TeachEngineering

What's In Our Stars? Student Procedures

1. Computer Prep

Installing and preparing the computer application

2. Equipment Prep

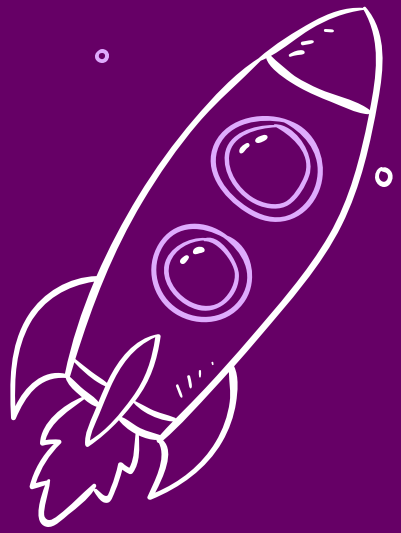
Setting up the lab equipment and samples

3. Data Collection

Running the experiment and collecting data

4. Post-Lab

Interpreting and analyzing the data collected



1. Computer Prep

Follow these steps to install the needed programs on your device.

ARDUINO IDE – DOWNLOAD/INSTALL

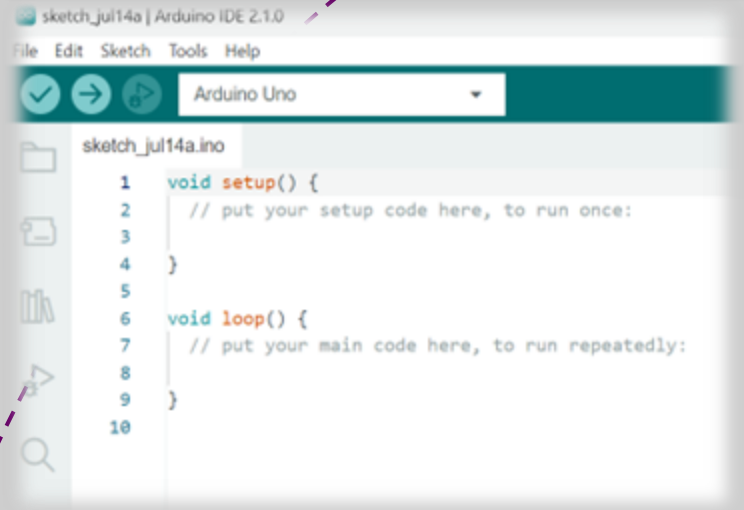
1. Go to https://www.arduino.cc/en/software and select the software that is appropriate for your student device.

2. Follow the installation prompts.

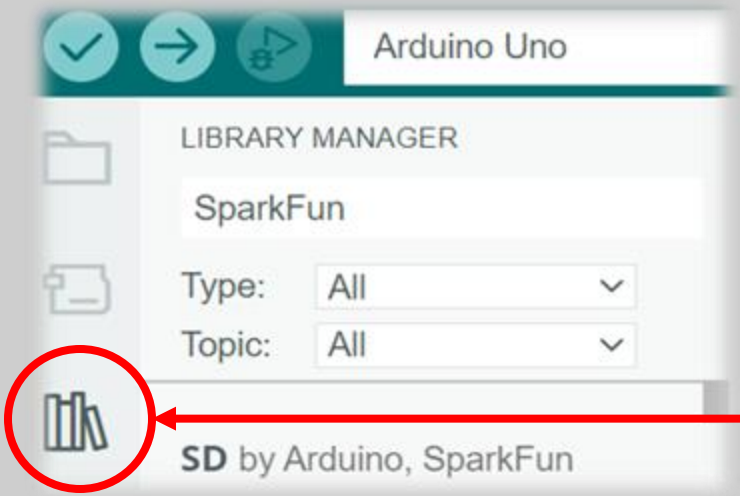
3. If asked for an admin username and password, raise your hand and your teacher will come to you.

SPARKFUN LIBRARY

1. Once installed, open Arduino IDE.

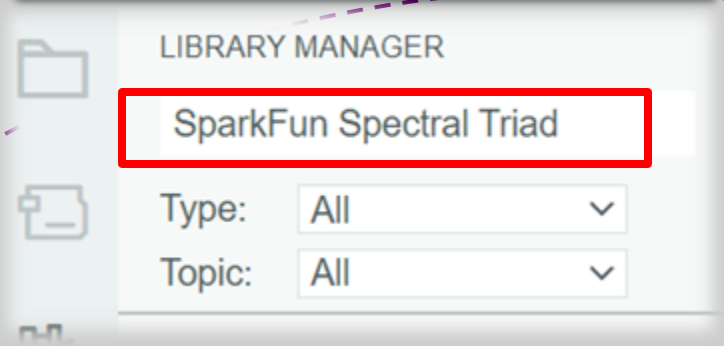


2. Click on the books icon on the task bar located on the left-hand side.

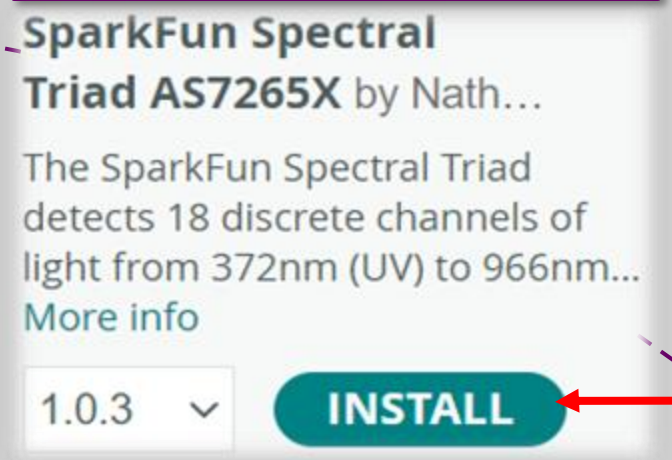


SPARKFUN LIBRARY (cont.)

3. Type "SparkFun Spectral Triad" into the search bar.



4. Select Install.

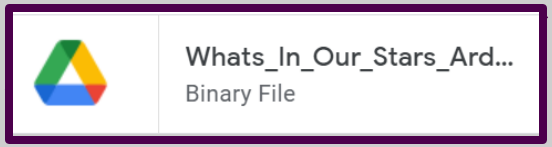


ACTIVITY CODE

1. Google Classroom

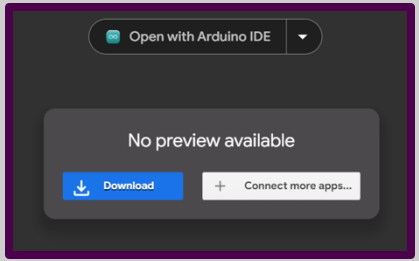
Go to the assignment posted in Google classroom.

