



# STEM KIT

## EDUCATOR GUIDE

\*Amplifier Not Included

## ELECTRIC GUITAR

CREATED FOR BOTH HOME AND SCHOOL



PERFECT FOR  
THE CLASSROOM

DESIGNED BY TEACHERS FOR TEACHERS

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# LESSON OVERVIEW

## Class Information

This workshop integrates history, science, and hands-on craftsmanship to teach students how to build their own electric guitars. It begins with an exploration of the instrument's history, highlighting its evolution and cultural impact, followed by a study of the science behind sound, vibration, and electromagnetic pickups. Students will then engage in hands-on construction of their guitars

## CONCEPTS



**History of Guitars**



**Sound & Vibrations**



**Electromagnetic Pickups**



**Circuitry**



**Engineering**

**101**

**How to Play Guitar Basics**



## LESSON OBJECTIVES

- Students will understand the history of the electric guitar and how it became a prominent musical instrument.
- Students will understand the role of pickups and wiring in creating sound, and they will be able to explain how changes in the electric circuit.
- Students will be able to identify and explain the function of the key parts of a guitar.
- Students will learn how to properly assemble and set up their electric guitar, including installing the strings, adjusting the neck tension, and tuning the guitar for optimal playability.

# EDUCATIONAL STANDARDS

## NGSS - Next Generation Science Standards

- 1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate. [Clarification Statement: Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.]
- HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]

# INTRODUCTION

Hello, everyone! I'm thrilled to have you here for this exciting journey into the world of electric guitars. But this workshop is about more than just crafting an instrument; it's about understanding the heart, soul, and science of music itself. We'll start by exploring the rich history of the electric guitar, from its revolutionary invention in the early 20th century to its iconic role in shaping music across decades and genres. Then, we'll dive into the science behind the sound, learning how vibrations and electromagnetic pickups work together to create the tones we all love. Of course, it's not all theory; we're going to get hands-on! You'll learn how to assemble, shape, and customize your guitar, step by step. And once your masterpiece is complete, we'll wrap things up with an introduction to playing the guitar. So, let's plug in, turn up the volume, and start learning!

## VOCABULARY

**Circuit**-The path that electricity follows in an electric guitar, connecting the pickups, controls, and output jack.

**Vibration** - The back-and-forth movement that creates sound when guitar strings are plucked.

**Sound Wave** - Invisible waves that carry sound through the air to your ears.

**Resonance** - How sound gets louder when it bounces around inside an object, like a guitar body.

**Pickups** - Small devices on an electric guitar that turn string vibrations into electrical signals.

**Amplifier (Amp)** - A machine that makes the electric guitar's sound louder.

**Fretboard** - The flat part of the guitar neck where you press the strings to change the notes.

**Chord** - A group of notes played together to make a nice sound.

**Tuning Pegs** - The small knobs on the guitar head used to tighten or loosen strings to change their pitch.

**Bridge** - The part of the guitar that holds the strings in place and helps transfer vibrations.

# History of the Electric Guitar

## Lets Start with a Question

Who knows what an electric guitar is? Have you ever seen or heard one?

### Every Solution Starts with a Challenge:

In the 1920s, musicians faced a challenge with acoustic guitars, which struggled to produce enough volume to be heard in large ensembles or crowded venues. This limitation led to the invention of the electric guitar as a solution to amplify sound.

## The Rise of the Electric Guitar

George Beauchamp, an innovator in the field, is credited with creating the first commercially successful electric guitar in the early 1930s, nicknamed the "Frying Pan" due to its circular body and long neck. This groundbreaking instrument used electromagnetic pickups to convert string vibrations into electrical signals, which could then be amplified. The "Frying Pan" set the stage for modern electric guitars, paving the way for their evolution in design, sound, and functionality.

After the invention of the "Frying Pan," the electric guitar gradually gained popularity, especially in jazz bands during the 1930s and 1940s. During this time, manufacturers like Gibson introduced new designs, such as the Gibson ES-150, which became one of the first widely used electric guitars. This era also saw advancements in amplifiers, which made the electric guitar a more versatile instrument capable of producing louder and clearer tones.

By the 1950s, the electric guitar had become a cornerstone of popular music, thanks in part to pioneers like Leo Fender, who developed the Fender Telecaster and Stratocaster—two iconic designs still in use today. These models were lighter, more durable, and easier to mass-produce than earlier versions, making them accessible to a broader range of musicians.

## History Continued

The electric guitar's versatility allowed it to shape the emerging rock 'n' roll genre, with artists like Chuck Berry, Elvis Presley, and Buddy Holly using the instrument to create energetic, revolutionary sounds that captivated audiences. This era marked the beginning of the electric guitar's association with cultural movements, symbolizing youth, rebellion, and creativity.

## The Evolution of Styles and Genres

As the electric guitar grew in popularity, it began to influence a wide variety of music genres beyond rock 'n' roll. Blues musicians like B.B. King and Muddy Waters used the instrument to craft emotional, soulful sounds, while jazz guitarists like Wes Montgomery brought a sophisticated, smooth style to their performances. By the 1960s and 1970s, the electric guitar had become central to the rise of psychedelic rock, heavy metal, and funk, with guitarists like Jimi Hendrix, Eric Clapton, and Carlos Santana pushing the instrument's boundaries through innovative playing techniques and effects pedals.

Today, the electric guitar remains an enduring symbol of music innovation, evolving alongside technology and continuing to influence countless genres worldwide. Its journey from a practical amplification solution to a cultural icon showcases its importance in both musical and societal history.

### To understand the electric guitar you have to hear it!

A great kid-friendly song with prominent electric guitar is "Johnny B. Goode" by Chuck Berry. It features a fun, upbeat rock 'n' roll sound and showcases classic electric guitar riffs that are energetic and easy to enjoy. The lyrics are also age-appropriate and tell an inspiring story about a young musician's dreams, making it relatable and exciting for students.

Something more modern? "We Will Rock You" by Queen is another excellent choice. While it's mostly percussion-driven, the electric guitar solo at the end is iconic and can introduce kids to the power and excitement of the instrument.

# Introduction to Sound and Vibration

Sound is made when things vibrate, or move back and forth very quickly. For example, when you pluck a guitar string, it vibrates. These vibrations make the air around the string move in waves. The air particles push and pull on each other, and this movement travels through the air until it reaches your ears. Your ears then turn these moving air particles into the sound you hear.

The faster something vibrates, the higher the pitch of the sound. So, a fast vibration, like a tiny, tight string, will make a high-pitched sound, while a slow vibration, like a big, loose string, makes a low-pitched sound. These vibrations are really important because they are what make the sound waves that we hear. Without vibrations, there would be no sound.

A good way to show this is by using a tuning fork, which is a tool that vibrates when hit. If you tap it on something soft, it will make a sound. The faster it vibrates, the higher the pitch.

## The Role of the Electric Guitar

An electric guitar makes sound when its strings vibrate. These strings are stretched across the body of the guitar, and when a guitarist plucks or strums them, they start to vibrate. The vibration of the strings creates a small sound, but it's not very loud. That's why electric guitars need something called a pickup.

