

MUSICAL RATIOS

PITAGORAS



PYTACORA



PHYLOLAVS

Est. Time: 60-90 minutes
Subjects: Math
Age Range: Middle School


[View the classroom lesson version](#)

TEACHROCK



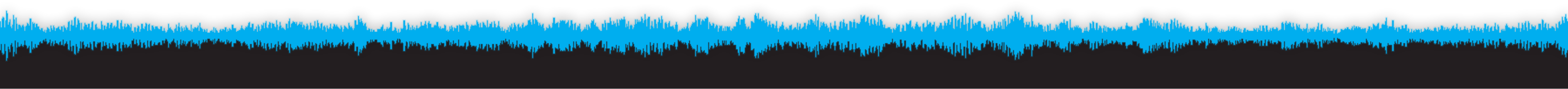
What role do ratios play in the Western musical concepts of rhythm and harmony?

In this lesson you will:

- Explore how ratios are used to make comparisons between two things
 - Identify how to find equivalent ratios using proportions
 - Examine the definitions of “rhythm,” “interval,” and “harmony” in Western music theory, and discover how these components of music are derived from ratios
 - Analyze the ways the ratios between two pitches determine their sonic characteristics
 - Identify the mathematics behind the Pythagorean 7-note scale
- 



Watch **this video** of two short pieces of music and jot down your impressions of each piece. Then, consider or ask a partner:

- How would you describe the mood or character of the first piece of music? How about the second piece? Was there one piece you preferred over the other? Why?
 - Both pieces were performed on the same instrument at roughly the same speed. What made them sound different?
 - What mathematical processes might be used to analyze the relationships between notes played in a piece of music?
- 


Mathematics can be used to analyze the particular qualities of a piece of music.

Ratios are used to compare two things and they can be written in a variety of ways.

Use “:” to separate the values **20 : 1**

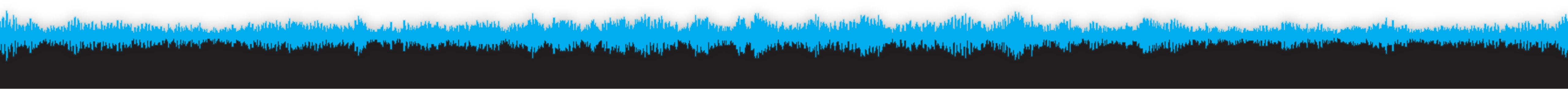
Use the word “to” **20 to 1**


Write it as a fraction $\frac{20}{1}$



One of the simplest ways ratios are used in music is with **rhythm**, or the ways the sounds in a piece of music are organized in time. Rhythm is usually based on the **beat**, or an underlying pulse of a song.

There are many different musical systems throughout the world which use ratios. The focus here will be the Western music system, which is the basis of Classical and Popular music.





Rhythms are built by subdividing the beat. Some of the most common ways to subdivide the beat are shown in the image above.

