

# Musical Instrument Acoustics

## Real Instruments

Guide for Instructors

### Flute

1. Answer these questions:

Family?

Woodwinds, open tube

Other Instruments?

Recorder, whistles, pan flutes

Methods of Excitation?

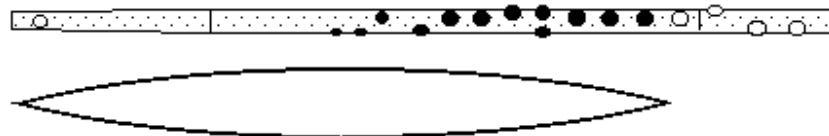
blown air

Methods of Response?

The tube resonates at the natural frequency of the tube.

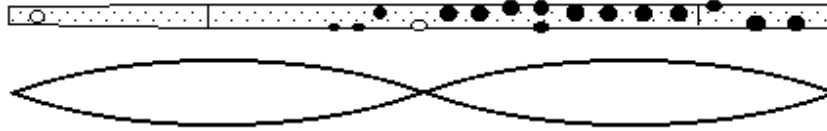
How is pitch determined?

Pitch is determined by the length of the tube. Pressing keys opens and closes holes in the tube which effectively changes the length. Also, holding keys down at certain node points creates harmonics and higher pitched notes. A combination



of these techniques allows the instrument to produce a wide range of pitches.





Relate to sound cannon lesson.

This is almost identical to the sound cannon. Instead of expanding the length of the tube, you are changing the position of the air pressure exit hole with the keys, effectively shortening the tube.

Calculation exercise.

Calculate the length of tube needed for concert A, and how to play it on the instrument, and how that pitch relates to the keys being pressed.

2. Take recordings of the instrument using the spectral analysis app, and show the time domain and frequency domain representations of the recording. Take screenshots for use in the presentation.
3. Explain the significance of the temporal and spectral shapes and how they relate to the sound perceived.
4. Use the synthesis app and try to recreate the sounds of your instrument by synthesizing the time domain and frequency domain envelope.
5. Create a presentation describing all of your findings to the group.

# Musical Instrument Acoustics

## Real Instruments

Guide for Instructors

### Clarinet

1. Answer these questions:

Family?

Woodwinds, closed tube

Other Instruments?

oboe, sax, english horn

Methods of Excitation?

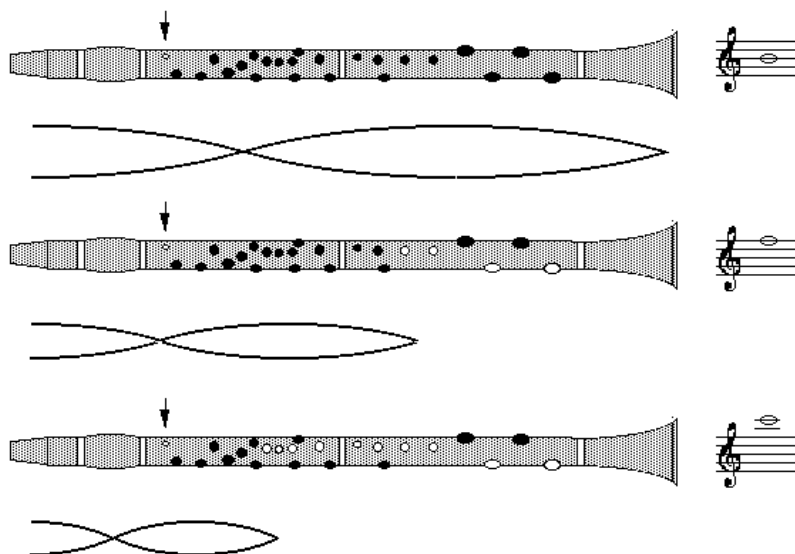
Mouthpiece vibrates and forces air through the tube.

Methods of Response?

The body resonates at frequencies related to its length.

How is pitch determined?

Pitch is determined by the length of the tube. Pressing keys opens and closes holes in the tube which effectively changes the length. Also, holding keys down at certain node points creates harmonics and higher pitched notes. A combination of these techniques allows the instrument to produce a wide range of pitches.



Relate to sound cannon lesson.

Works similar to closed tube. Odd harmonics only. Instead of expanding the length of the tube, you are changing the position of the air pressure exit hole with the keys, effectively shortening the tube.

Calculation exercise

Calculate the length of tube needed for concert A, and how to play it on the instrument, and how that pitch relates to the keys being pressed.