Pickups are special parts of the guitar that catch the vibrations of the strings and turn them into an electrical signal. This signal is then sent to an amplifier, which makes the sound much louder. The vibration of each string is different, and the pickup can tell whether a string is vibrating fast (high pitch) or slow (low pitch). That's how the guitar can play many different notes.

The body of an electric guitar doesn't help make the sound the way an acoustic guitar does. Instead of using the body to make the sound louder, electric guitars use pickups to turn the string vibrations into an electric signal, which is sent to an amplifier to make the sound loud enough to hear.

## Electric Guitar's Pickups

Pickups are the parts of the electric guitar that help turn the vibrations of the strings into electricity. They are small magnets wrapped with wire, and they are located right under the guitar strings. When the strings vibrate, they disturb the magnetic field created by the pickup. This disturbance creates a tiny electrical signal.

Pickups also affect the sound of the guitar in other ways. For example, a pickup near the neck of the guitar (the long part of the guitar with the frets) usually makes a warmer sound. Pickups closer to the bridge (the part near the end of the guitar) make a sharper, brighter sound. By moving your fingers along the guitar neck, you can change the pitch of the strings, and different pickups can give different sounds to those notes.

## Amplification

An amplifier is a machine that makes the sound of the guitar much louder. After the pickups turn the string vibrations into electricity, the amplifier takes this tiny electrical signal and makes it much bigger so that the sound can be heard. The amplifier has two parts: a preamp, which makes the signal a little bigger, and a power amp, which makes the signal loud enough for everyone to hear.

Amplifiers can also change how the guitar sounds. For example, many amplifiers have settings that let the guitarist change the amount of bass (low sounds), midrange (middle sounds), and treble (high sounds). This helps the guitarist make their sound softer or sharper, depending on what they want. Some amplifiers even add effects, like making the sound echo or sound "dirty" with distortion.

In class, you could show students how the volume of the amplifier changes the loudness of the guitar sound. Start with a low volume and slowly turn it up. This shows how the amplifier helps the sound grow louder. You can also explain how an amplifier works with the pickups to make the guitar sound much bigger than it would by itself!

# Understanding the Parts of a Guitar

An electric guitar has several parts that work together to make music. Let's start with the most important ones!

- **The Body:** This is the big, flat part of the guitar that you can hold and strum. It's made of wood, and it helps hold all the other parts of the guitar together.

- **The Neck:** The neck is the long part of the guitar where the strings are stretched over. It has metal strips called frets that help you change the notes when you press on the strings.

- **The Headstock:** At the very top of the guitar neck is the headstock. This is where you find the tuning pegs. The tuning pegs help tighten or loosen the strings, which changes the pitch (how high or low the sound is).

- **The Strings:** There are six strings on a standard electric guitar, and they are made of metal. When you pluck, strum, or pick them, they vibrate to make sound. Your classroom guitars only have 3 strings and can either use the included Nylon strings or Metal Strings.

- **Pickups:** These are the small parts that look like little magnets underneath the strings. When the strings vibrate, the pickups sense it and turn it into an electrical signal to make the sound louder.

- **The Bridge:** The bridge is the part of the guitar where the strings are held at the bottom. It helps the strings stay tight and keeps them in the right position to make the sound correctly.

- **Tuning Pegs:** The small knobs on the headstock used to tune the guitar by tightening or loosening the strings.

# How to Play the 3-String Guitar

A 3-string guitar works similarly to a 6-string guitar, but with fewer strings, which makes it easier to learn and play. Typically, the 3 strings on this guitar are tuned to a specific set of notes. For example, they might be tuned to the notes G, D, and A (these are the names of the strings), but you can also tune them to other notes depending on the style of music you want to play.

## How to Hold the Guitar

- **Sit or Stand Comfortably:** Make sure you're sitting with the guitar resting on your lap, or if you're standing, use a guitar strap to hold the guitar up comfortably.
- **Left Hand (Fretting Hand):** Your left hand will be pressing down on the strings, just like on a regular guitar. The difference is that you only need to worry about the 3 strings. Use your fingers to press the strings on the fretboard, making sure your fingers are on the metal strips (called frets) to change the pitch.
- **Right Hand (Plucking/Strumming Hand):** Your right hand will pluck or strum the strings. You can use your fingers or a guitar pick (a small piece of plastic) to strum across the strings.

## Playing Simple Notes and Chords

- **Plucking a String:** To make a sound, pluck one of the 3 strings with your right hand. You can pluck each string individually to hear a note. The higher up the neck you press your fingers, the higher the note will be.
- **Playing a Simple Chord:** A chord is when you press down multiple strings at once. Even though this guitar only has 3 strings, you can still play a simple chord by pressing your fingers on more than one string at the same time.
- **Experimenting with Sounds:** Try pressing different fingers on the strings to make different sounds. For example, if you press down on the second fret of one string, it will make a higher pitch than when you leave it open (not pressing it at all). This will help you get familiar with how pressing on the strings changes the sound.

## Have Fun and Experiment!

With just 3 strings, you can experiment and have fun. Don't be afraid to try different things and make your own sounds. The beauty of playing guitar is that there are no wrong ways to make music; just try things out and see what sounds you like best!

## ROCKSTAR OVERVIEW

Get ready to rock and roll! In this super fun project, you'll build your own guitar, learn how it makes awesome music with cool science, and discover how sound works through vibrations. You'll also dive into the history of the electric guitar and even learn how to play some basic chords and songs! It's all about creating, experimenting, and having a blast while making your very own music machine!

## WHAT YOU'LL LEARN

- 1. History of the Electric Guitar:** Learn how the electric guitar revolutionized the music world.
- 2. How Sound is Made:** Discover how vibrations create sound and how the guitar's strings produce music.
- 2. Electricity and Amplification:** Learn how an electric guitar uses pickups and an amplifier to make sound louder.
- 4. Creativity and Music:** Experiment with creating your own sounds and simple songs!

## LEARNING QUESTIONS

1. What happens to the sound when you pluck the strings harder or softer?
2. How does pressing the string on different frets change the sound?
3. What role do the pickups play in making the guitar louder?

