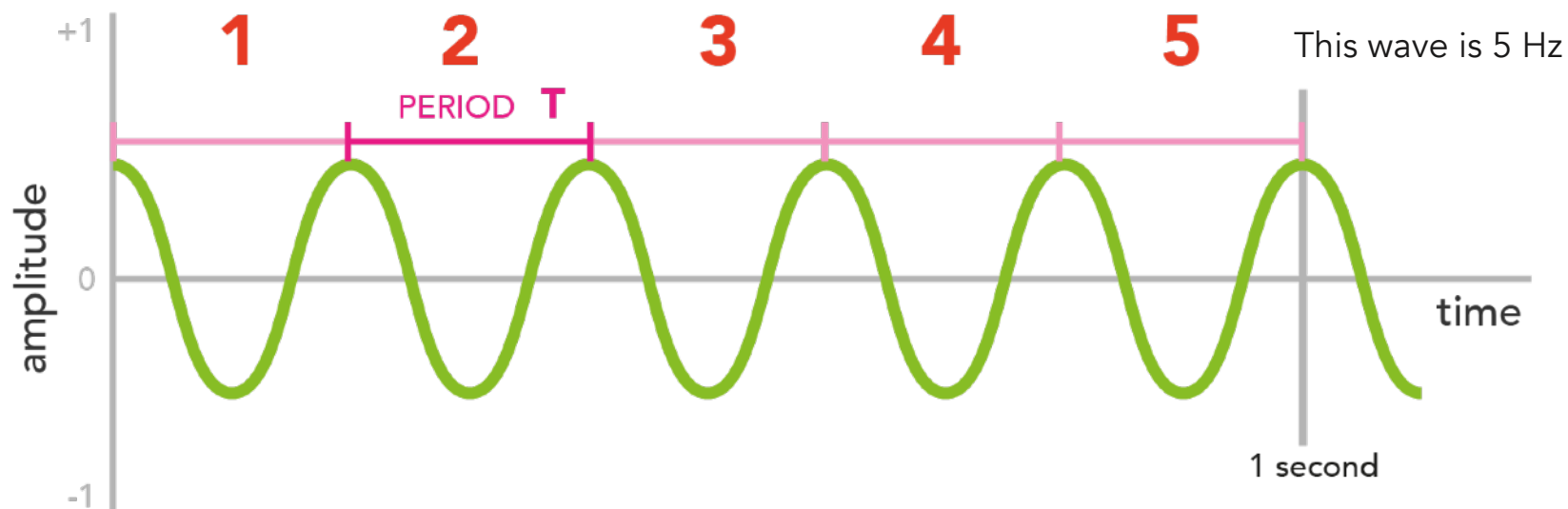
ELASTIC MEDIUM

# Frequency

**Frequency** is the wave property that is directly related to the pitch of the notes that we play on our instruments.

In the branch of physics known as acoustics, frequency is defined as the number of times a wave cycle occurs in one second and is expressed in hertz (Hz).

Frequency is the reciprocal of period, which in mathematical formulas is expressed:

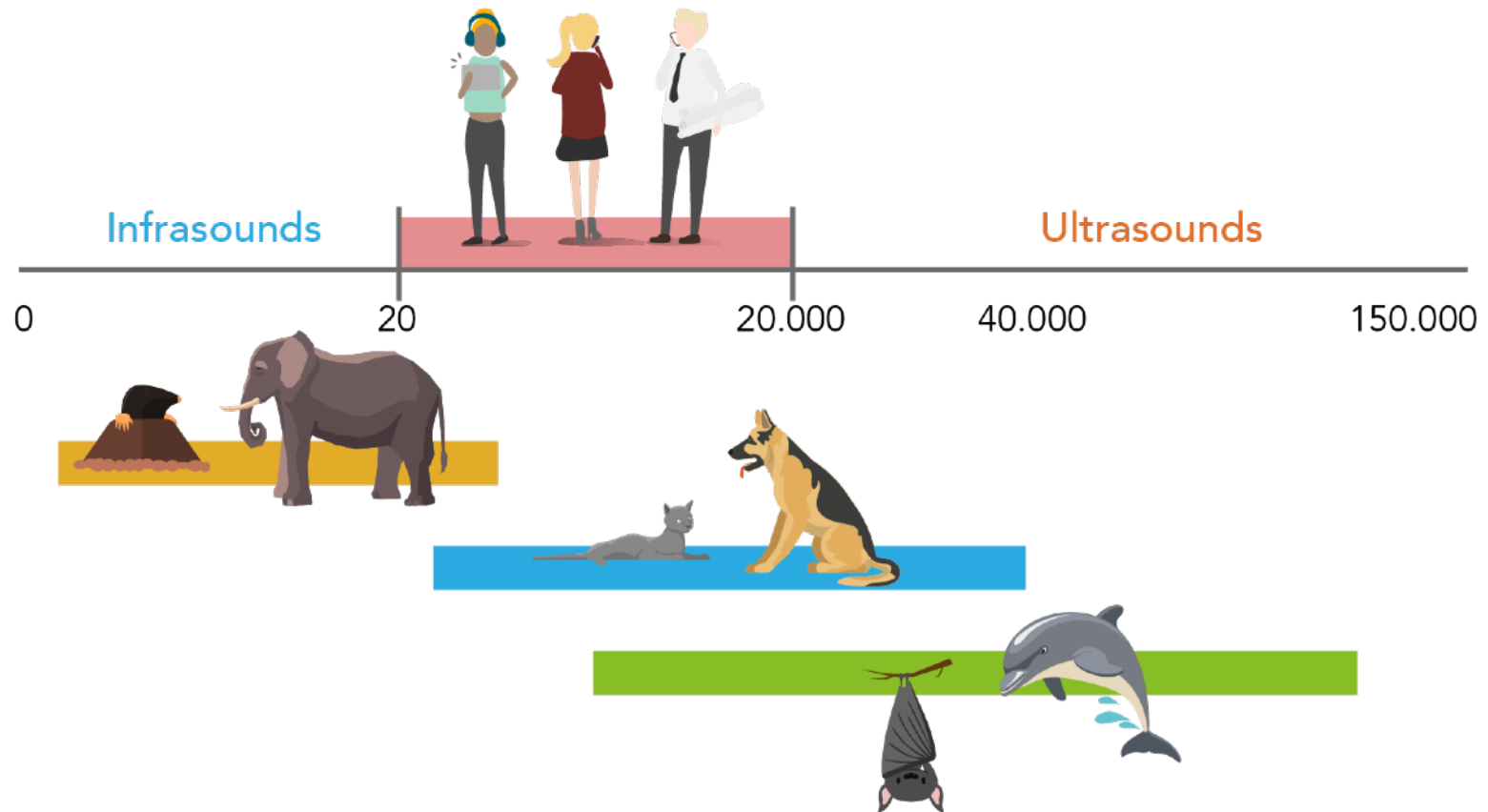


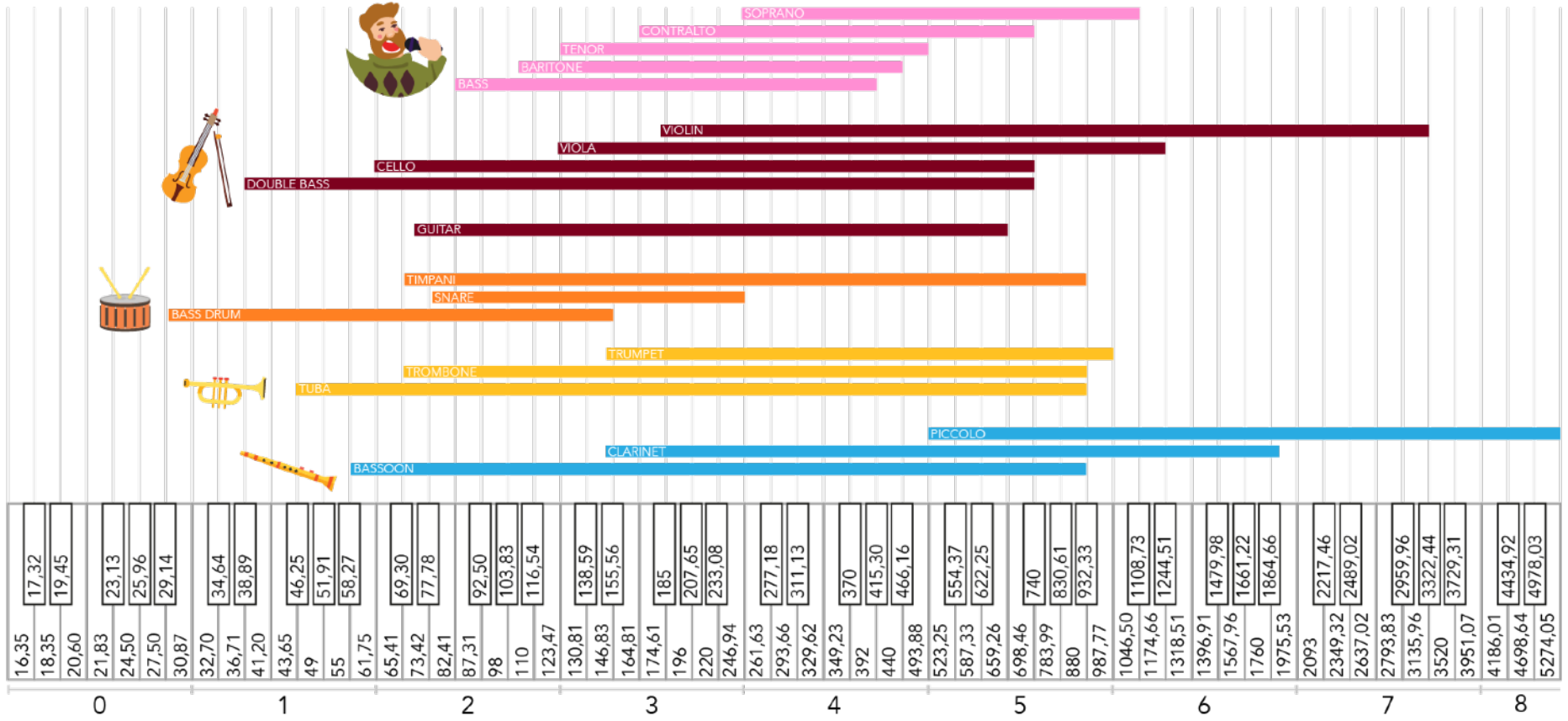
$$\text{frequency } f = \frac{1}{T}$$

stands for 1 second of time  
wave period

Humans do not perceive all frequencies but only a range:

# from 20 to 20,000 Hz





C1 = 32.70 Hz

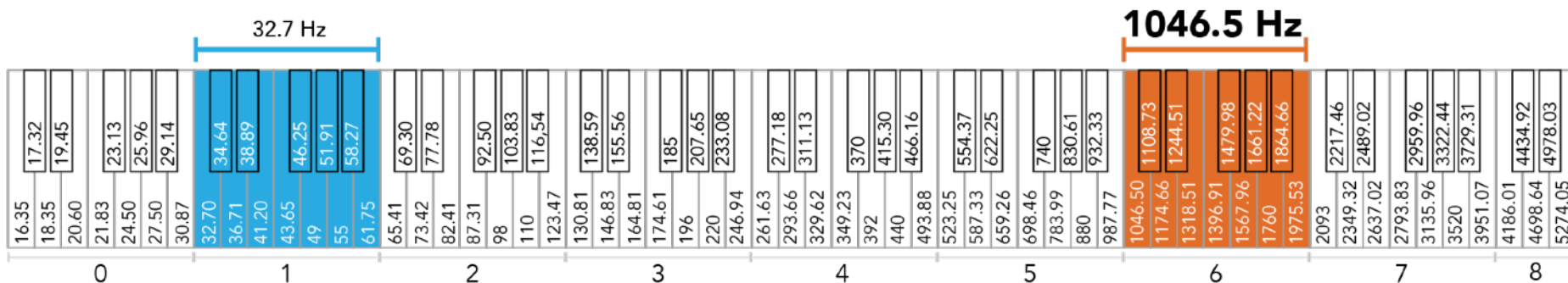
C2 = 65.41 Hz

The difference is **32.7 Hz**

C6 = 1046.50 Hz

C7 = 2093.00 Hz

The difference is **1046.5 Hz**

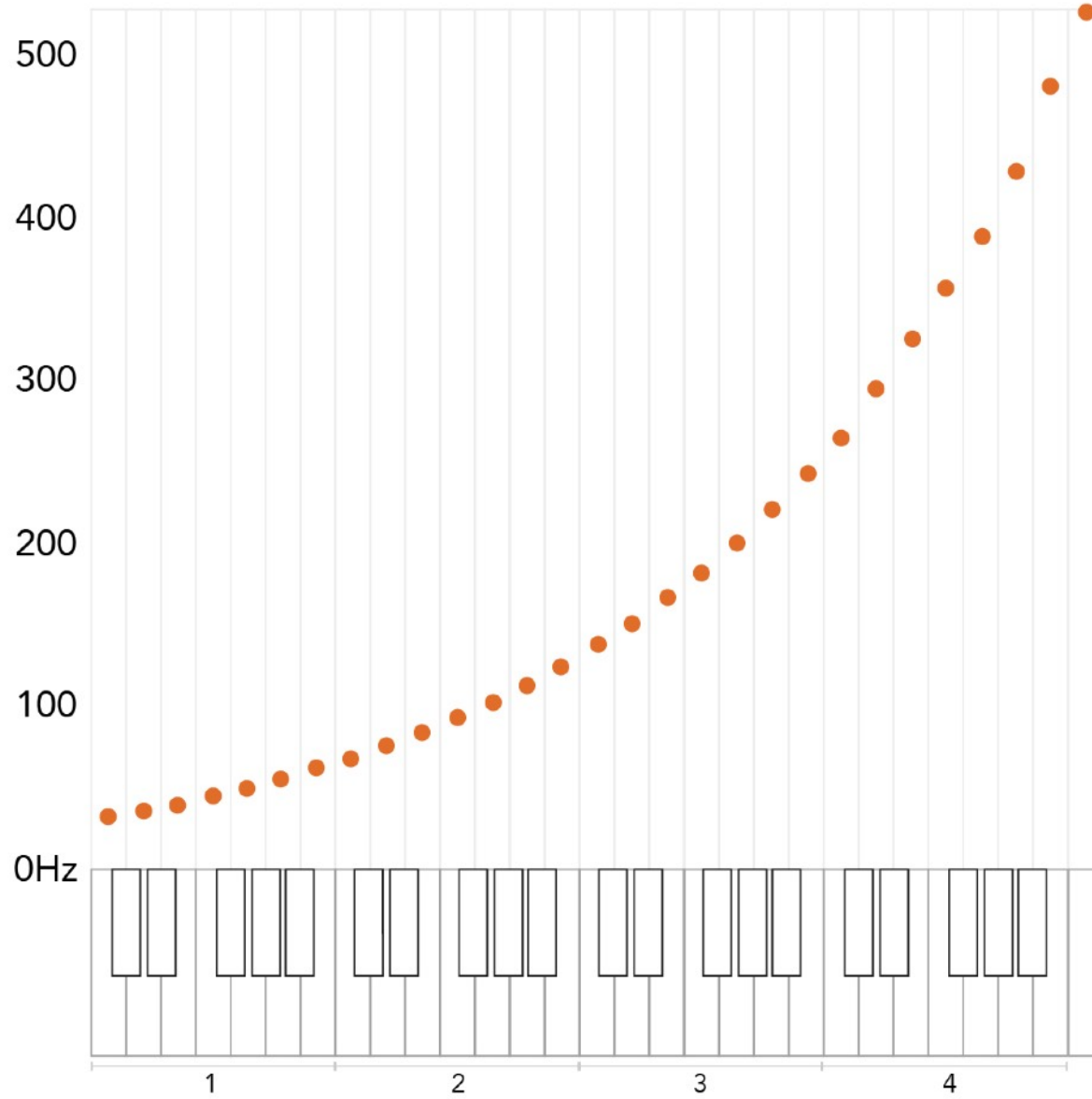


The measure of an octave, or any other musical interval, grows as frequency increases.

