

# CALCULATING PITCH

Est. Time: 60-90 minutes

Subjects: Math

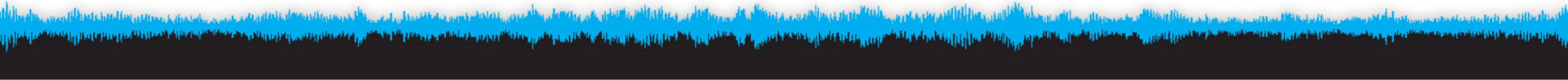
Age Range: Middle School

★ *TEACHROCK* ★



How do musical instruments produce different pitches, and what variables alter a musical instrument's pitch?

In this lesson you will:

- Define the term “pitch” in relation to musical sound
  - Explore the work of musician Mickey Hart and his electronic stringed instrument, the beam
  - Use arithmetic to gain a thorough understanding of how musical instruments produce pitch
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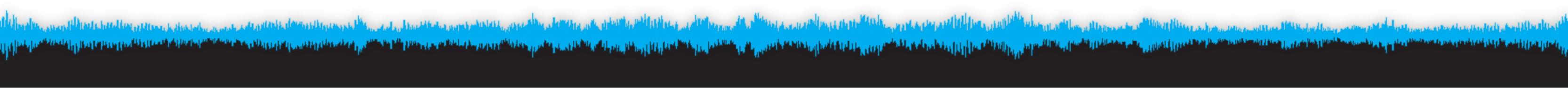
Pitch /piCH/ noun: the property of a sound and especially a musical tone that is determined by the frequency of the waves producing it; highness or lowness of sound

Consider or ask a partner:

- What might be some of the ways that pitch can be produced?
  - Do you have any experience producing pitch? If so, how?
- 



Watch **this video** of various pitches being produced, then consider or ask a partner:

- Do you recognize this instrument? What does it remind you of?
  - What does this instrument sound like? Does it sound high or low?
  - Can you describe how this instrument is constructed?
  - Why do you think it sounds the way it does? What factors might determine the frequency of an instrument, or whether an instrument sounds high or low?
  - Do you recognize the musician playing it? Considering how he's playing this instrument, what kind of musician do you think he might be? Do you know any of the musical groups he's played in?
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Mickey Hart is a Grammy-winning percussionist and musicologist best known as a member of the band, Grateful Dead.

The instrument he's playing is called "the beam" or "blaster beam." Hart has used it to produce special effects for film soundtracks, but it can also be used in music. He often plays the beam when he performs individually or with his bands.



The pitch or pitches an instrument produces depend on how the instrument is constructed and how the musician “activates”/plays the instrument.

Watch **the video** again. Jot down some notes on which variables might be determining the pitch this instrument produces.

*(Hint: consider what material is **vibrating** to produce the sound, and what variables go into that material’s construction.)*





While large, the beam is a relatively simple instrument: the only material that determines the pitch is the string; everything else on the instrument is built to support and amplify the sound of the string. The specific pitch produced on the beam is determined by the **tension** (*amount of force applied to the string*), **mass** (*the amount of matter or substance that makes up an object*), and **length of the string**.



Use **this handout** for calculations that will determine the frequency of a soundwave, or pitch of a note, that a string instrument produces.

$$f_1 = \frac{\sqrt{\frac{T}{\mu}}}{2L} \quad \text{where} \quad \begin{array}{l} f_1 = \\ T = \\ \mu = \\ L = \end{array}$$



This equation shows how to calculate the pitch of a note that a string instrument produces. Now, using the information in the equation, fill in the missing text on page 1 of the handout. Then, complete the calculation on page 1 with the information provided.

*\* If learning independently, conclude here and advance to the next slide. If learning with assistance from a teacher, continue onto the word problems on pages 2-4, and ask for assistance as needed.*

$$f_1 = \frac{\sqrt{\frac{T}{\mu}}}{2L} \quad \text{where}$$

$f_1$  = fundamental frequency in Hertz (Hz)

$T$  = tension of the string in Newtons (N)

$\mu$  = mass per unit length of the string in kilograms per meter (kg/m)

$L$  = length of the string in meters (m)





Watch **this video** of Mickey Hart playing drums, then consider or ask a partner:

- Based on what you are seeing in the video, what variables might contribute to the pitch created by a drum?
- Do you think drums have more or less variables that contribute to their pitch than string instruments? Why or why not?
- Do you think it would be easier or more difficult to calculate a drum's pitch based on variables, compared to a string instrument? Why or why not?

*(Hint: the pitch of a drum is affected by its diameter, depth, the tension of the membrane that is being struck, the thickness of the membrane being struck, and the area of the membrane being struck.)*



# SUMMARY

- **Pitch** is a musical tone characteristic created by the frequency of the soundwaves producing it
- **Mickey Hart is a Grammy-winning percussionist and musicologist** who plays a custom-made electronic multi-stringed instrument called, the beam
- The frequency of a soundwave produced by a stringed instrument like the beam is determined by the **tension, mass, and length of the string**
- **Diameter, depth, tension, thickness, and area**, all contribute to the pitch a drum produces



# BE CREATIVE

Using a collection of various rubber bands, an empty tissue box, and a handful of pushpins, create your own stringed instrument! **This video** will provide guidance for creating your instrument and how to test the sound of the “strings” created with the rubber bands.



# BE CURIOUS

What might be the variables that determine the pitch of a wind instrument or percussion instrument other than a drum (bells, xylophone, etc.)? Conduct research to see if your hypotheses are accurate. Document your research practices and results, then present your findings.



# BE CURIOUS

Explore **the history of the beam** at Mickey Hart's website.



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