# SAFETY WARNINGS:

**Please read all safety warnings before use:**

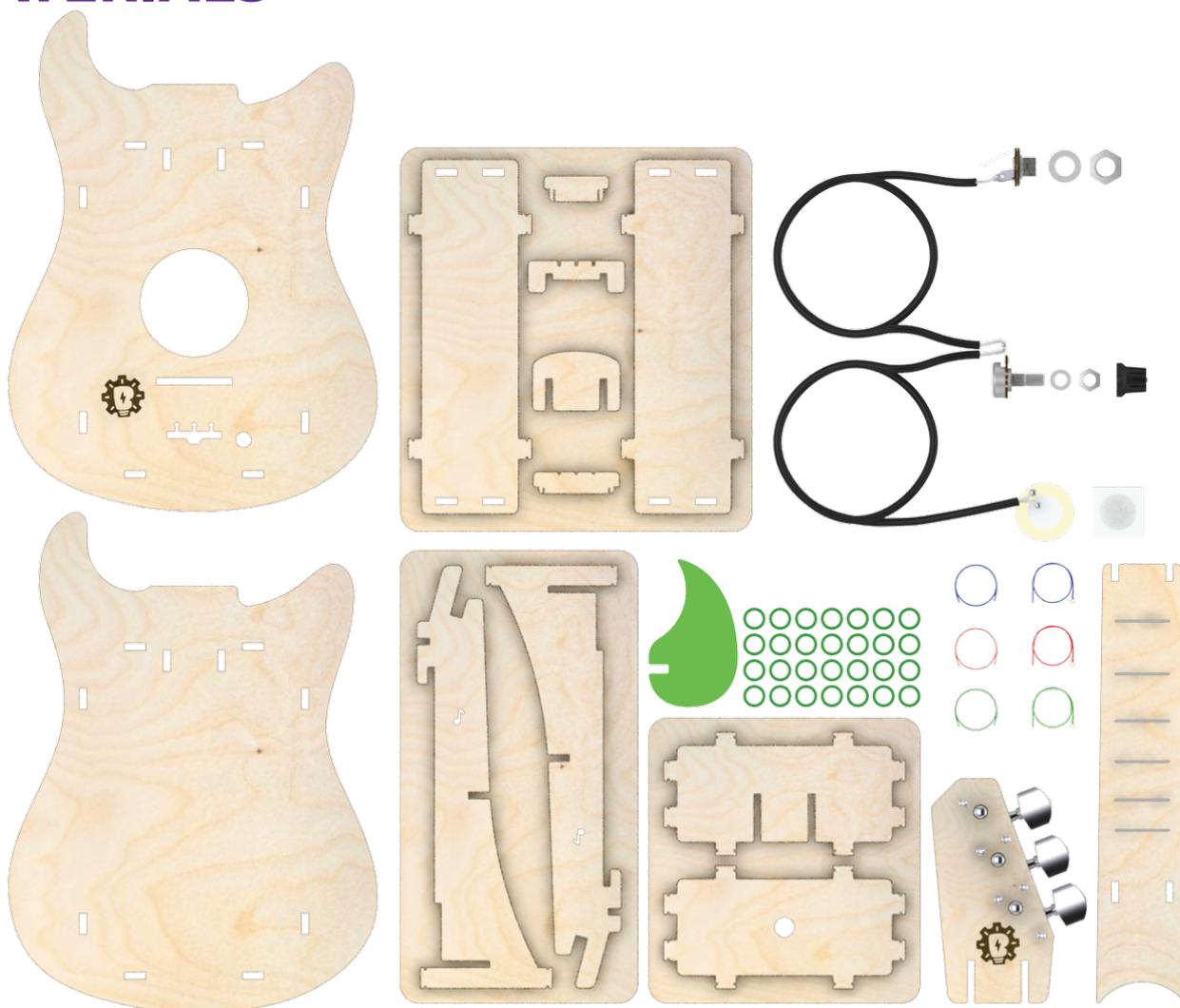
**Choking Hazard:** Small parts not for children under 6 years or any individual who have a tendency to place inedible objects in their mouths.

Eye protection should be worn at all times.

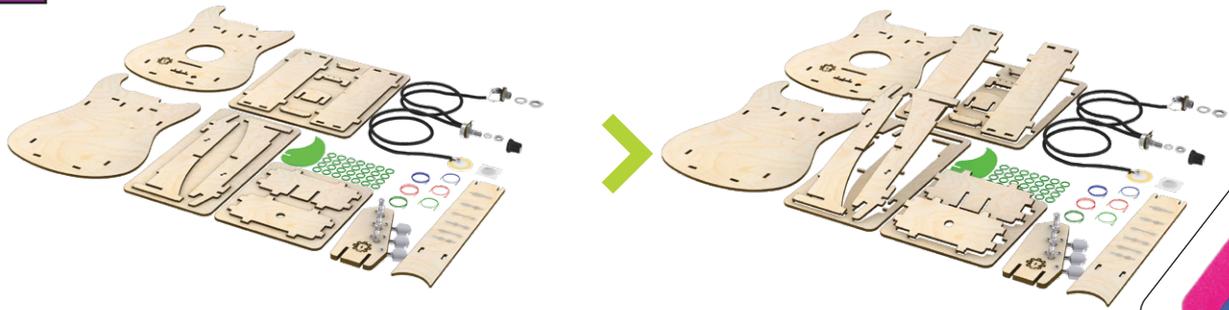
Use and handle metal strings with caution and care.

Adult supervision required.

# MATERIALS



1



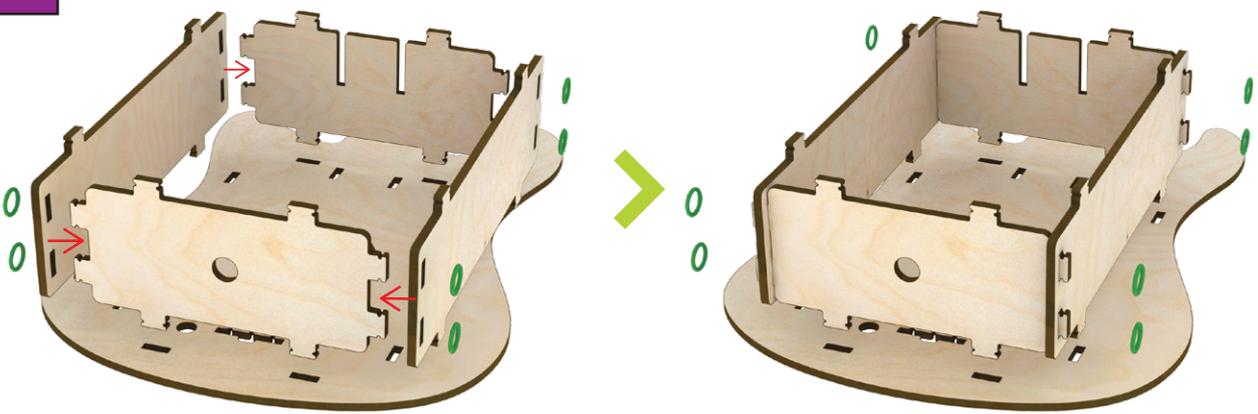
**NOTE:** If any wooden pieces are hard to remove, use a blunt tool to carefully punch them out, and ask an adult for help if needed. Use the sanding stick included in your kit (it looks like a small nail file) to smooth out any rough edges or spots where pieces don't fit together easily. Just find the tight spot and gently sand the edge until it fits just right.