Beat:Rhythm

4:1

4:2

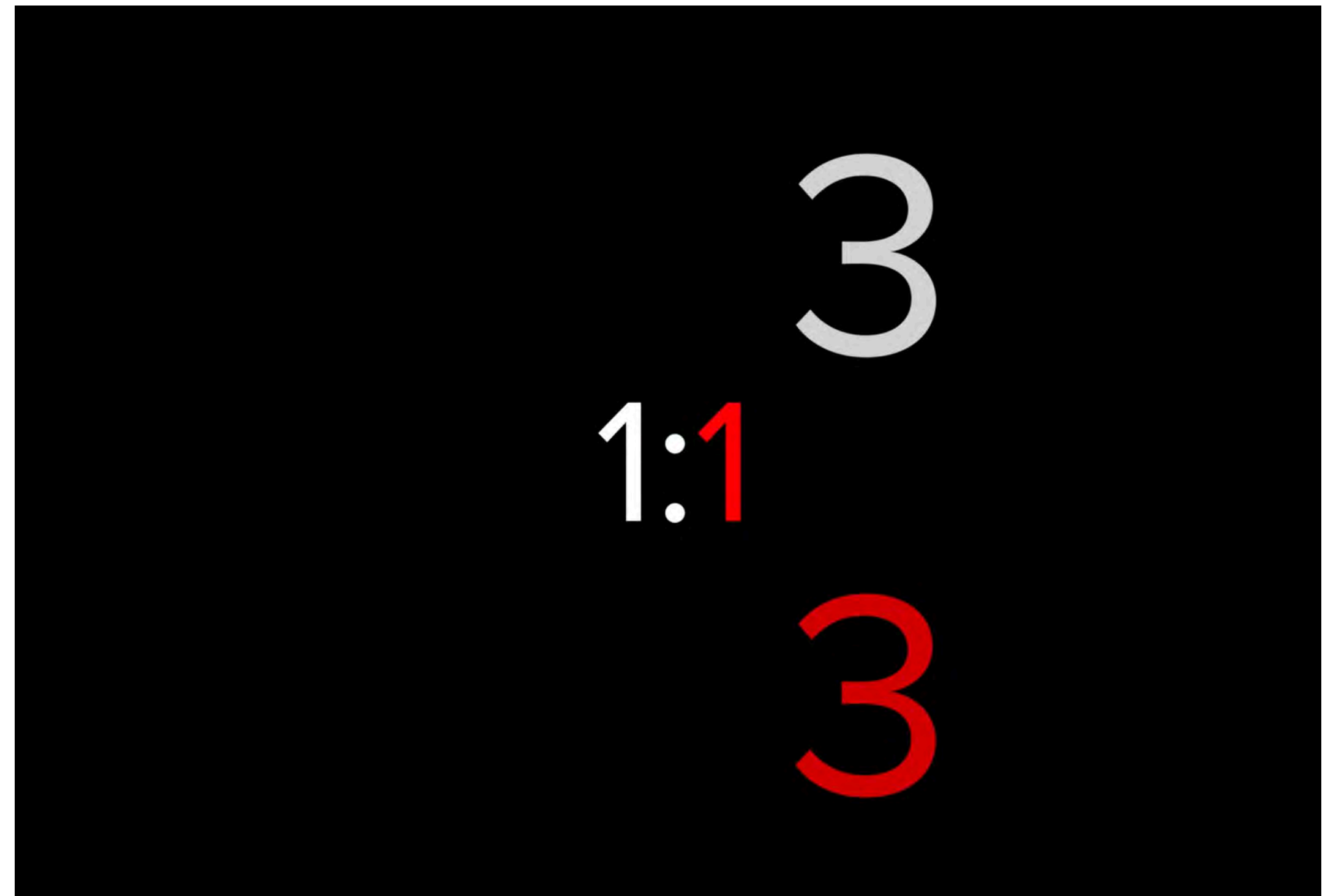
1:1

1:2

1:4



Watch **this video** about rhythmic subdivision. Then, watch the video again and try to clap along with the white numbers.






Beat:Rhythm


3:2

4:3

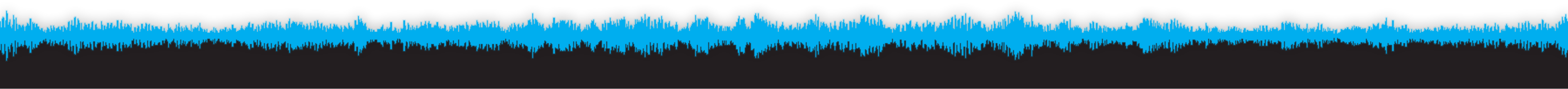
5:4

Keep in mind, while Western music is often built on multiples and factors of 4, this isn't always the case. Musicians could play 3, 5, 7, or 9 notes per beat. Additionally, in music, multiple rhythms are often played at once.





Watch **this video**, and again try to clap along with the red numbers. Pay particular attention to how “complex” or “busy” the rhythms sound. Then, consider or ask a partner:


- Which performance sounded more rhythmically “complicated” to you? Which sounded more “simple”?
 - Is there a relationship between the “complexity” of the rhythm and its ratio? If so, what is the relationship?
- 




Pitch in music also operates according to ratios.

