# Producing Patterns of Pitch

## Title: Producing Patterns of Pitches

**Estimated Time: 1 Period**

**Core Ideas (GSE Standards):**

**S1P1. Obtain, evaluate, and communicate information to investigate light and sound.**

d. Construct an explanation supported by evidence that vibrating materials can make sound and that sound can make materials vibrate.

**S4P2.**

**Obtain, evaluate & communicate information about how sound is produced & changed & how sound &/or light can be used to communicate.**

a. Plan & carry out an investigation utilizing everyday objects to produce sound & predict the effects of changing the strength or speed of vibrations.

or

**S8P4. Obtain, evaluate, and communicate information to support the claim that electromagnetic (light) waves behave differently than mechanical (sound) waves.**

f. Develop and use a model (e.g., simulations, graphs, illustrations) to predict and describe the relationships between wave properties (e.g., frequency, amplitude, and wavelength) and energy.

| **Science and Engineering Practices:** | **Patterns:** |
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| **Asking Questions and Defining Problems:**<br>Ask questions about what would happen if a variable changed. | Patterns can be used as evidence to support an explanation. |
| **Constructing Explanations and Designing Solutions**<br>Construct an explanation that of observed relationships. | **Cause and Effect Relationships**<br>Cause and effect relationships are routinely identified, tested, and used to explain change. |

**Authentic Scenario**

In this inquiry, students begin by investigating the properties of a piece of colored plastic pipe. After describing and investigating its properties, students go on to explore how key differences in each pipe can be used to lead an investigation of many key properties of sound.

Most of us know that sound is produced by vibrating objects that produce waves. When our vocal chords vibrate, they produce waves that travel through the air. When these waves enter the ear of a listener, they can be interpreted as sounds. When these sounds are produced in meaningful patterns, we may interpret them as warnings, music, intelligible language, or gibberish. While the interpretation of these sounds may now seem automatic to us, it takes a great deal of our brain's time and energy to understand these wave patterns when we are young. Understanding the patterns of a spoken language is very complex and it becomes even more difficult if we try to master the patterns of a language different than our native tongue.

**Guiding Question:**

How can differences in sound be used to produce meaningful and useful patterns?

| 5E Stage | Student Activities<br>How will students engage actively in the three dimensions throughout the lesson? | Teacher Activities<br>How will the teacher facilitate and monitor student learning? |
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| **Engage** | • In this exploration, we will begin by investigating the properties of a piece of colored plastic pipe. After you obtain your pipe, record as many descriptive terms as you can that characterize your pipe.<br>• After completing your observations, pair up with a partner who has a different pipe. Compare and contrast your pipes and list as many similarities and differences as you can muster. | • As needed, encourage students to develop a detailed list of similarities and differences<br>• Emphasize the quality and quantity of descriptive terms that are generated in this short time period. |
| **Explore** | 1. Compare the sounds produced by the pipe by pushing the bottom of it onto the palm of your hand. Describe your observations<br>2. Compare the sounds of your pipe to the sounds of your partners. Describe how they are similar and different.<br>3. Calculate the approximate frequency of sound that your pipe will produce.<br>The velocity of a sound wave (v) is equal to its frequency (f) times its wavelength (R). Rearranging this equation gives frequency=velocity/wavelength. The value for the velocity (speed) of sound is about 350 m/s in air under normal conditions.<br>The wavelength can be calculated by multiplying the tube length (in meters) by 4 (which is the number of pulses needed to make one sound wave inside the tube). | • Encourage students to make careful and detailed observations.<br>• Ask/answer appropriate questions to guide student work as they complete their calculations.<br>• As needed, complete a sample calculation of frequency. |
| **Explain** | **1.** Using your observations and calculations, describe the relationship between the frequency of your sound and the length of your pipe<br>2. Using your newly found musical talents, explain why music can transcend linguistic and cultural barriers. | • Emphasize the quantitative relationship between the frequency, speed, and wavelength of a sound wave ($8^{th}$grade).<br>• As needed, emphasize that understanding the patterns of a spoken language is very complex and difficult. This is also a great opportunity to emphasize the incredible challenge that our ELL learners are undertaking each day in school. |

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| **Elaborate** | As an extension, students can construct their own set of palm pipes or a different musical instrument in an attempt to create rhythmic patterns that can be enjoyed by all cultures. | • Encourage students to explore sound/music on a deeper level. |
| **Evaluate** | **Formative:**<br>• In groups, each student describes the relationship between the frequency of their sound and the length of their pipe.<br>**Summative:**<br>• As a class, groups can present their group composition.<br>• Students complete journal entries documenting observations, data, discussions, and conclusions. | **Formative:**<br>Facilitate ongoing questioning & discussion<br><br>Promote discussion of diagrams/models and explanations.<br><br>**Summative:**<br>Evaluate group presentations<br><br>Evaluate journal entries. |

**Teacher Notes:**

Palm pipes can be purchased from Steve Spangler www.SteveSpangler.com. While 3 sets of eight will cost around 30 dollars, they are virtually indestructible and can be used for science lessons, science night activities, and even for playing happy birthday to your students. As a result, the initial investment is well worth it.

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Music, the art of giving structural forms and rhythmic patterns to sound, provides a design for vibrations that can be created and enjoyed by all cultures. Using palm pipes, we can get a complete scale of notes with differing pitches.

The **Mystery Songs** are: 1) Mary Had a Little Lamb 2) Twinkle Twinkle Little Star 3) London Bridges 4) Ode to Joy

For Middle School:

We can change the pitch by either changing the speed of the sound or the wavelength. Since the speed of sound is difficult to change significantly, we can change wavelength by using pipes of different length. These changes impact the pitch of the wave that is produced by the palm pipe. The longer the wavelengths (pipe), the lower the pitch of the pipe. frequency (pitch) = velocity/wavelength

You can calculate the approximate frequency of sound that any length of pipe will produce. Here's how: The velocity of a sound wave (v) is equal to its frequency (f) times its wavelength (R). Rearranging this equation gives f=v/R. The value for v is about 350 m/s, the speed of sound in value for can be obtained by multiplying the tube length (in meters) by 4 (which is the number of transits a compression-expansion pulse makes inside the tube for one sound wave).