

# Science Of Music Study Guide

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# 1 Musical Definitions

Please refer to the file on Canvas for the full list of definitions. Below are the definitions the professor highlighted in class.

## 1.0.1 Acoustical Beating

The audible vibration created when two or more frequencies, that are not quite in a simple whole number relationship to each other, are sounded together. For example if 100 and 102 Hz are played together you can hear the 2 vibrations per second difference.

## 1.0.2 Audiation

“The mind’s ear”, or the ability to hear previously heard sounds in one’s mind.

## 1.0.3 Chord

Three or more different pitches occurring simultaneously.

## 1.0.4 Consonance and Dissonance

The concept of relatively pleasing sound, due to combinations of particular harmonies, melodic progressions, and/or rhythms. What is consonant or dissonant depends on what is culturally the norm.

## 1.0.5 Dynamics

Level(s) of loudness or softness in a piece of music. Italian terms such as forte and piano are used. Adding an “issimo” is a suffix that means even more of that quality and adding “mezzo” means not so much of this. Pianissimo versus mezzo piano.

## 1.0.6 Harmony

Two or more different pitches occurring simultaneously, usually creating a sense of consonance or dissonance.

## 1.0.7 Instrumentation

The set of instrumental components (e.g. a quintet of flute, clarinet, oboe, bassoon, and horn) in an ensemble, piece of music, or at a particular point in a piece.

## 1.0.8 Melody

The succession of notes (usually pitched) forming a recognizable pattern, a.k.a. the “tune”, “ditty”, or “theme”. In Jazz it is called the “head”.

## 1.0.9 Motive

A recognizable, prominent melodic or rhythmic fragment, somewhere between 2 and 7 notes in length, that is used as a basis of development and adapted throughout a piece.

### **1.0.10 Music**

Sound(s) which cause, or have as their purpose, an emotional experience and/or temporal aesthetic reaction in the minds and/or behaviors of one or more listeners. These sounds are usually organized with respect to time, and incorporate accepted principles of construction.

### **1.0.11 Note**

One melodic or rhythmic event; also, its written representation.

### **1.0.12 Octave**

Distance between two pitches whose frequencies are in a 2:1 Hertz relationship.

### **1.0.13 Pitch**

An audible uniform frequency, of sufficient duration, that produces a psychomusical sensation. The Western pitch system contains 12 different pitches A through G, with repetitions at the octave.

### **1.0.14 Range**

The full extent of pitches, from highest to lowest tones, that an instrument, voice, or composition has.

### **1.0.15 Rhythm**

A series of musical sounds in some combination of short and long durations. Often notated using note values such as whole notes, half notes, quarter notes, eighth notes, etc.

### **1.0.16 Scale**

Divisions of the naturally occurring octave into x number of steps. The ordered collection of pitches or frequencies that result when a given mode is played with respect to a given key center. There are hundreds to thousands of scale types.

### **1.0.17 Timbre**

The particular sound signature of an instrument or voice.

### **1.0.18 Triad**

A chord consisting of three pitches in a root-third-fifth relationship.

## **2 What are waves**

EXPLAIN WHAT WAVES ARE (INCLUDING WAVELENGTH)

## 2.1 Simple Harmonic Motion

## 2.2 Amplitude and Frequency

### 2.2.1 Overtones, Partial, Harmonics

## 2.3 Standing Waves

## 2.4 Resonance

### 2.4.1 Mechanical Coupling

## 3 Variables to Know

<i>Variable</i>	<i>Abbreviation</i>	<i>Units</i>	<i>UnitsAbrv</i>	<i>Misc</i>
<i>Frequency</i>	<i>f</i>	<i>Hertz</i>	<i>Hz</i>	$\frac{1}{sec}$
<i>SpeedOfSound</i>	<i>C(V<sub>air</sub>)</i>	<i>Meters/Second</i>	<i>m/s</i>	<i>344m/s</i>
<i>Wavelength</i>	<i>λ</i>	<i>Meters</i>	<i>m</i>	
<i>Length</i>	<i>L</i>	<i>Meters</i>	<i>m</i>	

## 4 Equations to Know

Wavelength:

$$\lambda = \frac{C}{f}$$

Drt equation:

$$d = rt$$

This is common equation where distance is equal to rate times time.