Western music is often built on different groups of seven different pitches called “**scales.**”

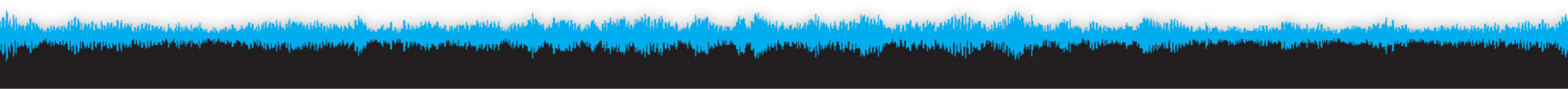
The basis of most scales in Western music was developed by the Ancient Greek Mathematician Pythagoras, using ratios - but it's important to know that similar systems were developed before that in ancient Mesopotamia.






Use **this handout** to conduct the same sort of calculations Pythagoras conducted to create a seven-note scale. Share your work with a partner or your class.

Then, use **this handout** to investigate what the Pythagorean scale sounds like. If an option, review and read the introductory paragraph with a partner. Share your work with a partner or your class.






The **TeachRock Techtool** plays the notes you calculated from the Pythagorean scale. The techtool lists the notes numerically rather than alphabetically, so “C” is “1”, “D” is “2,” and so on.

Use the techtool to observe how pairs of notes in the scale sound when played together. If an option, conduct the experiments below with a partner (*you can also conduct them individually by accessing the techtool on multiple devices*):

- Hold down the “1” (C) button on the techtool, while each additional number in the sequence (2, 3, 4. . .) is pressed on separate devices.
- Listen closely to the sound of each interval, and down your observations on the chart in **Handout 2**.

There are no “right” answers in describing these intervals. The “ratio” portion of the chart and the questions below the chart will be filled in later in the lesson.





Use **this handout** to calculate the ratios between each interval.


After completing the handout, enter the mathematical ratios calculated for each interval in the “ratio” column on the graph in **the Pythagorean Scale handout**. Then, consider or ask a partner:

- Which of the seven did you feel were the most “pleasant” sounding?
- Do you think there is a relationship between the simplicity of an interval ratio and how “pleasant” it sounds?

Rounding Rule 1: Do not round

$$\frac{45}{180} = 0.25 = \underline{\hspace{2cm}}$$

Rounding Rule 2: Round to the nearest 10ths place

$$\frac{331.2}{562.1} = 0.\underline{5}892190 = \underline{\hspace{2cm}}$$


Watch **this video** again, and with what you learned in the class, consider or ask a friend:

- Why might the two melodies played in this video sound different or evoke a different mood?



SUMMARY

- **Ratios** are used to compare two things and **many different musical systems throughout the world use ratios**
- One of the simplest ways ratios are used in music is with **rhythm**
- In music, multiple rhythms are often played at once
- **Pitch** in music also operates according to ratios and Western music is often built on different groups of seven different pitches called **scales**
- **The Ancient Greek Mathematician Pythagoras** created a simple template for scales using ratios but similar systems were developed before that in **ancient Mesopotamia**
- Two or more notes played simultaneously creates an interval relationship



BE CREATIVE

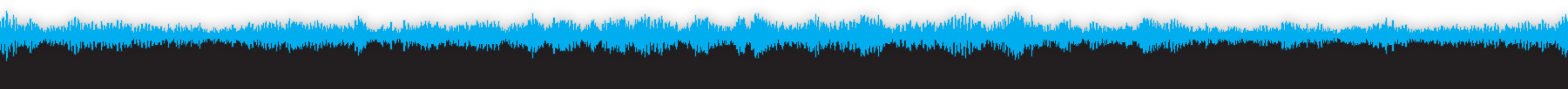
Use **this handout** to examine the sine wave graphs of various intervals, and consider how the mathematical ratios of intervals compare to their visual representations.



BE CURIOUS

Use **this handout** to reinforce the skills and concepts explored in this lesson.

Teacher's Guide



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