2. Select



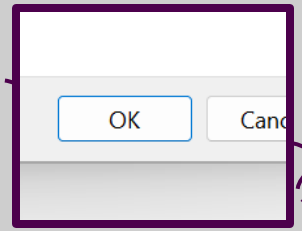
Click on the attachment labeled "Whats_In_Our_Stars_ Arduino_Code."

3. Open



Select the option at the top that says "Open with Arduino IDE."

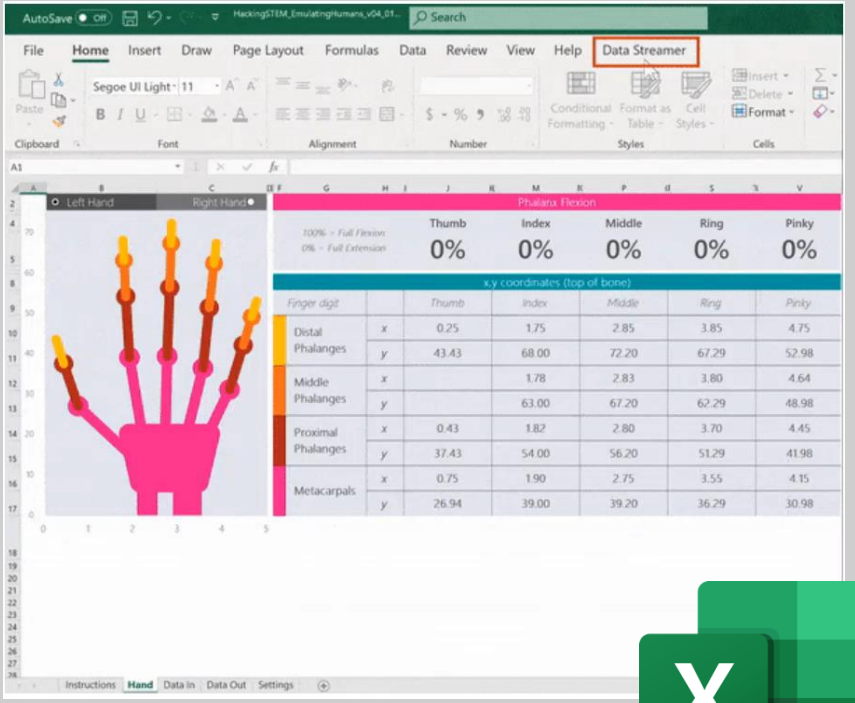
4. OK!



Click "Okay." (This just creates a file within the Arduino sketchbook.)

EXCEL DATA STREAMER

1. Open Microsoft **Excel**. (You may have to type it into your Windows search bar.)
2. Go to **File** > **Options** > **Add-Ins**.
3. Make sure **COM Add-ins** is selected in the **Manage** box and click **Go**.
4. In the COM add-Ins dialog box, make sure to select the box next to **Microsoft Data Streamer for Excel** add-in, then click **OK**.



Video Source: Microsoft Support LINK

DATA DASHBOARD

1. Google Classroom

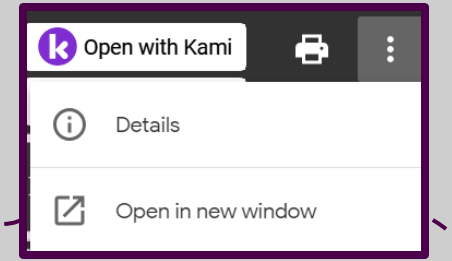
Go to the assignment posted in Google classroom.

2. Select

Click on the attachment labeled "Whats_In_Our_Stars_ Data_Dashboard."

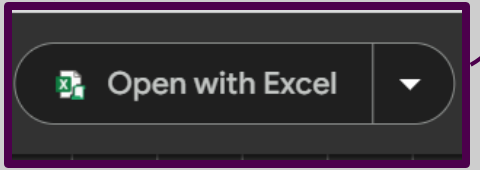
3. New Window

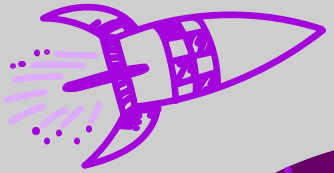
Select the three dots in the upper right-hand corner and then click "Open in new window."



4. Open

When the new window loads, select "Open with Excel" at the top of the screen.



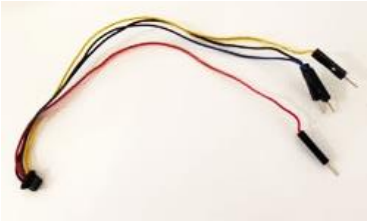


2. Equipment Prep

This section includes procedures for wiring/hooking up the spectrometer.

SPECTROMETER SETUP

SparkFun Triad Spectroscopy Sensor



SparkFun 4-pin Qwiic connect cable (or 4 jumper cables)

