# Worksheet: Spectra and Dispersion

Name: _____ Group name: _____

1. Download the "FFT Spectrum Analyzer" (Android) or "Audio Spectrum Analyzer dB RTA" (iPhone) onto your phone. Start the app. In the Android app, hit the "BL" button on the top and change the frequency axis to linear scale.

   (a) Strike a (labelled) tuning fork on the puck and hold it towards the microphone. Press the pause button on your spectrum app, if present. Sketch the spectrum you observe (you don't have to draw the noise, which is the wiggly bit at the bottom). What does the height and the location of the peak represent?

   (b) Take a guitar and pluck the G string (the fourth string from the top when the guitar is facing away from you, neck pointing left) and record the spectrum. Again, sketch the spectrum, indicating the location of the peaks.

   (c) You should see multiple peaks. What are those extra peaks? (See prelab)

(d) Use your knowledge of standing waves to explain the location of the peaks:

| **peak** | **shape of standing wave** | **wave length λ (in terms of string length *L*)** | **frequency f = c/λ** |
|---|---|---|---|
| 1st | | $\lambda = 2L$ | 200 Hz |
| 2nd | | | |
| 3rd | | | |
| 4th | | | |

(e) Gently place your finger on the G string exactly on top of the fifth fret (= the fifth "dividing line" on the fret board, counted from the neck of the guitar). This is exactly 1/4 of the length of the string. Do not press down, just place it there! Again pluck the string – you should hear a much higher tone (if its just slightly higher, you have probably pressed too hard). Again, sketch the spectrum.

(f) Compare the spectrum of the string struck with and without your finger. You will notice that with the finger on a position at 1/4 of the length string, some of the peaks are much smaller or gone completely. Use the table above to explain this:

(g) **Bonus** (save for last): cover two holes of the train whistle and record the spectrum. Explain the peaks using standing waves for a pipe:

| **peak** | **shape of standing wave** | **wave length λ (in terms of string length *L*)** | **frequency f = c/λ** |
|---|---|---|---|
| 1st | | | |
| 2nd | | | |
| 3rd | | | |

2. Use the color mixer to mix the following colors: blue, yellow and white and another color of your choice (other than red and green). Indicate the settings for each of the dials:

| **color** | **Red** | **Green** | **Blue** |
|---|---|---|---|
| blue | | | |
| yellow | | | |
| white | | | |
| | | | |

3. Connect the bottom loop of slinky to the bottom of a styrofoam cup using tape. Make sure that there is a good connection. The styrofoam cup is there to amplify the sound of the slinky.

   (a) Keep the slinky tight to the cup. Put the cup to your ear and hit the end of the slinky with your hand. Then put the cup away from your ear (this is going to be loud!) and let the slinky drop to the floor. Try to describe the sounds that you hear and difference in frequency, amplitude, length.

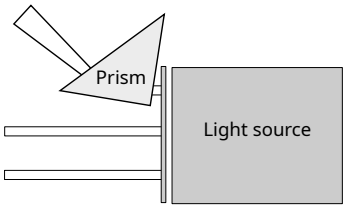
   (b) Explain how and why the sound changes when it travels along the slinky vs. when travelling through air. Why do you hear the “biiiiiuuu” sound?

(c) Build a slink-y-phone: attach a second styrofoam cup to the other end of the slinky. Again make sure it's well attached to the cups on both ends. Two people stand about one meter apart. One person speaks/sinks/etc. into one cup (make sure the cup covers the mouth) and the other person listens to the other cup while closing the other ear. Describe what you hear!

(d) Try different sounds of different frequencies. Try to imitate the frequency of the tone the slinky naturally makes when it moves. Why does the slinky prefer sounds of a particular frequency range?

4. Connect the white light source (rectangle) to the power supply. Use the three slits plate and slide the gray base of the lamp until the rays are approximately parallel ("collimated").

(a) Put a prism close to the light source such that one of the rays clearly separates. Describe what you see. How can it be white light before and something else afterwards?




(b) What physical principle allows a prism to split up light?

(c) Put a second prism, tip-forward, in the path of the separated ray. Adjust the prism such that the ray separates, and you get blue light on one side and the rest on the other. Now put a red plate in front of the light source. What happens and why? What does the red plate do?