2



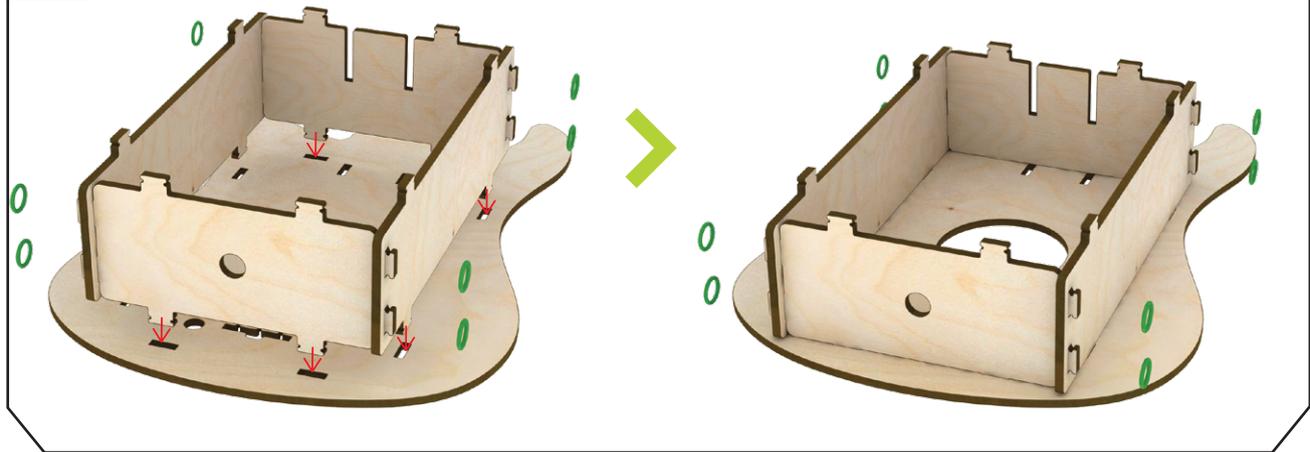
*O-Ring Fasteners are used frequently in this kit. Take the time to look at how they are used*