Area of a circle follows the equation  $A = \pi * r^2$ .

Open-Open Pipe fundamental:

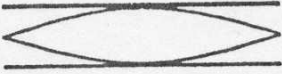
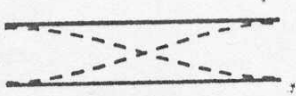
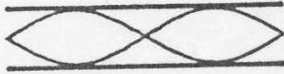
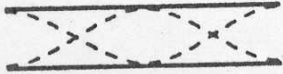
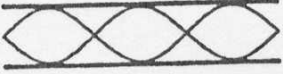



$$f_1 = \frac{C}{2L}$$

The open-open pipe is also called a half wave resonator, strings also follow the half wave resonation pattern. The overtones follow increasing consecutive integer harmonic multiples. Below is an illustration of the half wave resonator sound waves.

Open-open pipe, string  
or conical pipe

$$n = m + 1$$

$$f_n = n \frac{V_{\text{air}}}{2L}$$

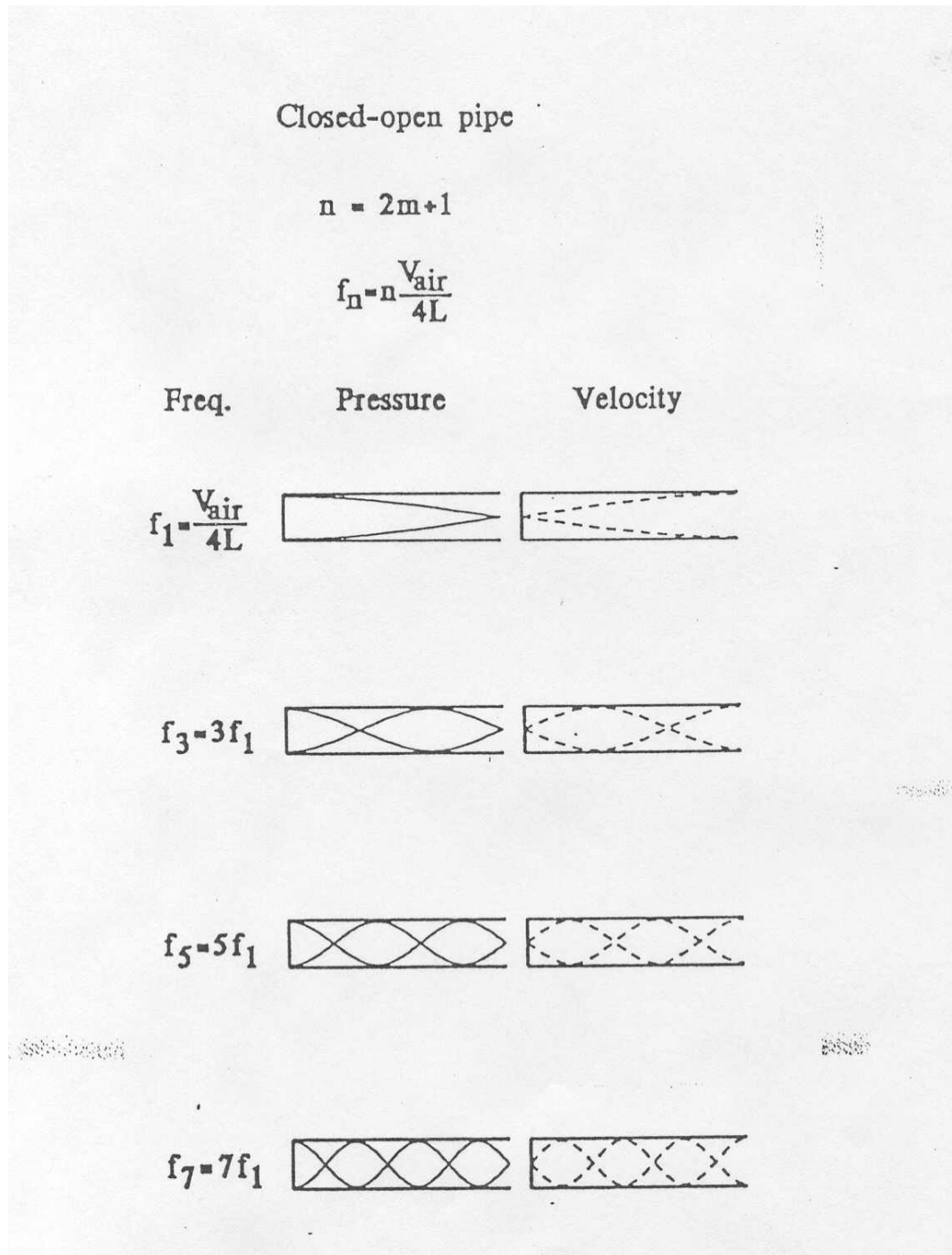
Overtone index $m$	Freq.	Pressure	Velocity
0 (fund.)	$f_1 = \frac{V_{\text{air}}}{2L}$		
1	$f_2 = 2f_1$		
2	$f_3 = 3f_1$		
3	$f_4 = 4f_1$		