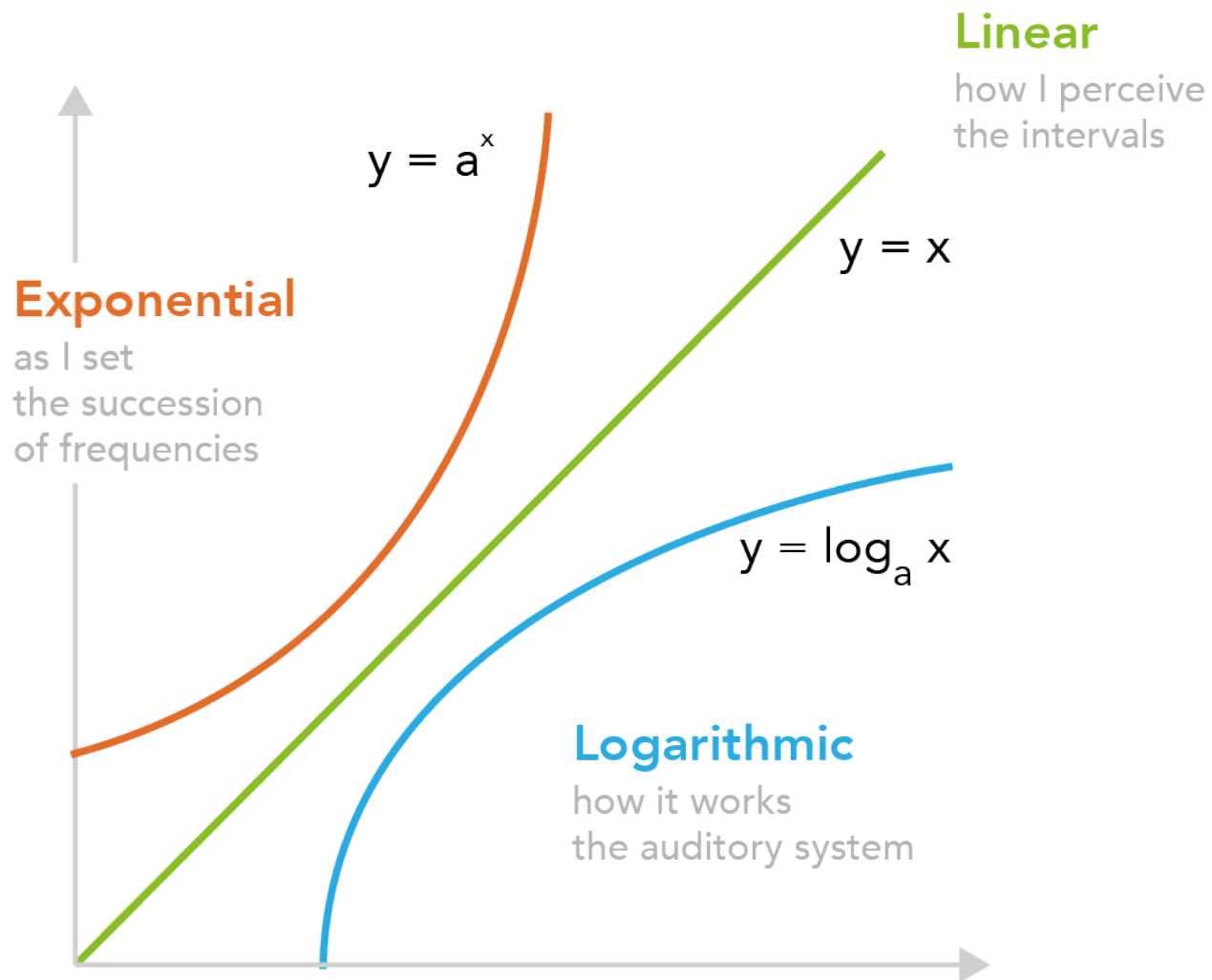
Practically, the steps between notes that we perceive to be all the same actually correspond to frequency values, in hertz, that grow larger and larger. They follow an **exponential trend** (larger and larger steps) rather than a linear trend (steps that are all the same).