3

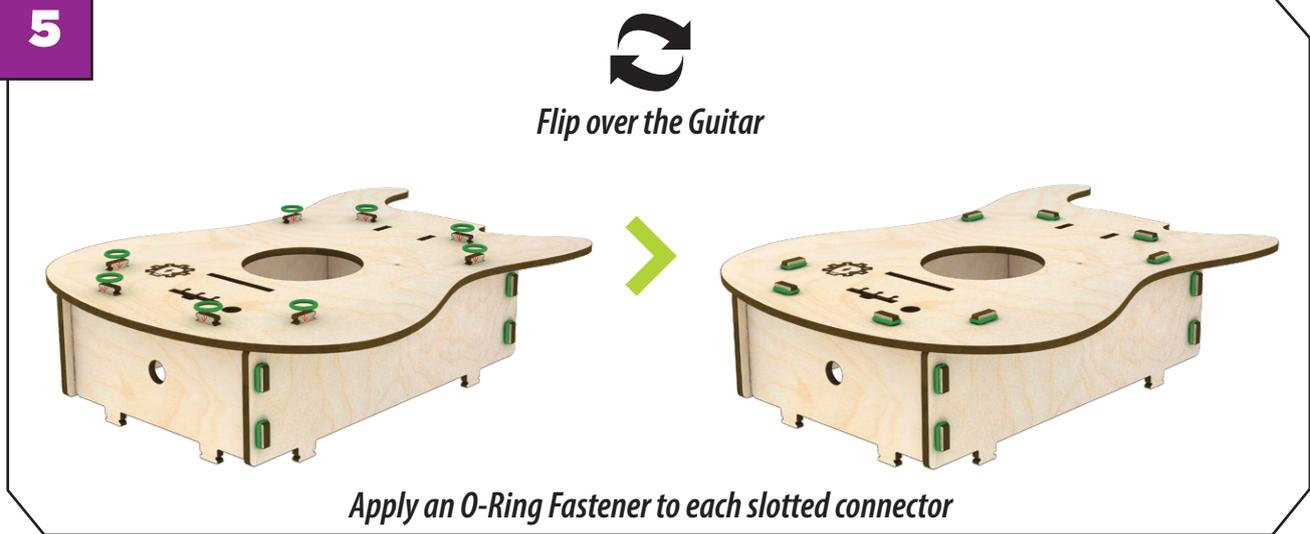


*Apply an O-Ring Fastener to each slotted connector*

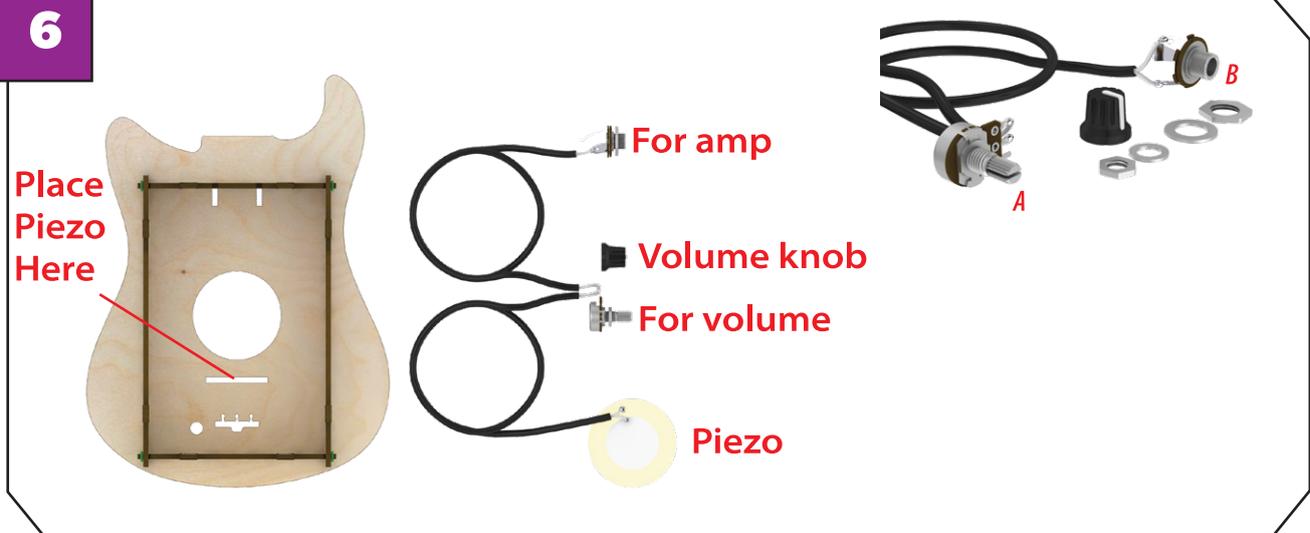
4



5



6



7

*Place the sticky circle on the Piezo*



8

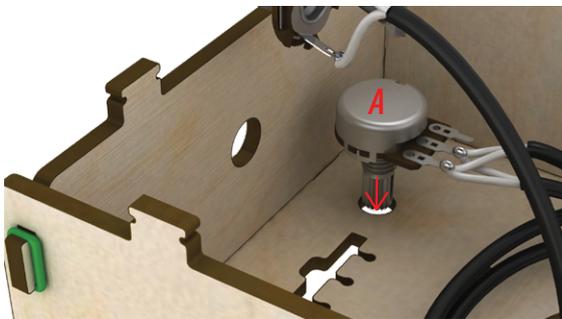


*Remove the Paper*

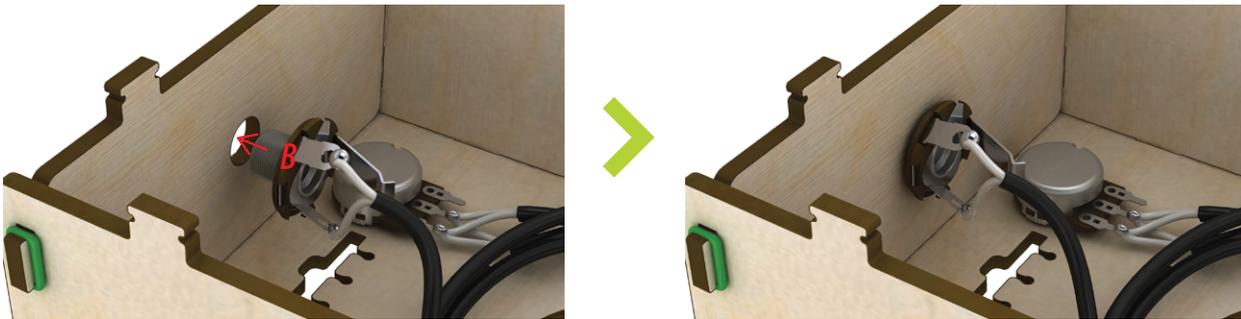


*Place Piezo directly under the bridge cutout*

9



10

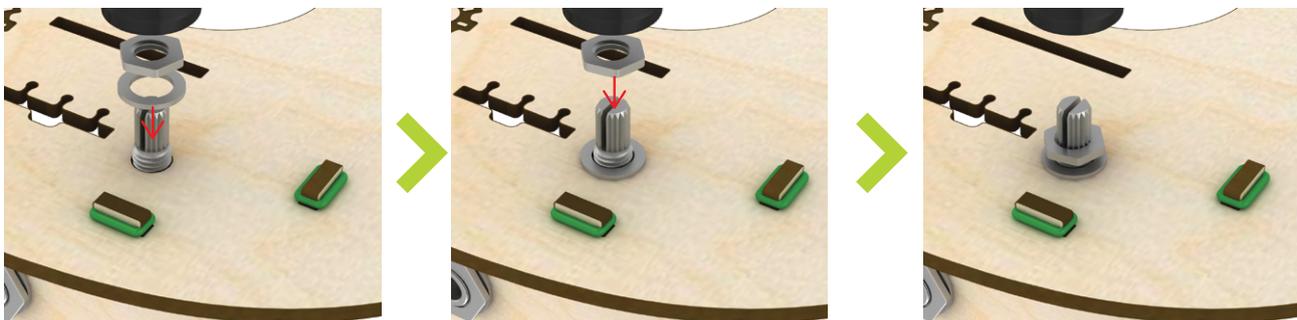


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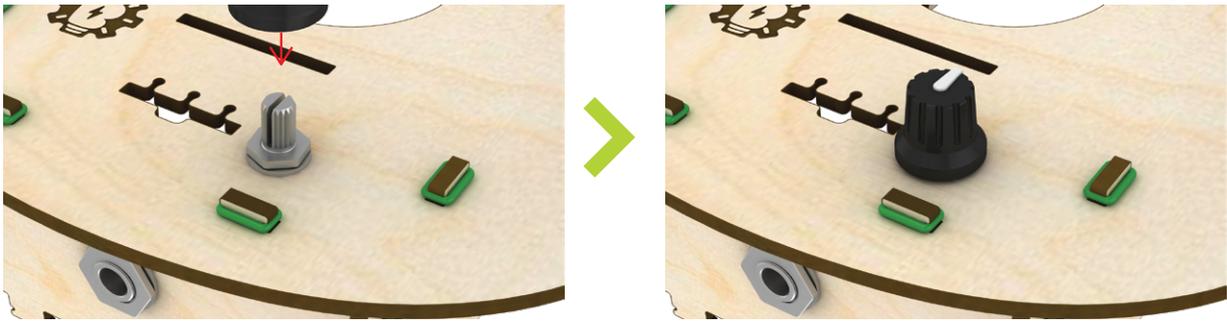
*Screw & Tighten  
Nut to finish*

12

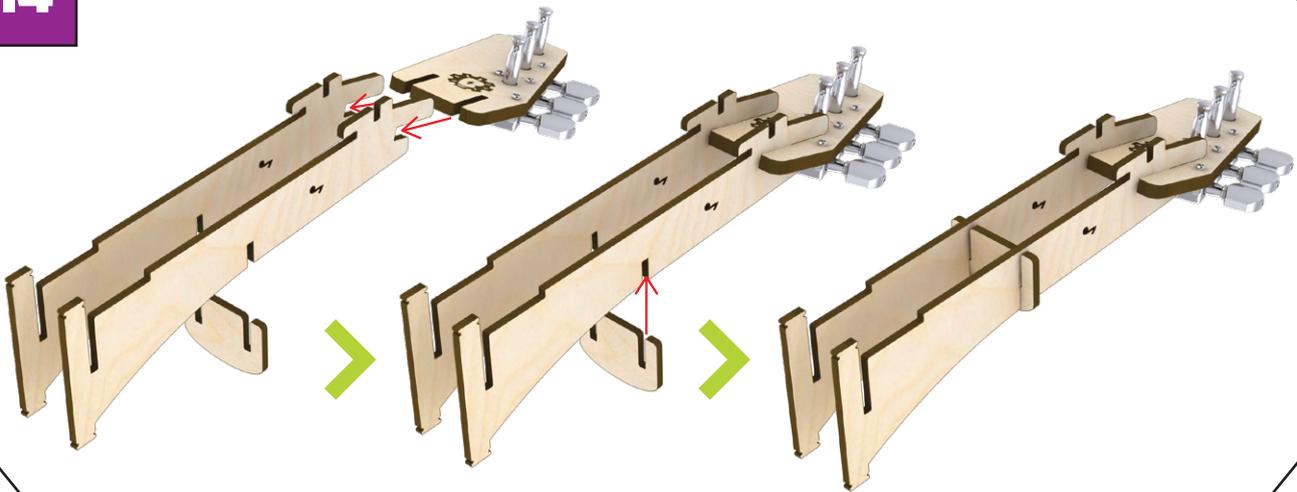


*Screw & Tighten  
Nut to finish*

13



14



15



16



*Apply an O-Ring Fastener to each slotted connector*

17

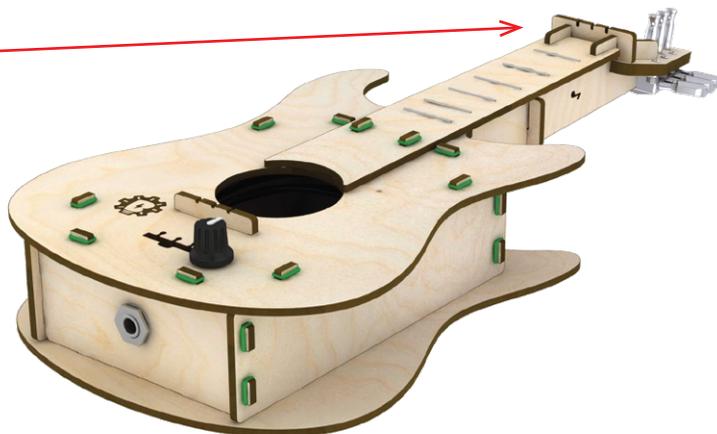
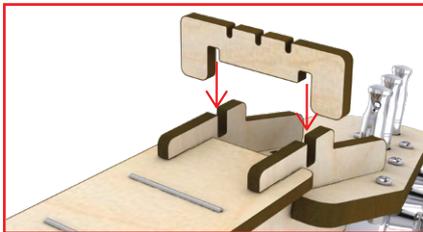