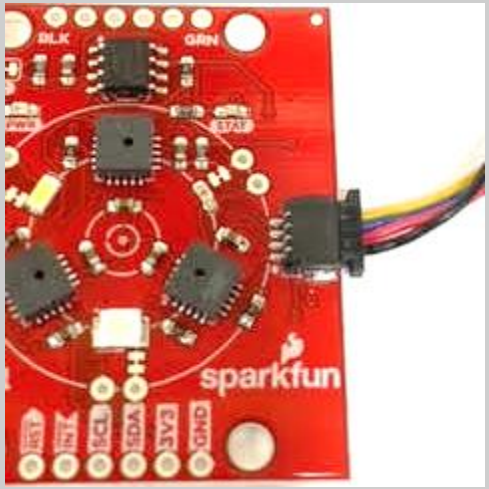
Scissors

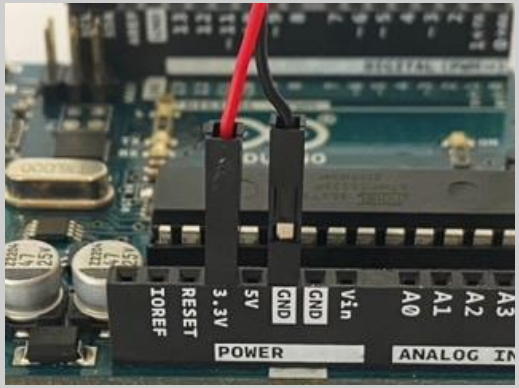
Arduino Uno Board

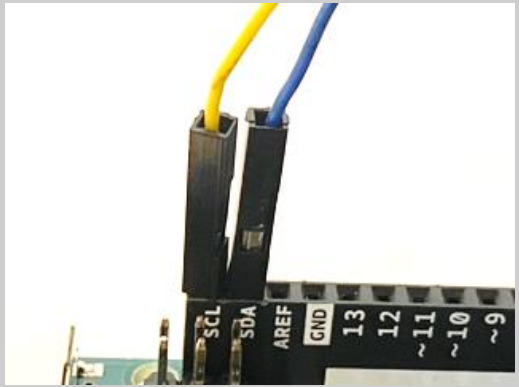
USB-C to USB-A cable

Black cardstock or thin cardboard cut into a 3”x 3” square

SPECTROMETER SETUP



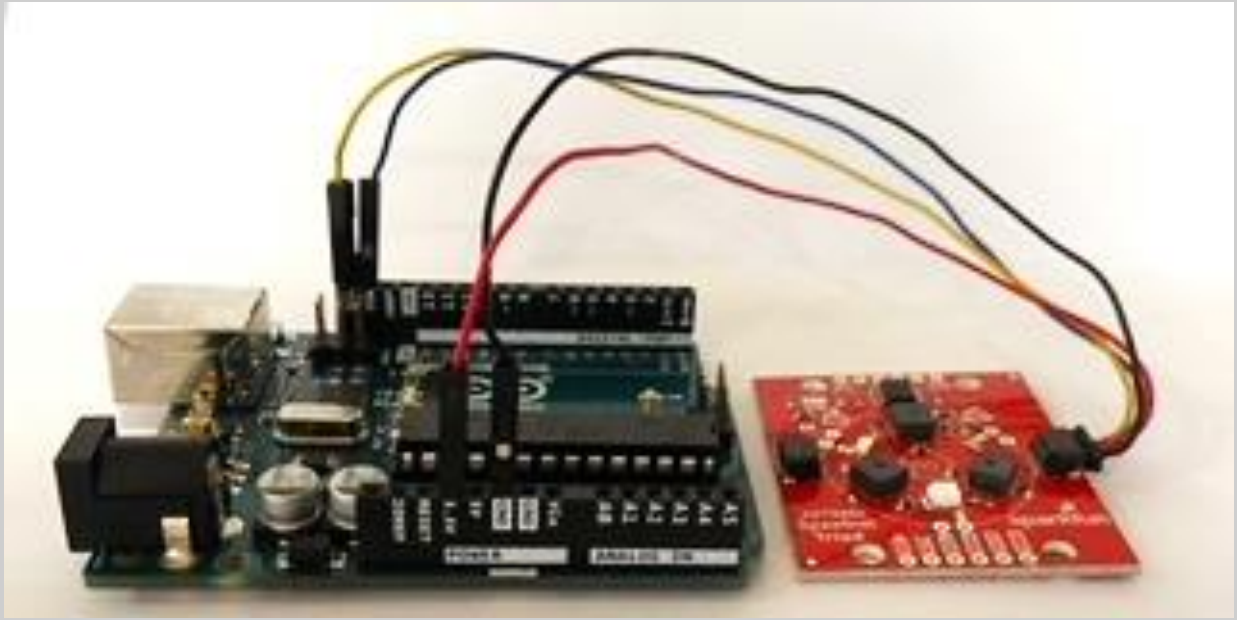




- Black = GND
- Red = 3.3V
- Blue = SDA
- Yellow = SCL

Connect the triad sensor to the Arduino, making sure that each colored cable goes to the correct pin! (see above)

SPECTROMETER SETUP

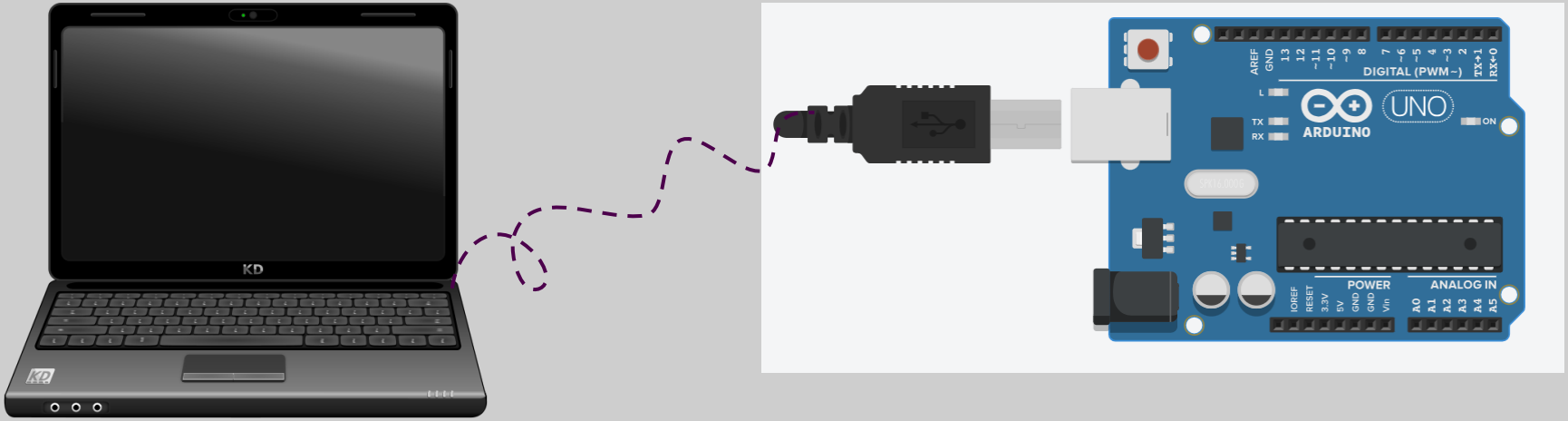


- **Black = GND**
- **Red = 3.3V**
- **Blue = SDA**
- **Yellow = SCL**

Connect the triad sensor to the Arduino, making sure that each colored cable goes to the correct pin! (see above)

SPECTROMETER SETUP

Use the provided USB cable to connect the spectrometer to your device.



