

Mathematical Melodies

Lesson Plan | Grades 3–12

MIM

MUSICAL INSTRUMENT MUSEUM

ARIZONA ACADEMIC STANDARDS

Arizona Mathematics Standards

3rd Grade: 3.NF.A.1, 3.NF.A.2,
3.MD.B.4, 3.MP.1-8

4th Grade: 4.NF.B.3, 4.NF.B.4, 4.MD.A.2,
4.MD.B.4, 4.MP.1-8

5th Grade: 5.NF.A.2, 5.MD.B.2, 5.MP.1-8

6th Grade: 6.RP.A.1, 6.RP.A.3, 6.MP.1-8

7th Grade: 7.RP.A.2, 7.RP.A.3, 7.MP.1-8

8th Grade: 8.MP.1-8

Arizona Science Standards

3rd Grade: 3.P4U.1.3

4th Grade: 4.P4U.1.1

8th Grade: 8.P4U.1.4

Arizona Arts Standards: Music

3rd–12th Grades: 10.a., 10.b., 11.a.

Key Vocabulary

- **Fraction:** a number that represents the number of equal parts of a whole, or the division of one number by another
- **Frequency:** the number of waves (e.g., of sound or electromagnetic energy) that pass a fixed point each second (e.g., a sound with a frequency of 1,500 hertz)
- **Interval:** the difference in pitch between two tones
- **Monochord:** a one-stringed instrument
- **Octave:** a pair of notes, one with a frequency double that of the other
- **Pitch:** the perceived highness or lowness of a sound, often associated with the frequency of sound waves
- **Ratio [6th grade and up]:** the quotient of two numbers or mathematical expressions (e.g., the ratio of six to three can be expressed as 6:3 or $\frac{6}{3}$), or the relationship in quantity, amount, or size between two or more things (e.g., women outnumbered men by a ratio of three to one)

Materials

- Writing utensil
- Laptops, computers, or tablets with internet access
- Digital or paper copies of the **String Math Student Worksheet**
- Digital or paper copy of the **Teacher Answer Key**
- Materials to make monochords in groups
 - Meter sticks or yardsticks
 - Nylon string or guitar strings
 - Small metal eye hooks
 - [Optional] Metal washers

Objectives

Students will discover the mathematical relationship between string length and pitch in string instruments and demonstrate their understanding through hands-on exploration with a monochord instrument, playing a familiar song using common intervals on Chrome Music Lab.

Click here or scan the QR code to find additional images, videos, detailed teaching instructions, and worksheets!



Mathematical Melodies

Lesson Plan | Grades 3–12

MIM

MUSICAL INSTRUMENT MUSEUM

ENGAGE [5–10 minutes]

Facilitate a discussion around the question “*What connections are there between math and music?*”

Play the video “**Ancient Math and Music**” from PBS Learning Media. Before watching the video, ask your students:

- Describe the relationship between mathematics and musical intervals, such as octaves, fifths, and fourths.
- Do you think mathematics was invented or discovered? Explain.

Discuss these questions again after watching the video clip.

EXPLORE [20–30 minutes]

Have students access Chrome Music Lab’s **Strings** activity on their devices. From the front of the class, pluck the whole string on the leftmost side of the application. Have the whole class hum the pitch that they hear. Ask: “*Does that sound high or low to you?*” Pluck the next string to the right (either segment of the string will work in this case) and ask: Does half the string sound higher or lower than the whole string? [Answer: higher.]

- a. [3rd–5th grade] *What fraction of the string did I just pluck?* [1/2]
- b. [6th–8th grade] *What is the ratio of the half string to the whole string?* [1:2]

Give students five minutes of work time to complete **Activity 1** on the **String Math Student Worksheet**. Afterward, review the steps to building a monochord with the materials listed. Give students 15–20 minutes to build a monochord in their groups and experiment with shortening and lengthening the segment of string that is plucked to see what sounds are produced.

EXPLAIN [5–10 minutes]

Review what the octave, perfect fifth, perfect fourth, and major third intervals sound like by singing (or playing on YouTube) the beginnings of the songs mentioned in the “**Ancient Math and Music**” video. (Note that the video does not review major thirds; the first two notes of “When the Saints Go Marching In” demonstrates a major third interval.)

Explain that in Western European music, the octave, perfect fifth, perfect fourth, and major third are thought to be especially pleasing or beautiful and so we hear them often.

ELABORATE [15–20 minutes]

Play the video of Louis Armstrong singing “**When the Saints Go Marching In.**” Have the students follow the key in **Activity 2** to play the first part of “When the Saints Go Marching In” on the **Strings** app on Chrome Music Lab. Explain that they can do this using what they have learned so far because the song uses all the intervals they have learned about.

Give students time to play the song, circulating to offer help and answer questions as they work.

EVALUATE [5–10 minutes]

Have students complete the **Exit Ticket** question on their worksheets. Grade student responses using the rubric below.

RUBRIC

| Exceptional | Almost There | Not Yet |
|--|---|---|
| The student clearly explains the relationship between string length and pitch using the required vocabulary words appropriately. | The student explains the relationship between string length and pitch using the required vocabulary words but shows some misunderstanding in their usage. | The student attempts an explanation of the relationship between string length and pitch but does not use the required vocabulary words or shows significant misunderstanding of the lesson. |