*Flip over the Guitar*



*Apply an O-Ring Fastener to each slotted connector*

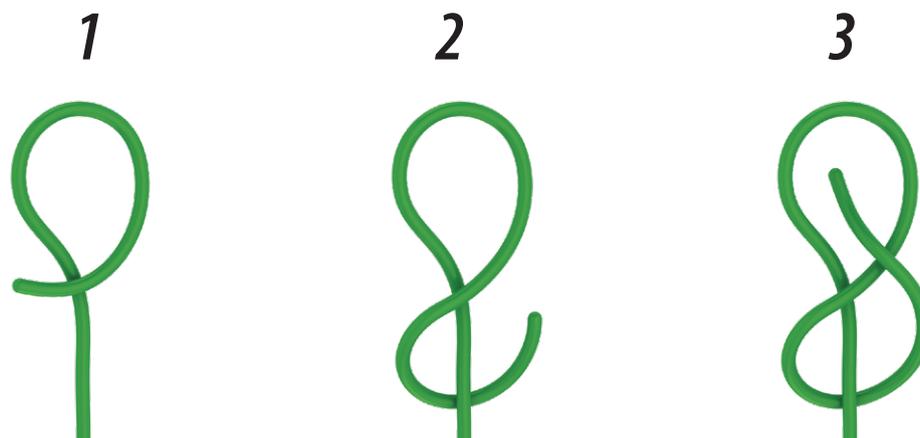
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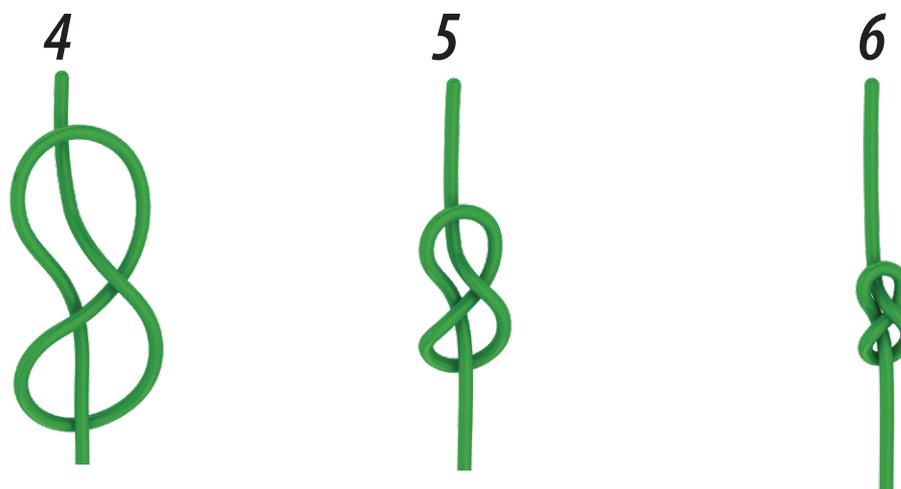
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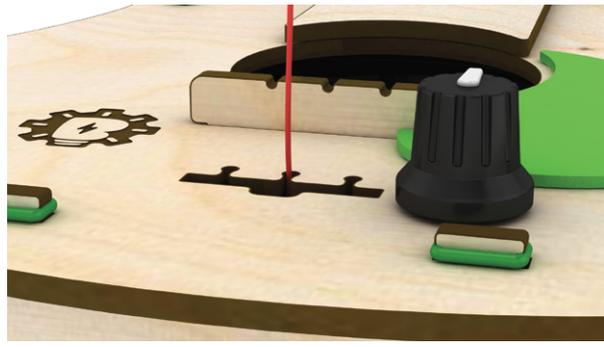
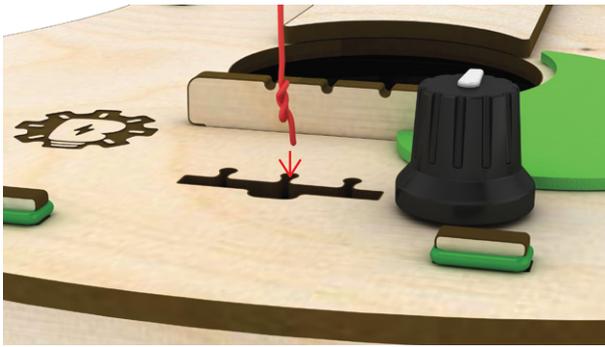


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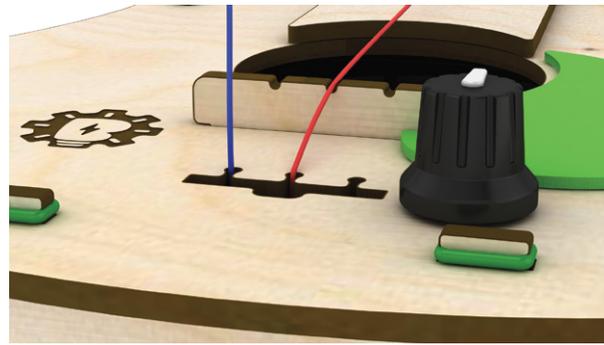
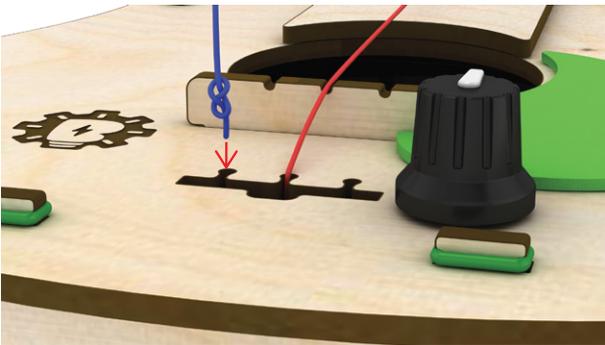