Open-Close Pipe fundamental:

$$f_1 = \frac{C}{4L}$$

The open-closed pipe is also called a quarter wave resonator. The overtones follow an increasing consecutive

odd integer harmonic multiples. Below is an illustration of the quarter wave resonator sound wave.



#### 4.1 End Correction

$$L_A = L_P + 0.61 * r$$

- $L_A$  is the acoustical length
- $L_P$  is the physical length
- $r$  is the radius of the tube/pipe

## 5 Sound Intensity Level

Loudness is a subjective perception; whereas the sound intensity level is a measure of power over a given area due to the pressure waves. For example, you need to add eight more players to make something “sound” twice as loud (from one base player). Sound intensity level, since it would be measured as power over an area, is measured in watts per meter squared, however we transform this into a logarithmic scale using decibel units due to the large range of hearing in the ear.

### 5.1 Logarithms

Logarithms are the inverse of exponents. Below are some logarithmic properties to recall what logarithms are:

$$\log_b a = x; b^x = a$$

$$\log(x * y) = \log(x) + \log(y)$$

$$\log(x/y) = \log(x) - \log(y)$$

$$\log(x^a) = a * \log(x)$$

### 5.2 Decibels

Our basis of 0 dB starts at  $1 * 10^{-12} \frac{W}{m^2}$ . 100 dB would be  $1 * 10^{-2} \frac{W}{m^2}$ . This makes every change in 10 dB equal to multiplying our sound level by 10, so a change in 1000, would be a change in 30 dB.

#### 5.2.1 Rules of thumb

1. Doubling the sound intensity level requires adding 3 decibels (doubling in volume).
2. Doubling the distance from a sound source, you subtract 6 decibels (quartering the volume).

### 5.3 Hearing Limits

The standard ear drum has a SIL range between 0 dB and 120 dB (starts to damage). You can see the power over area of these units by using the calculation methods stated above.

## 6 The Amazing Ear

### 6.1 Outer Ear

### 6.2 Middle Ear

#### 6.2.1 Malleus: Hammer

#### 6.2.2 Incus: Anvil

#### 6.2.3 Stapes: Stirrup

### 6.3 Inner Ear

## 7 Pitch and Pitch Names

### 7.1 Pitch versus Frequency

### 7.2 Musical Staff

### 7.3 Pitch Names

## 8 Misc

### 8.1 Timbre

### 8.2 ADSR

1. Attack Time
2. Decay Time
3. Sustain Level
4. Release Time

### 8.3 Combination Tones

### 8.4 Psychoacoustics

#### 8.4.1 Octave Equivalence

#### 8.4.2 Fundamental Tracking

The brain supplies or tracks the missing fundamental that is produced through combination tones.

#### 8.4.3 Masking

Two sounds that are close to each other might have one mask the other sound. Our perception would only hear the louder of two similar sounds. There are some types of masking: temporal masking and backward masking. The sensitivity range of the frequency will also determine which sound is masked out.



#### **8.4.4 Tonal Fusion**

Two different instruments are playing together, but it sounds like there is only one instrument playing.