

HANDOUT 8B-2: SETTING UP YOUR GUITAR TO PLAY A FULL OCTAVE

An *octave* is a series of eight notes whose frequencies vary in such a way that the lowest note of the octave has a frequency that one half as much as the highest note of the octave. Here is a chart of all of the notes on a piano and their frequencies:

Note	Hz	Note	Hz	Note	Hz	Note	Hz	Note	Hz	Note
C1	32.7	C2	65.4	C3	130.8	C4	261.6	C5	523.3	C6
C#1	34.6	C#2	69.3	C#3	138.6	C#4	277.2	C#5	554.4	C#6
D1	36.7	D2	73.4	D3	146.8	D4	293.7	D5	587.3	D6
D#1	38.9	D#2	77.8	D#3	155.6	D#4	311.1	D#5	622.3	D#6
E1	41.2	E2	82.4	E3	164.8	E4	329.6	E5	659.3	E6
F1	43.7	F2	87.3	F3	174.6	F4	349.2	F5	698.5	F6
F#1	46.2	F#2	92.5	F#3	185.0	F#4	370.0	F#5	740.0	F#6
G1	49.0	G2	98.0	G3	196.0	G4	392.0	G5	784.0	G6
G#1	51.9	G#2	103.8	G#3	207.7	G#4	415.3	G#5	830.6	G#6
A1	55.0	A2	110.0	A3	220.0	A4	440.0	A5	880.0	A6
A#1	58.3	A#2	116.5	A#3	233.1	A#4	466.2	A#5	932.3	A#6
B1	61.7	B2	123.5	B3	246.9	B4	493.9	B5	987.8	B6

Notes and Frequencies Chart

The Major Scale

Key	C	C#	D	D#	E	F	F#	G	G#	A	A#	B	C
C	1		2		3	4		5		6		7	1
D		7	1		2		3	4		5		6	
E		6		7	1		2		3	4		5	
F	5		6		7	1		2		3	4		5
G	4		5		6		7	1		2		3	4
A		3	4		5		6		7	1		2	
B		2		3	4		5		6		7	1	

On a guitar, the frets mark where to place your fingers so that as you move them down the neck, you can play a full octave of notes on one string. On a real guitar, the finger is placed between two frets, but for the purposes of this project guitar, you can just mark the frets where you actually need to place your finger.

To set up your guitar to be able to play an octave, do the following:

1. Get a tuner app (such as the Pano Tuner app) to know what note you're playing and its frequency.

2. Pluck the open string on your guitar. Determine what note it is played and tune the string so that it will play the starting note of any major scale keys shown in the major scale chart. This will tell you what major scale octave your string will play after you mark the frets.
3. Once you know your starting note (denoted by a 1 on the major scale chart), determine what frequencies you will need to locate for notes 2–8 (the rest of the octave).
4. Move your finger along the string, pressing on the string and plucking the string until you can locate the frequency for note 2 on your octave. When you find it, mark it on your guitar.
5. Repeat step 4 for each remaining note until you have seven frets marked (for notes 2–8). The open string is note 1.

HANDOUT 8B-I: GUITAR DESIGN PROJECT EXPECTATIONS AND RUBRICS

PROBLEM

- To build a guitar using recycled, reused materials that meets the listed constraints
- To present the guitar to the class and play an octave and a song using the guitar



DUE DATES

- Presentation of guitar in class:

- Final report: _____

CONSTRAINTS

- No parts or pieces can be from a real guitar.
- The guitar must be constructed out of recycled and re-purposed materials.
- The guitar must be clearly audible across the classroom.
- The guitar must be tunable (i.e., have a string or strings that can be tightened and loosened).
- The guitar must have frets marked so that a full octave can be played.
- The guitar must contain a resonating cavity.
- The guitar must be robust enough to be played multiple times.

SAFETY PRECAUTION

Wear personal protective equipment (eye protection) during the setup, hands-on, and takedown segments of the activity.

PROCESS

This project will be completed outside of class time. At the beginning of the project, it is expected that time will be spent brainstorming and trying out different ideas before finalizing and implementing a plan. *Enter all aspects of the design process in your engineering notebook, using the format at the back of the notebook.*

Make special note of the following aspects of your guitar design:

1. The design process you followed to get from the initial problem to the final solution (i.e., your brainstorming and sketches of initial ideas → your analysis of materials to choose the best ones → your building, testing, and redesign → the marking of the frets for playing an octave → the final result)
2. The analysis of the guitar's parts, pieces, and aspects to optimize the guitar to meet the constraints
3. How the various parts and pieces of the guitar were put together as a system to make the final product

If you need help on any aspect of this project, don't hesitate to ask the teacher. If you are lacking materials, see the teacher. If you need help with the tuning portion or marking the frets to play an octave, bring the guitar in to school before the day it is due so that the teacher can help you.

PRESENTATION

To present your guitar to the class, you will be asked to play through the entire octave correctly and then to play a simple song. Some examples of simple songs are "Twinkle, Twinkle, Little Star," "Happy Birthday," and "Joy to the World"; however, you can choose another song, as long it uses most of the octave's notes and you get the teacher's approval ahead of time.

GRADING

The grading for this project uses multiple rubrics. You will be graded on the final guitar, on your group's presentation, on your engineering design notebook (individual grade), and on your final report.

FINAL REPORT

A final report (one per group) should be typed and submitted and should include the following items:

- **Heading:** Title, date, group members' names
- **Materials:** A list of materials that you used to build your guitar
- **Final Design Sketch:** A sketch of the final design of the guitar. It can be hand-drawn on the typed report, created by computer, or drawn and then scanned and inserted.
- **Build Process:** An explanation of the build process your group followed to build the guitar

- **Pictures:** Pictures of the guitar during the build process (can be jpegs inserted into the final report), with annotations for each picture. The pictures can be included within the “Build Process” section of the report separate after that section.
- **Analysis:** A summary of analysis that was done on parts and pieces of the guitar to gather data to make more informed design choices
- **Reflection:** A reflection about the project, including a discussion of how and why your final completed guitar differed from your original, brainstormed design. Also, within your reflection, include a discussion of difficulties your group encountered in the design and build process and how the group was able to overcome those difficulties.
- **Changes:** A discussion of changes your group would make if you had to build another guitar or to redo this project and why your group would want to make those specific changes.