REPEAT STEPS 20 - 21 FOR ALL THREE COLORED NYLON STRINGS

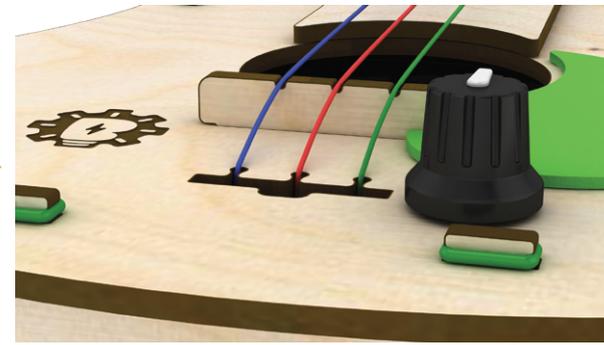
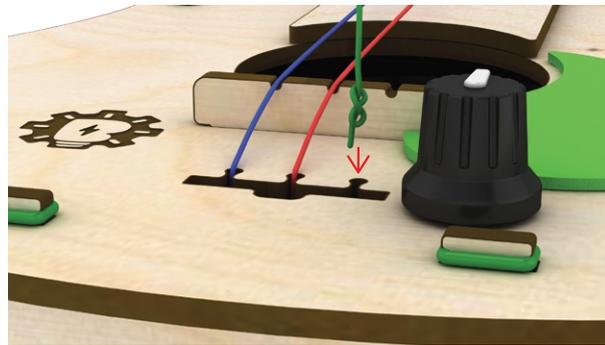
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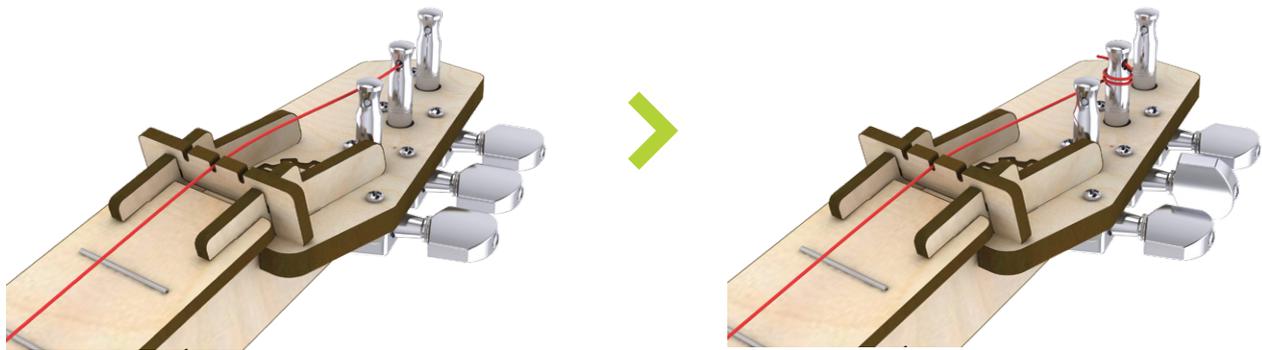
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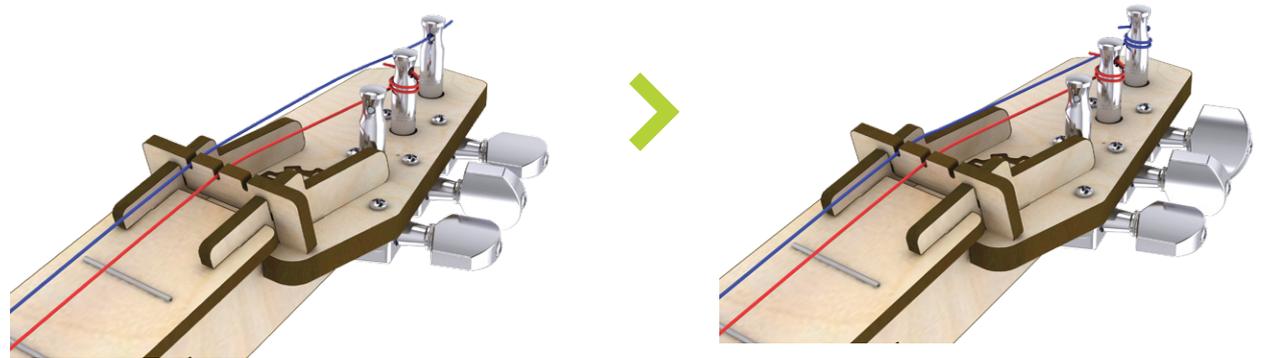
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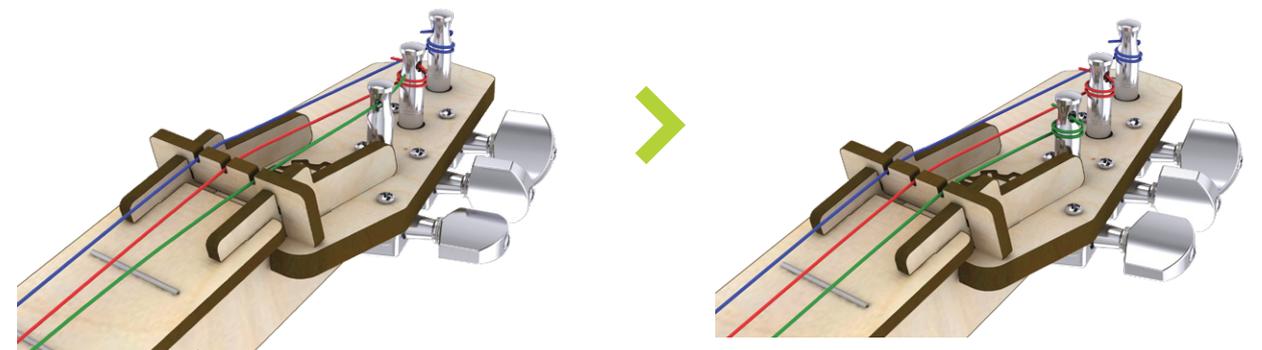
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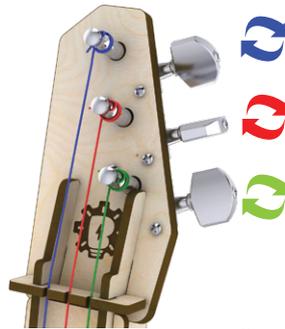
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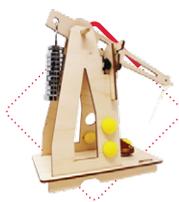
**Tune your Guitar**

**We recommend using Pano Tuner**



**Congrats Music Engineers!  
Now you're ready to ROCK!**

*If you enjoyed this STEM Kit, check out some of our other Kits!*



TREBUCHET



SEED SCIENCE



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# GUITAR LESSON ACTIVITIES

## Introduction to Sound

Sound is created by vibrations. When you pluck the strings of a guitar, they vibrate and produce sound. In this activity, you will explore how changing the strings, their length, and how you play them can change the sound they make!

### Activity 1: Observing Vibrations

Step 1. Pluck one string on the guitar and watch it closely.

Step 2. Place your finger gently on the string after plucking.

**Question 1:** What do you see happening to the string after you pluck it?

**Question 2:** What happens to the sound when you stop the vibration by touching the string?

### Activity 2: Exploring Pitch

Step 1. Pluck each of the three strings on the guitar.

Step 2. Compare the sounds of the strings.

**Question 1:** Which string makes the highest-pitched sound?

**Question 2:** Which string makes the lowest-pitched sound?

**Question 3:** Why do you think the strings produce different sounds?

### Activity 3: Changing the Length of the String

Step 1. Press down on one string near the middle of the guitar's neck and pluck it.

Step 2. Now, press down closer to the body of the guitar and pluck the same string again.

**Question 1:** What happens to the sound when the string is shorter vs longer?

**Question 2:** Why do you think the strings produce different sounds?

# WORKSHEET ( BEGINNER )

## INSTRUCTIONS:

Label the Electric Guitar

Below is a diagram of an electric guitar. Can you label all the parts?

Use the word bank to help you!