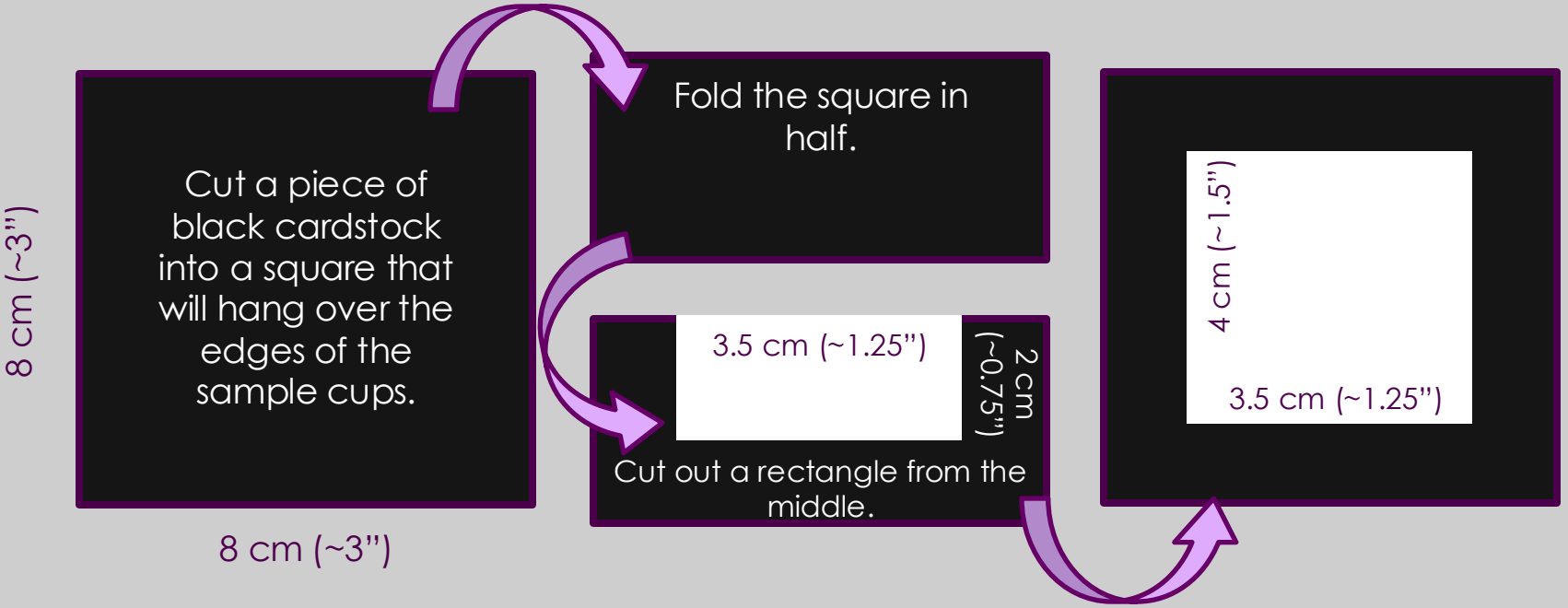
SAMPLES SETUP

Grab one cup of each substance and one unknown for your group to have a set of 4 samples.

The name of the substance will be on each sample cup. (e.g., Iron Filings)

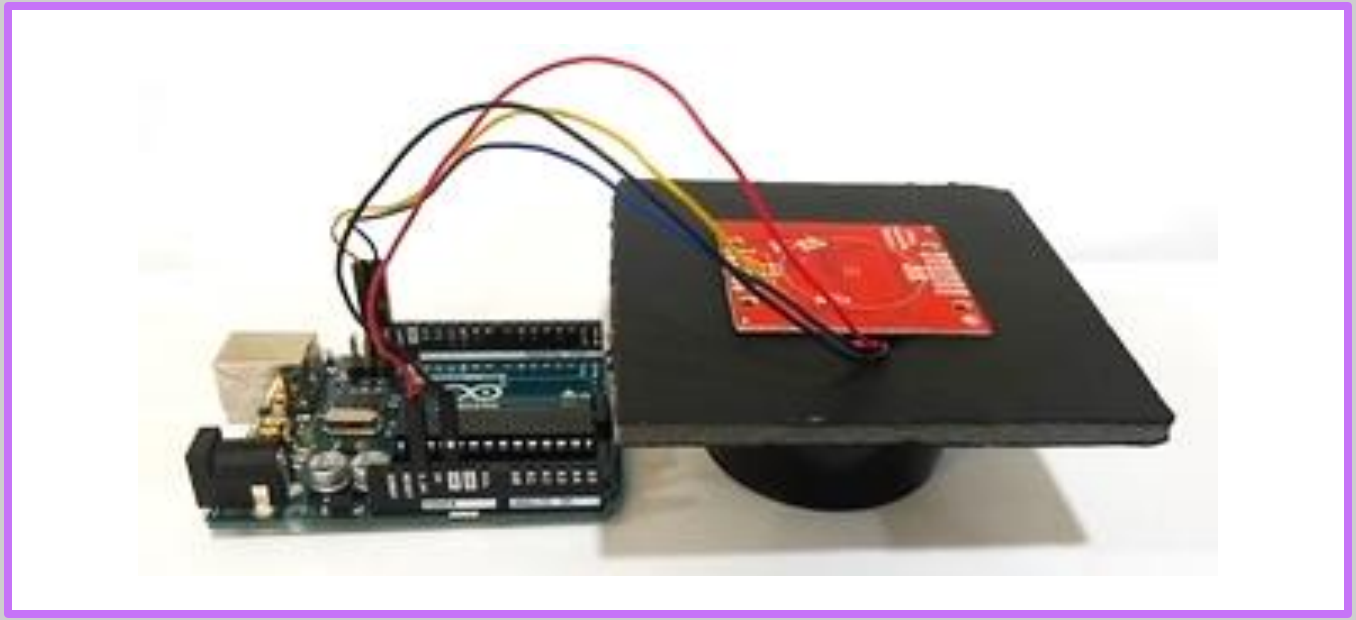
SAMPLE SETUP

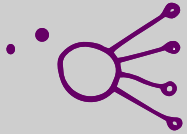
Once you have your spectrometer set up, and your samples selected and portioned into containers, you'll need to create a "cover" to place over the sample cup for the sensor to sit on and to eliminate ambient light.



