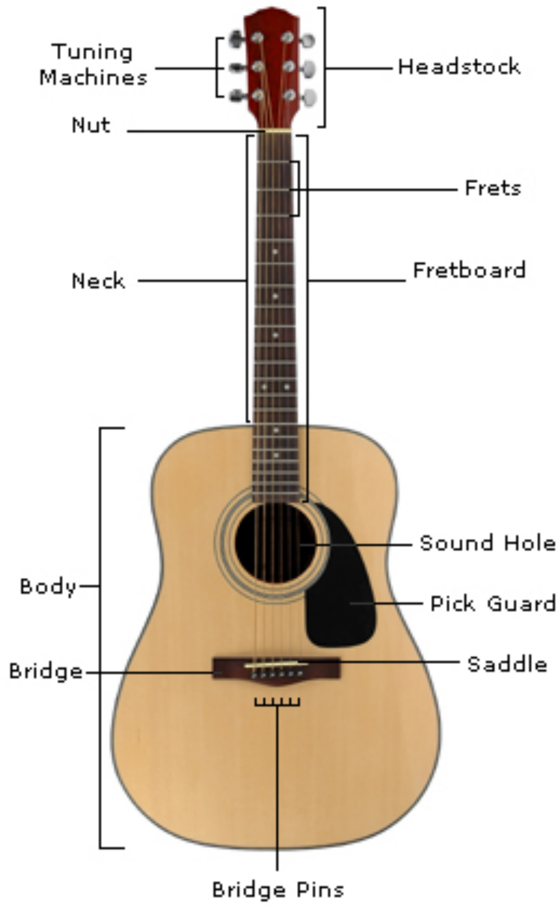
Algebra II String Instrument Lab

USEFUL REFERENCES

Graphing Website: www.demos.com

Anatomy of a Guitar



Fraction to Decimal Conversion Chart

Fraction	Decimal
1/8	0.125
2/8	0.25
3/8	0.375
4/8	0.5
5/8	0.625
6/8	0.75
7/8	0.875

Part 1

1. Using the guitar, ukulele, or bass on loan from the music class or your home, measure the distance from the bridge to each of the first 12 frets. Please note that fret 0 is also called the 'nut' which you can see in the diagram on the previous page. Be as accurate as possible, measuring to the nearest eighth of an inch and using the conversion table on the previous page. Enter the data into the chart table immediately below. (10 minutes)

Fret	**Nut (0)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Distance													

2. Watch the following video, 'Desmos Table Instruction', beginning at the 27 second mark: https://www.youtube.com/watch?v=L5spXQ7YoEY (2 minutes)

3. Head to www.desmos.com and enter your data into a table so you can plot data about your string instrument. (7 minutes)

4. *What* kind of a function does this appear to be? *How* can you tell? Discuss with your lab group for two minutes before writing or diagramming your response in the space below. Alternatively, feel free to record your observations in a 1-2 minute audio recording. (5 minutes)

5. Hopefully you notice something interesting about the relationship between fret number and the length from the bridge to each fret. Pause at this point for a quick class discussion on *exponential functions*, *logarithmic functions*, *rates*, and *mathematical models*. (10 minutes)

6. Next, with your lab partners, experiment with finding a mathematical model that accurately describes your raw data from step 1 plotted in 'Desmos'. To do this, create a mathematical model (i.e. equation predicting the fret versus fret length pattern) on 'Desmos' on the same graph as your raw data from step 1. (5 minutes)

   Your team's most accurate mathematical model:

7. Print out a screenshot of your mathematical model and instrument data as plotted on ‘Desmos’. (5 minutes)

8. Take a moment to write down seven to eight adjectives describing your work in ***Part 1***. Drawings are encouraged too! (3 minutes)

Part 2

1. Now we will be shifting our attention away from the fretting pattern and towards sound. Take a few minutes to play around with the tuning forks available in class. Notice that the 'pitch' of each sound is related to the number of waves passing by your each in one second. This unit of waves per second is called frequency and is measured in Hertz. (5 minutes)

2. Notice how each tuning fork has a number on it. This number corresponds to the frequency of each note.

3. Now we will graphing this data in 'Desmos'. Start a new table for 'Steps away from E' and frequency. Enter the data immediately below and then graph it. Notice we do not have a value of 1, 3, 6, 8, or 10. Those who play music, what do you know about scales that can explain this omission? (5 minutes)

Note	**E**	**F#**	**G#**	**A**	**B**	**C#**	**D#**	**E**
Steps away from E	0	2	4	5	7	9	11	12
Frequency (Hz)	329.63	369.99	415.30	440	493.88	554.37	622.25	659.26

4. *What* kind of a function does this appear to be? *How* can you tell? Discuss with your lab group for two minutes before writing or diagramming your response in the space below. Alternatively, feel free to record your observations in a 1-2 minute audio recording. (5 minutes)

5. With your lab partners, experiment with finding a second mathematical model that accurately describes your raw data as plotted in 'Desmos'. To do this, create a second mathematical model predicting 'Steps Away from E' versus frequency. Use 'Desmos' once more to do this. (5 minutes)

   Your team's most accurate mathematical model:

6. Print out a screenshot of your second mathematical model and frequency data as plotted online. (5 minutes)

7. Take a moment to write down seven to eight adjectives describing your work in ***Part 2***. Drawings are encouraged too! (3 minutes)

8. Compare and contrast the bases (i.e. 'b' values) from your mathematical models in ***Part 1*** and ***Part 2***. What do their values tell about the patterns we see in fretting and pitch? (2 minutes)

Part 3 (*Optional for home*)

1. What is the specific, mathematical relationship between the frequencies of the open E and the 12th fret E?

2. Why is it called an *octave* (from 'octa'; Greek for 'eight') if it is twelve frets higher?

3. Harmonics are where the string is reduced to fraction of the original length (L_0). At what fret is the length equal to ½ L_0, 2/3 L_0, and ¾ L_0? What notes correspond to these frets?

4. What are the frequencies of these corresponding notes?

5. What are the mathematical underpinnings of consonance and dissonance? Consider watching this video: 'A Visual Representation of Consonance and Dissonance' https://www.youtube.com/watch?v=tafPfbm4jug

6. Why do the chords E, A, and B work so well together? These notes are really common in blues and rock and roll.

7. Watch a quick video on harmonics and harmonic distortion: https://www.youtube.com/watch?v=FzeZbJceKZE