I construct a scale that is **exponential** (with larger and larger frequency steps) to compensate for the **logarithmic** way our hearing works in order to to perceive notes with a **linear** pattern (with steps that are all perceived the same).

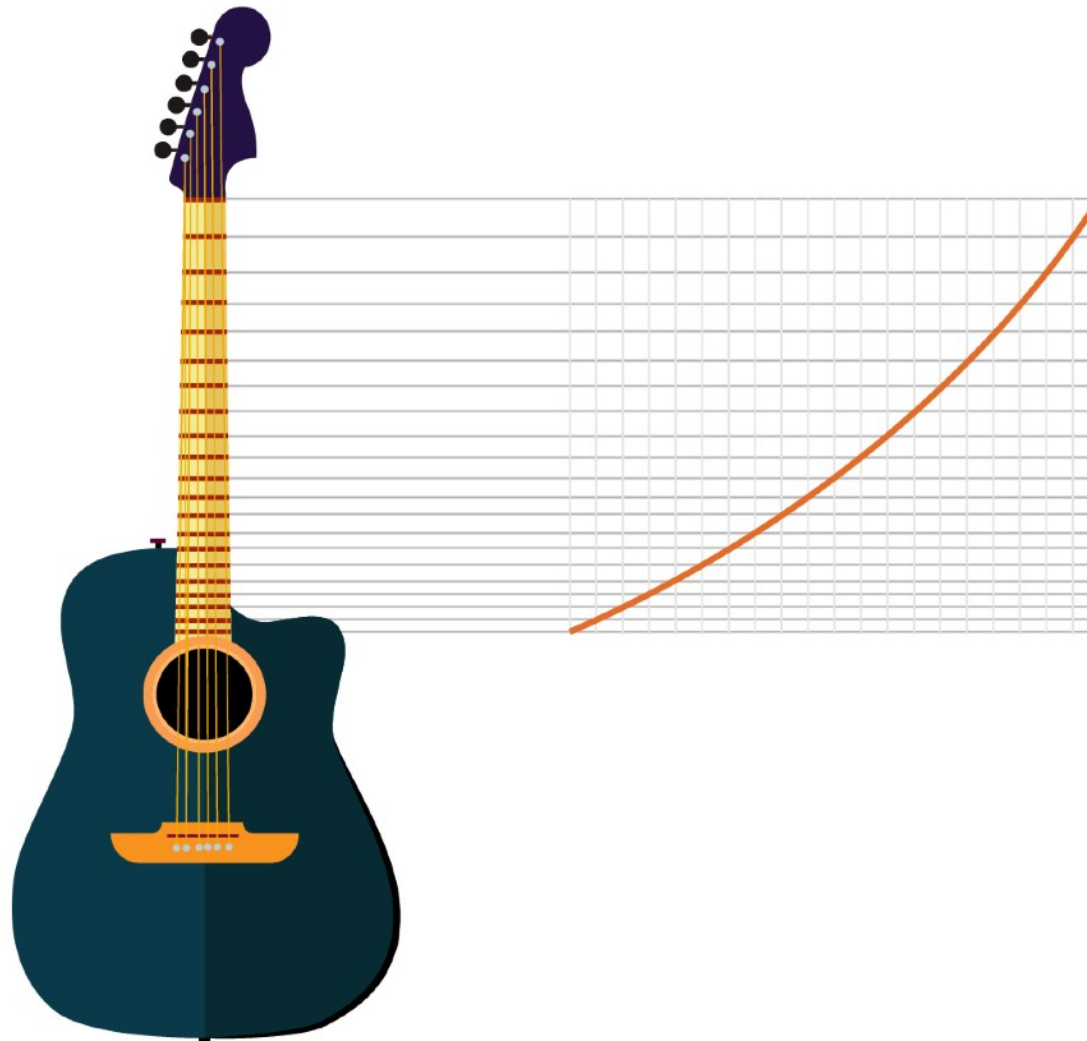




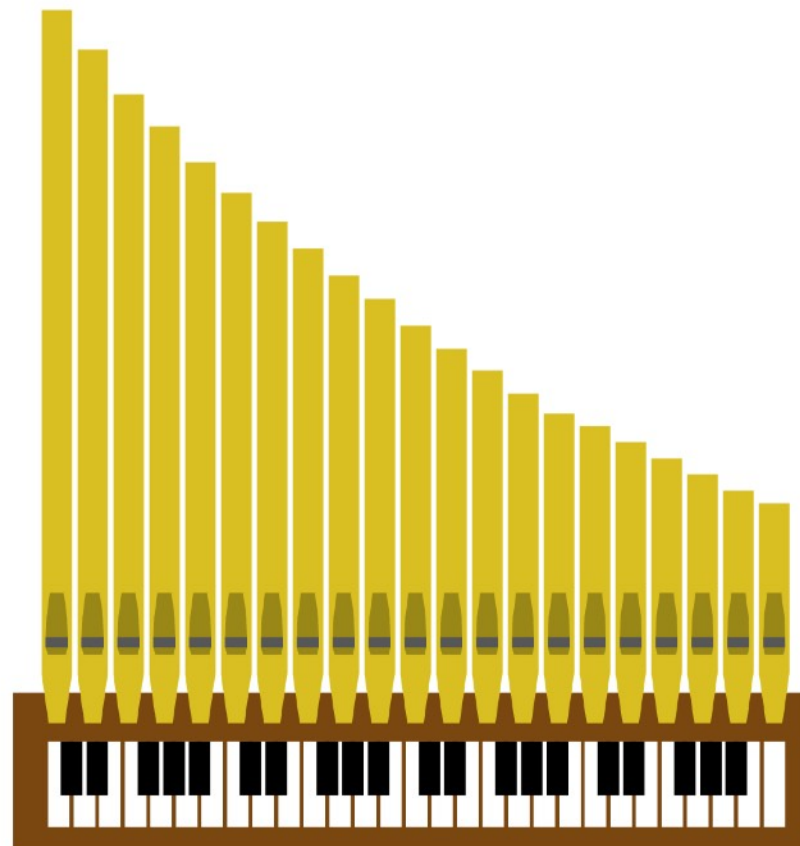