COMPLETE SETUP

When your setup is complete, it should look like this:





3. Data Collection

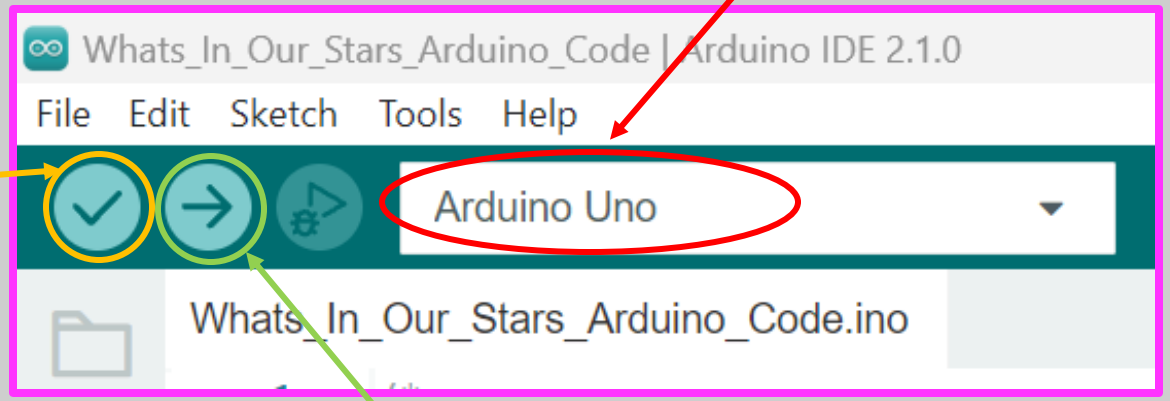
Part 3 describes how to conduct the experiment and collect data on “lab day.”

DATA COLLECTION –

Part 1: Arduino IDE

1. Select your device from the dropdown menu.

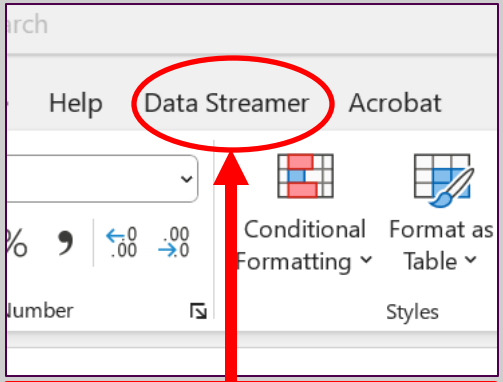
2. Verify the sketch code.



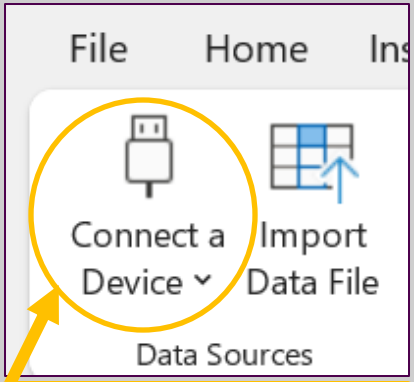
3. Upload the code to the Arduino.

DATA COLLECTION –

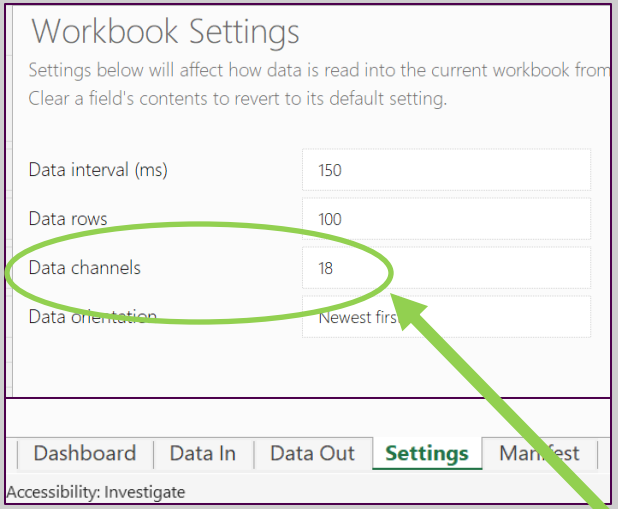
Part 2: Excel Dashboard



1. Select "Data Streamer" from the top menu bar.



2. Select "Connect a Device" from the top menu bar, then "Arduino."



3. Select the "Settings" Sheet from the bottom menu and make sure "Data channels" is set to **18.**

DATA COLLECTION –

Part 3: Check Dashboard Data Table

- The table on the first sheet should look like the one to the right. →
- If it does, you are good to go! You can skip to Slide 25.
- If you have any of the "Average Intensity" cells showing the error "#REF", follow the directions on the next slide.

	Wavelength	Average Intensity
INFRARED	410nm	#DIV/0!
	435nm	#DIV/0!
	460nm	#DIV/0!
	485nm	#DIV/0!
	510nm	#DIV/0!
VISIBLE	535nm	#DIV/0!
	560nm	#DIV/0!
	585nm	#DIV/0!
	610nm	#DIV/0!
	645nm	#DIV/0!
	680nm	#DIV/0!
	705nm	#DIV/0!
	730nm	#DIV/0!
	760nm	#DIV/0!
	810nm	#DIV/0!
	860nm	#DIV/0!
	900nm	#DIV/0!
	940nm	#DIV/0!

DATA COLLECTION –

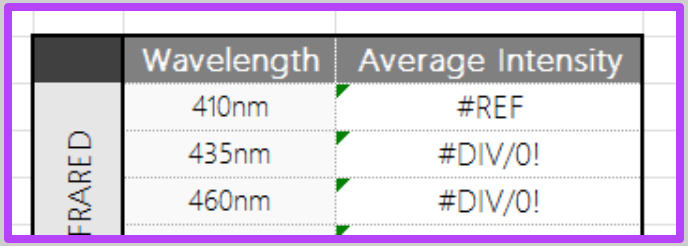
*Part 3A: Dashboard

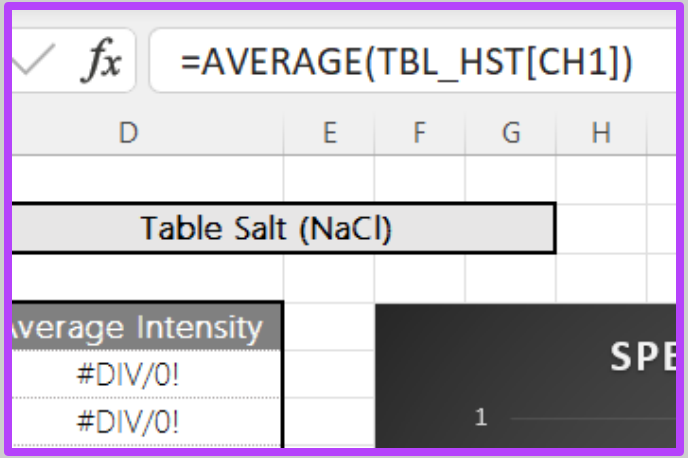
Data Table **TROUBLESHOOTING**

1. The error "#REF" indicates that the reference cells for the formula are not found, but the good news is, it's an easy fix!