Word Bank:

Neck/Fretboard

Strings

Headstock

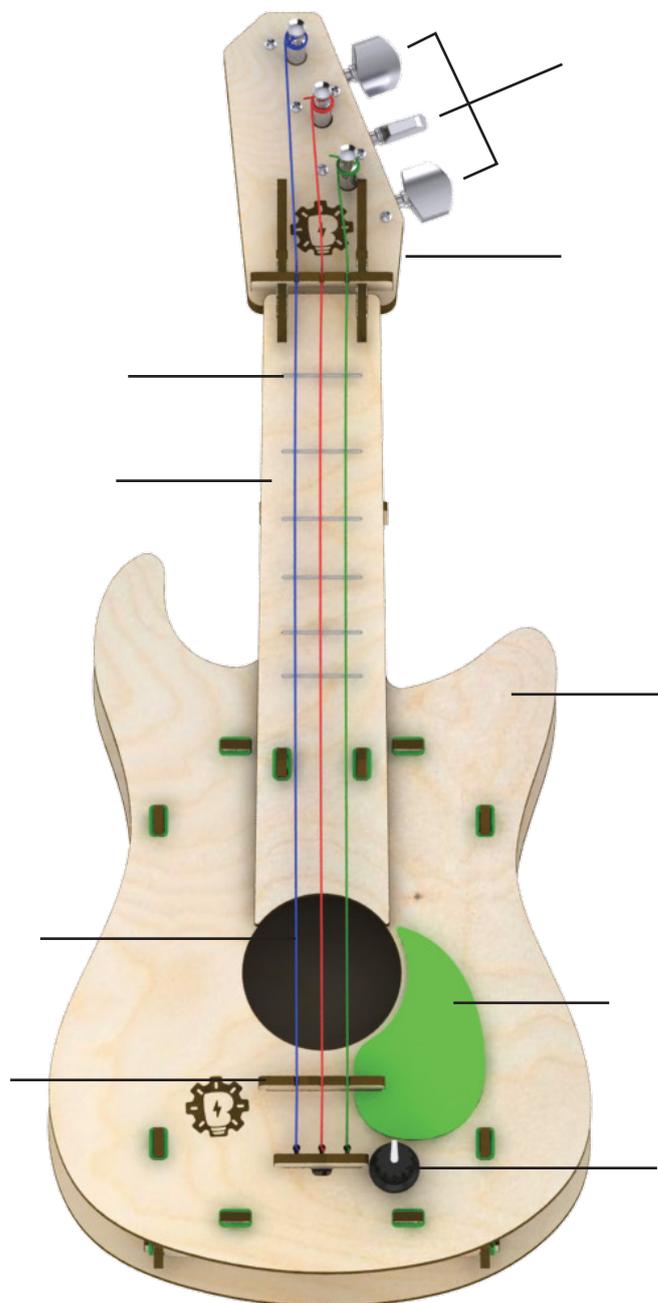
Body

Bridge

Frets

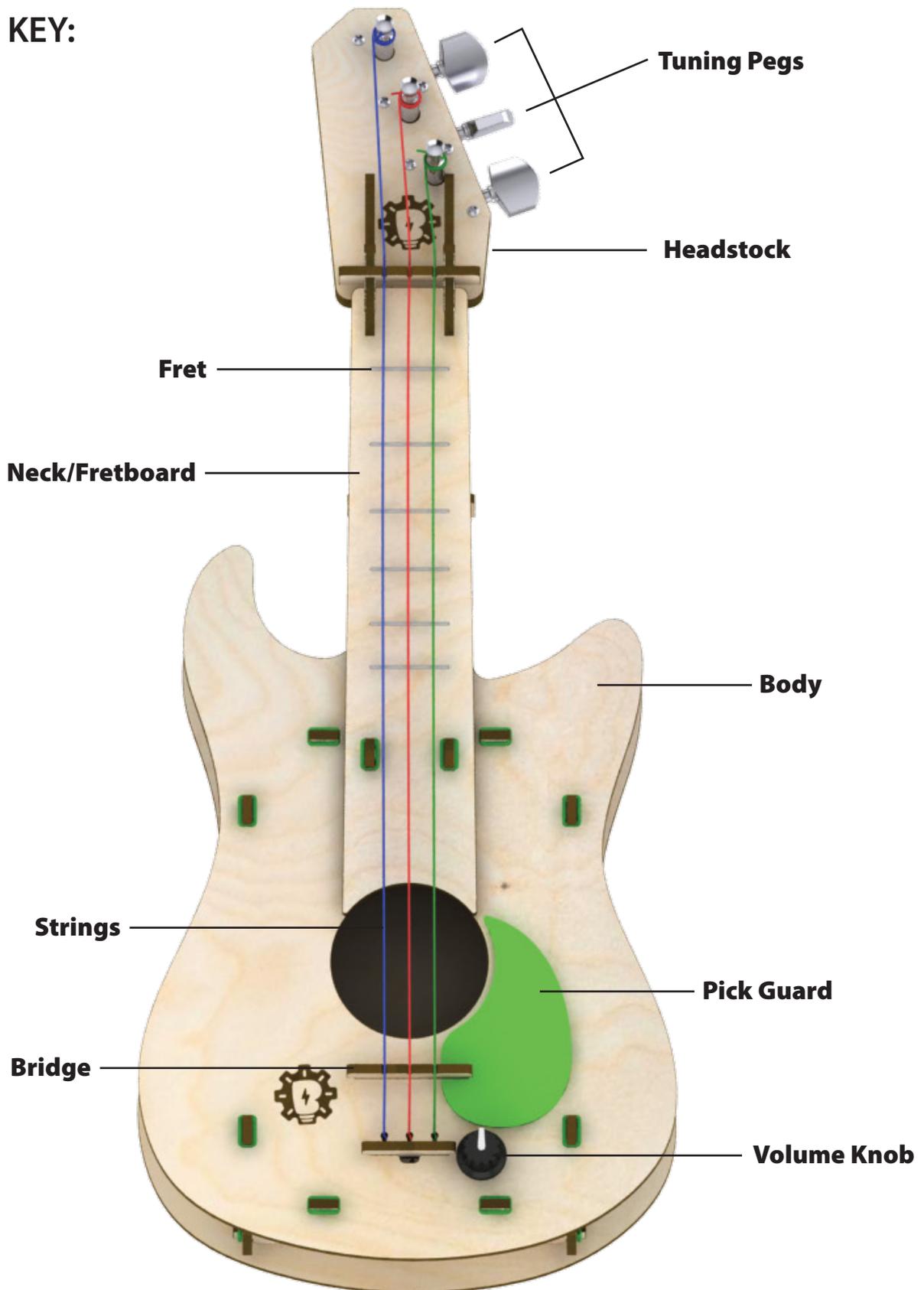
Tuning Pegs

Pick Guard



# WORKSHEET ( BEGINNER )

ANSWER KEY:



# WORKSHEET ( ADVANCED )

Name(s): \_\_\_\_\_

Date: \_\_\_\_\_

## INSTRUCTIONS:

Answer the following questions about how the electric guitar works. Write your answers in the spaces provided.

What happens when you strum the strings of the guitar?

*Hint: Think about how the sound is made!*

---

---

What part of the guitar turns the vibrations from the strings into sound that you can hear?

---

---

## Explore Sound and Vibration

Let's explore how sound and vibration work with the guitar! Circle the correct answer for each question.

When a string vibrates faster, the sound will be:

- a) Lower
- b) Higher

What happens if you tighten a guitar string?

- a) The sound gets lower
- b) The sound gets higher
- c) The sound stays the same