Physics 100 Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Musical Instrument Project and Contest

Goal: Create a one-octave, electric string instrument that can be played steadily, accurately, and with audible volume when unplugged.

Maximum Group Size: 3 (Group members who do not contribute sufficiently may be penalized)

Provided Materials:

* Pine board (approximate dimensions 2’ x 1.5” x 0.75”)
* Used electric guitar strings
* Materials for a magnetic pickup (or a pre-made pickup)
* Laser cut pegs and peg box
* Monofilament Fishing line, string
* Hot glue
* Drywall screws
* Cardboard available in recycling bin

Restrictions:

* Energy source: human power transferred to mechanical motion and mechanical waves (no electricity, chemical energy, nuclear fusion, etc.)
* Allowed materials: 1) Used electric instrument strings and 2) anything else that is not used for its intended purpose (other than basic building supplies – e.g. screws can be used to screw things together).

Fret Placement -- You can place your frets (or fret markings) by ear, or you can calculate their placement.

* When the frequency of a sound is doubled, its pitch goes up by one *octave*.
* On a piano, if you play a note and then “walk” up the keyboard playing every note, you will take twelve steps on your way to the next octave. Each of these “steps” is called a *half step.*
* If the first note that you play has a frequency of 440hz, the next half step will have a frequency of 440\*2(1/12). The half step after that will have a frequency of 440\*2(2/12). The next one has f=440\*2(3/12). And so on. Twelve half steps equals an octave, and 440\*2(12/12) = 880. Advancing one octave doubles frequency.
* If you start at a particular frequency, f, the frequency of a note **n** half steps above **f** will be **f\*2(n/12).**

**Recording and turning-in Instrument project files**

1. Tuning
   1. Option 1: using a tuner (iphone or other), tighten or loosen your peg until your pitch reaches the pitch you want.
   2. Option 2: Open Audacity or some online tone generator, and create a sound with the pitch you want. Adjust your string tension until your instrument sounds like the generated tone.
   3. Checking your tuning: Use a tuner. Alternatively, play your open string record it with Audacity. Select the sound waves for that note and click “change pitch” under the *effects* menu. You will see the current pitch. Do not actually change the pitch in audacity.
2. Make sure that your files are loud enough. Here’s how:
   1. In Audacity, the amplitude of your sounds should be at least 0.5 on the graph.
   2. If your sounds are not loud enough, select the whole file and choose “amplify” under the “effects” menu.
   3. Do not amplify beyond an amplitude of about 0.5.
3. How to create a .WAV file:
   1. Record a track in Audacity
   2. Save the file in your folder (in case something doesn’t work right, and you need to do it again)
   3. Under the “file” menu, choose “export.”
   4. Enter a file name with at least one of your names, a song description, and the key (e.g. “Bubba Song in C sharp major”
   5. Click on the the “save type as” button and select WAV. You don’t need to enter any of the information regarding artist, track, etc.
4. **How to turn in your project: Email your project to Mr. Stapleton as follows:**
   1. List all of the group members’ names in the body of the message
   2. Type the name of your tonic and provide its frequency
   3. Attach all of the files to one e-mail
   4. Cc your fellow group members, so that they know you turned this in – and so that they have copies.

**Project Grading:**

* Requirements for 80%
  1. Record a major scale in Audacity, and export it as a WAV file.
  2. Record a major key **song** in Audacity, and export it as a WAV file.
  3. Write down your “tonic” (the first note in your scale) and its frequency.
* Requirements for 90%
  1. Record an A major scale in Audacity, and export it as a WAV file.
  2. Record a major key song, in Audacity, and export it as a WAV file.
  3. Write down your “tonic” (the first note in your scale) and its frequency.
* Requirements for an 100%
  1. Record an A **major** scale in Audacity, and export it as a WAV file.
  2. Record an A **minor** scale in Audacity, and export it as a WAV file.
  3. Record a **major** key **song** in Audacity, and export it as a WAV file.
  4. Record a **minor** key **song** in Audacity, and export it as a WAV file.
  5. Record a chromatic scale of all 13 semitones in an octave, and export that as a WAV file.
  6. Write down your “tonic” (the first note in your scale) and its frequency.

**About the Contest:**

The competition will have three parts. Teams will receive a rank score for each of the three parts of the competition. The team with the highest overall ranking (lowest number, when ranks are added together) is the overall winner.

1. **“Unplugged” volume contest. Play the loudest note without electronic amplification.** 
   1. Volume in decibels will be measured by a sound meter held a distance of at least 20cm from every part of the instrument.
   2. The tone must be created by a plucked or struck string.
2. **Use your instrument to determine some object’s speeds, using the Doppler Effect.** 
   1. You will hear the sound of some vehicles passing by (directly toward you and then directly away). You may use your instrument to determine the change in pitch. Then use that change in pitch to calculate the speed of the object. **The change in pitch will be no more than one octave, and will take place in an A scale.**
   2. Your score will be sum of your errors in velocity. The smallest total error wins.
3. **“Name that tune.”** 
   1. Teams will have 120 seconds to play as many identifiable songs as possible. Each team member will play for 60 seconds while the other team member sits out of sight.
   2. Songs will be selected randomly from a song list that will be provided ahead of time.
   3. Minus 2 points for each wrong answer. Plus 2 for each right answer.