Electronic Keyboard Activity Handout

TEAK
1) Check to ensure that the power clips are plugged in to the correct socket. The chord with the mark on it should be connected to the green board.
2) Snap the battery clips onto two 9V batteries that should be included with kit
3) Plug in the supplied speaker into the holes labeled SP+ and SP-
4) Plug a 33kΩ resistor in between pins F1 and F2A and Also a 1.2kΩ resistor between G1 and G2. This will provide a set-up where you can test to make sure everything is working.

Press a Key to determine if everything is connected the right way. Do you hear sound? _____ (Y/N)

Nodes F1, F2A, F_GND, G1, and G2 are the points where you can control the signal that gets sent to the speaker. Let’s get an Idea of how we can design the keyboard’s tone.

Putting a resistor between G1 and G2 allows you to control the gain of the circuit. Again, gain is the amount by which a signal is amplified. Any amplifier has a limit to how high it can boost a signal as nothing can have infinite energy or infinite power. The signal eventually makes its way to the speaker, so the bigger the signal the louder the sound. Hence changing the gain directly affects the volume of the keyboard. Without explaining the theory a relationship results from the combination of the added resistance between G1 and G2, the surface mount component R2 and IC3. Together they form what is called an inverting op-amp configuration with:

\[
Gain = \frac{R_{G1-G2}}{R_2} = \frac{R_{G1-G2}}{1,000,000}
\]

To increase volume, one must increase gain which means that one has to increase the resistance between G1 and G2.
Let's test this to make sure the circuit is functioning as it should.

1) One person play a note while a partner measures the volume from 1 foot away with the dB meter. Record the tested dB reading with \( R_{G1-G2} = 1.2 \text{k\Omega} \)
   a. \( \text{dB} = \) _____

2) Take out the 1.2kΩ resistor and put in a 4.7kΩ resistor. Note this should make the keyboard louder. One person play the same note while a partner measures the volume from one foot away with the dB meter. Record the dB reading.
   a. \( \text{dB} = \) _____

3) Record observations. Was the sound in fact louder?
   a. __________________________

4) What happens when this resistance is made as big as possible?
   a. The largest resistance you can have in a circuit is actually having no path at all to go between two points. This is called an open-circuit, or infinite resistance.
   b. Take out the resistor entirely and test the volume
      i. \( \text{dB} = \) _____
   c. Note that for an infinite gain you measure a finite volume. Finite means that it is measurable. This is because there is only finite energy in any system, be it an electrical/mechanical/optical/biological/solar system. So when you try to apply infinite gain to a signal, the signal hits a peak that it cannot surpass. Creating a cut waveform that looks like a square top with some distortion. This is called clipping. Put the resistor that works best back in when you are done measuring the clipping volume.

\[ \text{Volts} \]

\[ a \]

\[ -a \]

a and \(-a\) are the maximum levels that the system can support. At this point clipping begins.
5) Next insert the capacitor between F2B and F_GND

What you have just done is created a low-pass filter. A capacitor is a device that can store electrons, and thus can charge up and discharge. So as long as electrons haven’t reached a steady state capacitors permit their flow and oscillation. By connecting the capacitor from the signal path (F2B) to ground(F_GND) high frequency content is removed from the signal. Slower changing signals still pass through the circuitry.

6) Now try playing a sound, and record your observations
   a. ___________________________________

   Generally, the low-pass filter allows for a smoother softer tone more slowly varying like a sine wave (Shown Below).
7) Another configuration you can try is a high-pass filter by switching the position of the resistor and capacitor.

8) Now try playing a sound, and record your observations
   a. ________________________________________________
9) This kind of filter makes a more higher pitch tone, with a sharper less balanced waveform.

10) Choose your filter and pick the required $R_{G_1-G_2}$ to create the design of your choice.

   a. Record your design specifications
      i. ______________________________________

11) Test functionality of keyboard by trying to play piece. See Excel Sheet Music.

12) Test with a teammate to determine the overall symphonic sound you can make.

   a. Press and hold reset until you and a few partners are ready to release at the same time.
      Release and listen to your design choices blend together with the choices of other groups.