2. Take recordings of the instrument using the spectral analysis app, and show the time domain and frequency domain representations of the recording. Take screenshots for use in the presentation.
3. Explain the significance of the temporal and spectral shapes and how they relate to the sound perceived.
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### French Horn

1. Answer these questions:

Family? Brass, Closed Tube

Other Instruments? Trumpet, trombone, tuba.

Methods of Excitation? Buzz lips, create airflow.

Methods of Response?

The body resonates at frequencies related to its tube length.

How is pitch determined?

Pitch is determined by valves directing airflow through a series of tubes.

Relate to sound cannon lesson.

Works similar to closed tube. Odd harmonics only. Tube length is changed by opening and closing valves. However cone shape can make approximate better as an open tube, if you understand this maybe you can explain it better.

Calculation exercise

relate tube length to a specific pitch. Maybe introduce cones. make a relation of tube length to a certain pitch. Calculate the length of tube needed for concert A, and how to play it on the instrument, and what pipes are used.

2. Take recordings of the instrument using the spectral analysis app, and show the time domain and frequency domain representations of the recording. Take screenshots for use in the presentation.
3. Explain the significance of the temporal and spectral shapes and how they relate to the sound perceived.
4. Use the synthesis app and try to recreate the sounds of your instrument by synthesizing the time domain and frequency domain envelope.
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# Musical Instrument Acoustics

## Real Instruments

Guide for Instructors

### Guitar

1. Answer these questions:

Family? String

Other Instruments? guitar, mandolin, banjo. violin.

Methods of Excitation? pluck the string.

Methods of Response?

String vibrates at frequency proportional to length and tension.

Air inside body, as well as the body, resonates to amplify the sound.

How is pitch determined?

Pitch is related to the length, mass, and tension of the string.

Relate to sound cannon lesson.

Similar to open tube. velocity is related to tension, no tube diameter necessary.

Calculation exercise

Given a tuned steel string guitar, calculate the tension of the string, and using that tension, calculate fundamental frequencies at various lengths.

Using tuned high e string, calculate the mass of the high e string given the density of steel, use that mass to calculate the tension on the string. Use the tension to calculate the fundamental frequencies of strings of different length (notes played on the same string).

2. Take recordings of the instrument using the spectral analysis app, and show the time domain and frequency domain representations of the recording. Take screenshots for use in the presentation.
3. Explain the significance of the temporal and spectral shapes and how they relate to the sound perceived.
4. Use the synthesis app and try to recreate the sounds of your instrument by synthesizing the time domain and frequency domain envelope.
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## Real Instruments

Guide for Instructors

### Bowed Strings

1. Answer these questions:

Family? Strings

Other Instruments? Viola, cello, bass

Methods of Excitation?

pluck, bow.

bow grabs and releases the string in lots of plucks.

Methods of Response?

String vibrates at frequency proportional to length and tension.

Air inside body, as well as the body, resonates to amplify the sound.

How is pitch determined?

Pitch is related to the length, mass, and tension of the string.

Relate to sound cannon lesson.

Similar to open tube. velocity is related to tension, no tube diameter necessary.

Calculation exercise

Given a tuned steel or gut, calculate the tension of the string, and using that tension, calculate fundamental frequencies at various lengths.

Using tuned string, calculate the mass of the string given the density, use that mass to calculate the tension on the string.

Use the tension to calculate the fundamental frequencies of strings of different length (notes played on the same string)

2. Take recordings of the instrument using the spectral analysis app, and show the time domain and frequency domain representations of the recording. Take screenshots for use in the presentation.

3. Explain the significance of the temporal and spectral shapes and how they relate to the sound perceived.

4. Use the synthesis app and try to recreate the sounds of your instrument by synthesizing the time domain and frequency domain envelope.
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### Percussion

1. Answer these questions:

Family?

Percussion

Other Instruments?

Snare Drum, Tom-Tom, Bass Drum, Cymbals, Xylophone

Methods of Excitation?

Strike with sharp impulse.

Methods of Response? depends. Idiophones vs. Membranophones .

Idiophones, the body of the instrument is struck and vibrates based on the density and length of the material struck.

Membranophones have a vibrating membrane that responds related to tension and material. They are usually stretched outside of drum shell, which acts as a resonant body.

How is pitch determined?

tension head

Relate to sound cannon lesson.

Calculation exercise. Show wiki page, talk about nodes and 2dwaves

2. Take recordings of the instrument using the spectral analysis app, and show the time domain and frequency domain representations of the recording. Take screenshots for use in the presentation.
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4. Use the synthesis app and try to recreate the sounds of your instrument by synthesizing the time domain and frequency domain envelope.
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