2. Click on the Average Intensity for 410nm.

3. Type the following formula into the cell: **=AVERAGE(TBL_HST[CH1])**





DATA COLLECTION –

*Part 3A: Dashboard Data Table **TROUBLESHOOTING**

4. Each cell formula going down the column should increase by 1 channel.

5. See the table to the right for the correct formulas for Average Intensity at each wavelength.

6. You can copy and paste the formulas for each wavelength from the next slide!

	Wavelength	Average Intensity
INFRARED	410nm	=AVERAGE(TBL_HST[CH1])
	435nm	=AVERAGE(TBL_HST[CH2])
	460nm	=AVERAGE(TBL_HST[CH3])
	485nm	=AVERAGE(TBL_HST[CH4])
	510nm	=AVERAGE(TBL_HST[CH5])
VISIBLE	535nm	=AVERAGE(TBL_HST[CH6])
	560nm	=AVERAGE(TBL_HST[CH7])
	585nm	=AVERAGE(TBL_HST[CH8])
	610nm	=AVERAGE(TBL_HST[CH8])
	645nm	=AVERAGE(TBL_HST[CH10])
	680nm	=AVERAGE(TBL_HST[CH11])
	705nm	=AVERAGE(TBL_HST[CH12])
	730nm	=AVERAGE(TBL_HST[CH13])
	760nm	=AVERAGE(TBL_HST[CH14])
	810nm	=AVERAGE(TBL_HST[CH15])
	860nm	=AVERAGE(TBL_HST[CH16])
	900nm	=AVERAGE(TBL_HST[CH17])
	940nm	=AVERAGE(TBL_HST[CH18])

DATA COLLECTION –

*Part **3**A: Dashboard

Data Table **TROUBLESHOOTING**

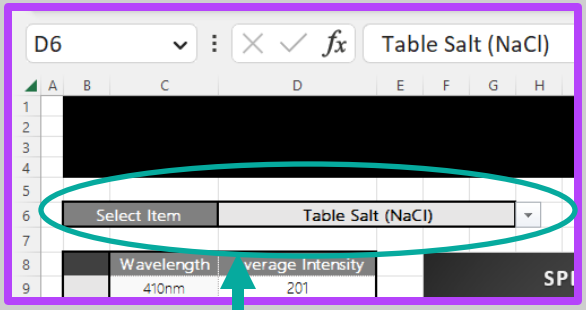
Click on the text box to the right →,

Select all the text, then copy, and paste!

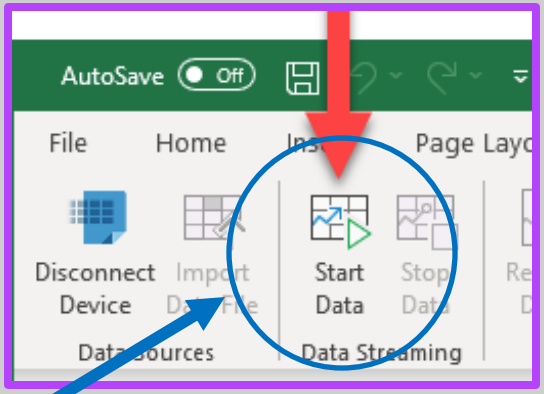
=AVERAGE(TBL_HST[CH1])
=AVERAGE(TBL_HST[CH2])
=AVERAGE(TBL_HST[CH3])
=AVERAGE(TBL_HST[CH4])
=AVERAGE(TBL_HST[CH5])
=AVERAGE(TBL_HST[CH6])
=AVERAGE(TBL_HST[CH7])
=AVERAGE(TBL_HST[CH8])
=AVERAGE(TBL_HST[CH9])
=AVERAGE(TBL_HST[CH10])
=AVERAGE(TBL_HST[CH11])
=AVERAGE(TBL_HST[CH12])
=AVERAGE(TBL_HST[CH13])
=AVERAGE(TBL_HST[CH14])
=AVERAGE(TBL_HST[CH15])
=AVERAGE(TBL_HST[CH16])
=AVERAGE(TBL_HST[CH17])
=AVERAGE(TBL_HST[CH18])