# Equal temperament



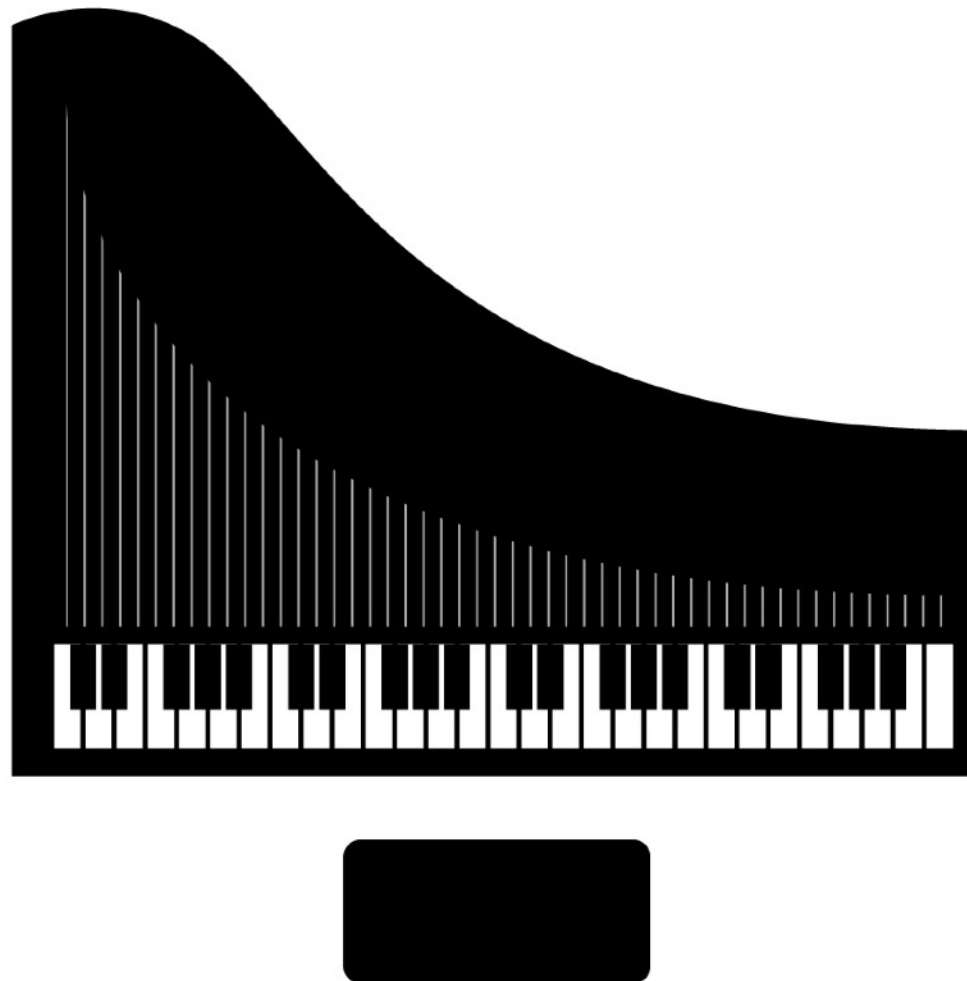
# Guitar frets widths



# Organ pipes length



# Piano strings lengths



# Equal temperament

How then is the frequency of a note calculated?

The ratio between the frequencies of two successive semitones is a constant ratio,  $r$ .

Given a base frequency  $f$ ,

to get the next semitone  $X$  I need only do:  $f * r_{ET}^X$  where  $r_{ET} = \sqrt[12]{2}$   
1.0594631...

EXAMPLE

$$C1 = 32.7$$

$$C\#1 = 32.7 * r$$

$$D1 = 32.7 * r * r = 32.7 * r^2$$

$$D\#1 = 32.7 * r * r * r = 32.7 * r^3$$

$$E1 = 32.7 * r * r * r * r = 32.7 * r^4$$

$$\dots = \dots = \dots$$

$$C2 = 32.7 * r^{12} = 32.7 * 2$$

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