DATA COLLECTION –

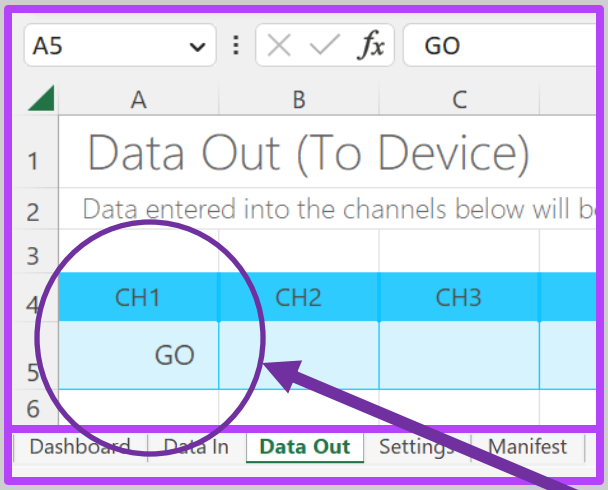
Part **4**: Start Data



4. On the Dashboard Sheet, select the substance name from the dropdown menu.



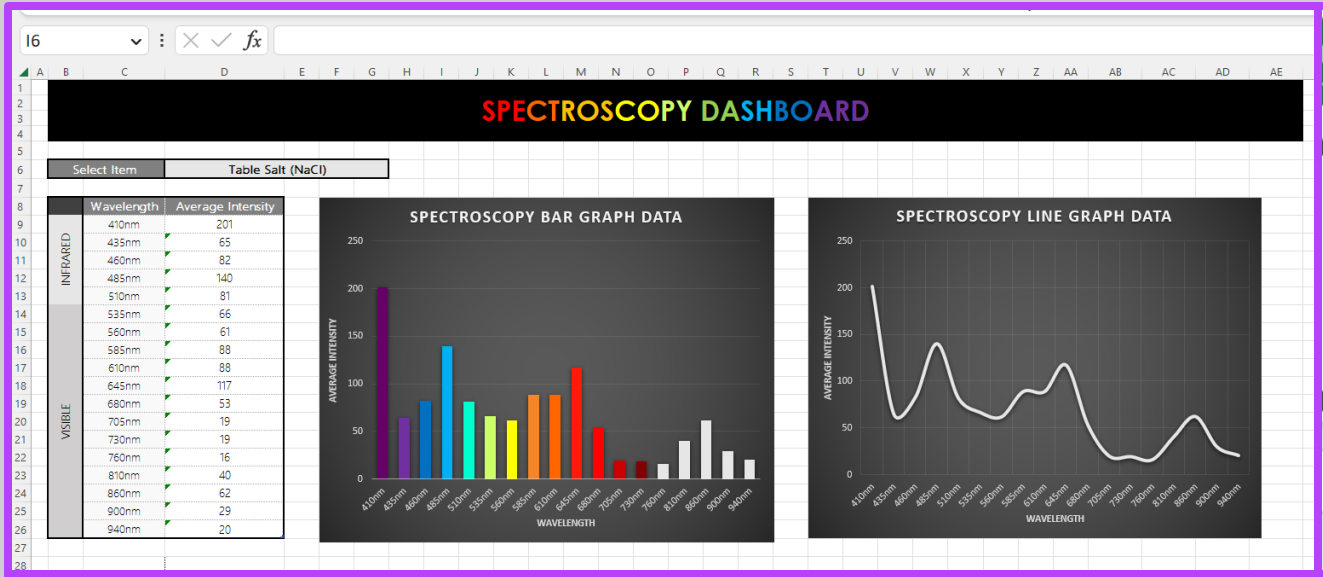
5. Click "Start Data" from the Data Streamer menu bar.

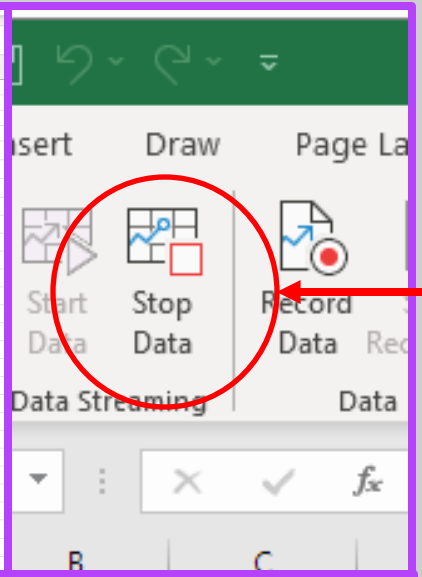


6. Click on the "Data Out" Sheet from the bottom menu. Then type "GO" into cell A5 and hit Enter.

DATA COLLECTION –

Part **5**: Collect Data



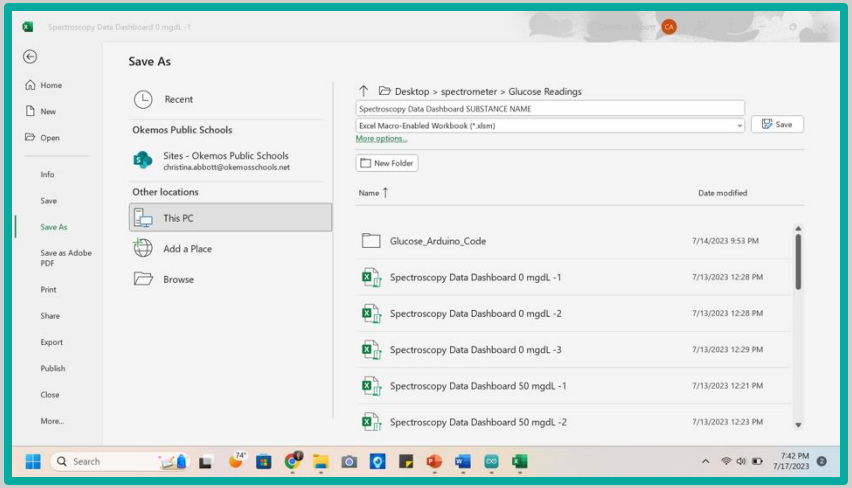


Return to the Dashboard Sheet using the menu at the bottom of the screen. You should now see values in the data table for average intensity, a bar graph, and a line graph created for you.

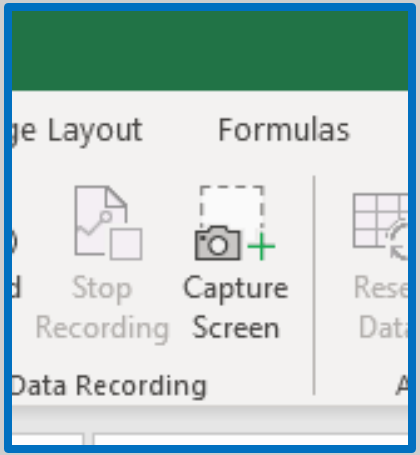
Once the values have stabilized **(~10 seconds)**, click "Stop Data" toward the top of the screen.

DATA COLLECTION –

Part **6**: Save Data



OPTION #1: Select "File" then "Save As."
Suggestion: Save files using the following pattern:
"ClassPeriod_Group#_SameName"
"ClassPeriod_GroupInitials_SameName"
e.g., "Hr1_ABC_TableSalt"



OPTION #2: Select "Capture Screen"

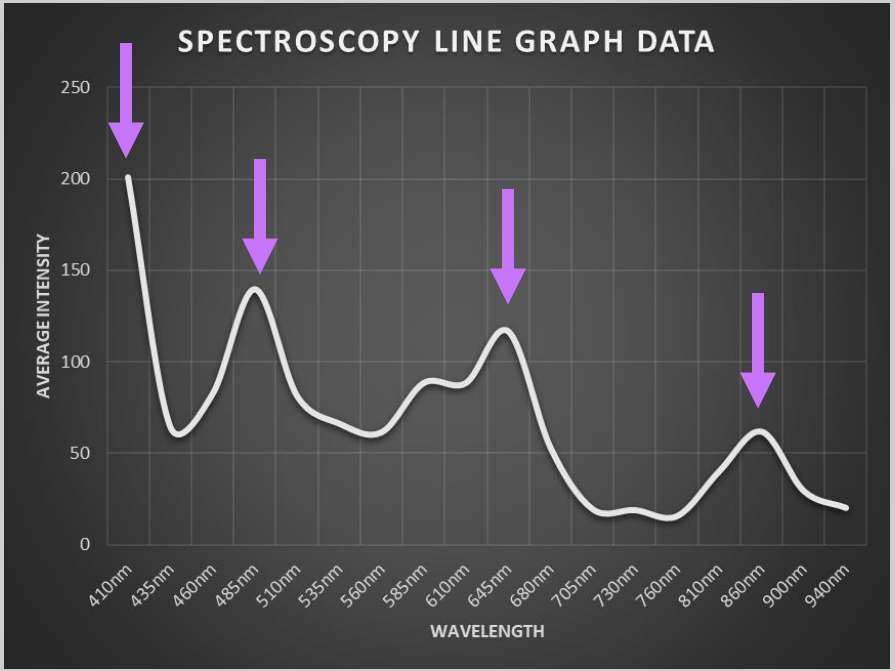
Within the Data Streamer menu is "capture screen"; this creates an image of the sheet shown that students can save.

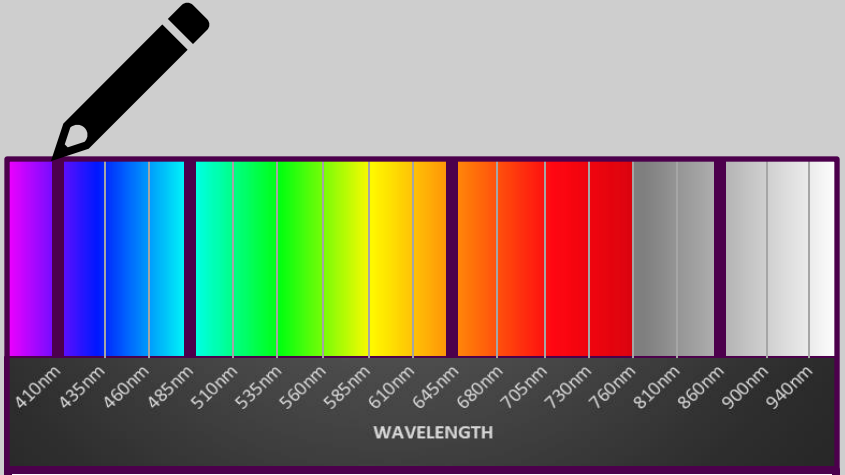
OPTION #3: Use the "Print Screen" shortcut.

Using this keyboard shortcut does the same thing as screen capture above, but automatically saves the image to your "screenshots" folder.

DATA COLLECTION –

Part 7: Record Data



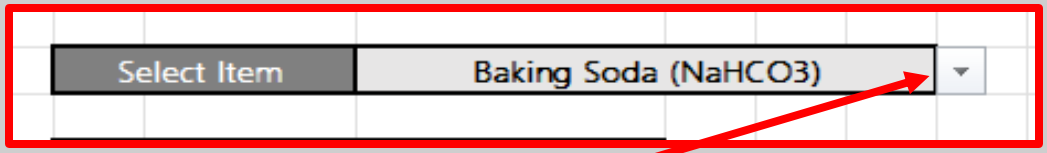


Identify the wavelength values where "peaks" occur on the line graph (see left).

On the student worksheet, use a black marker to draw lines on the provided spectrum at each of the wavelengths where a peak occurred.

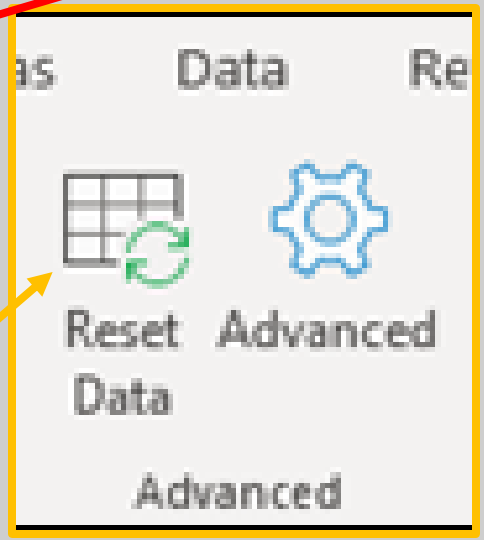
DATA COLLECTION –

Part 8: Reset Data



1. Select the next substance to be sampled from the dropdown menu on the dashboard.

2. Click on the "Reset Data" icon under the data streamer menu.



3. Press the reset button on the Arduino.

DATA COLLECTION –

Part **9**: Repeat

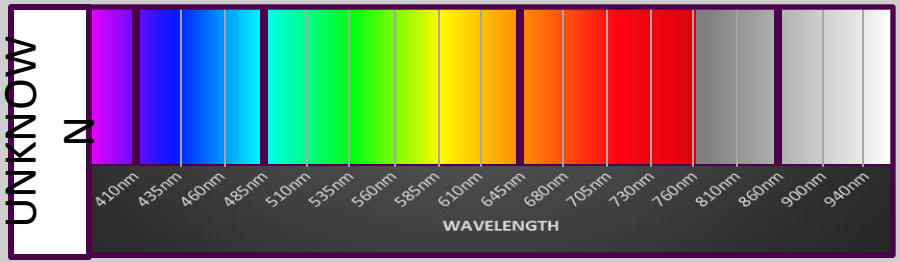
Repeat the steps to collect data for each of the known samples and the unknown sample.

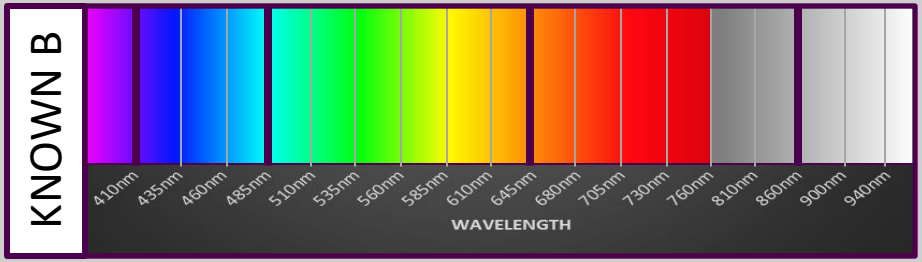
4. Post Lab

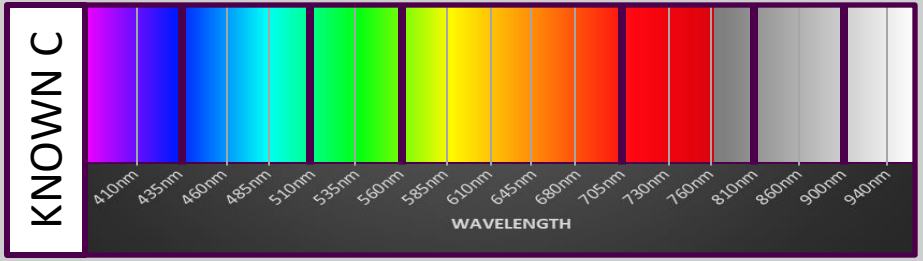
Final steps of the lab activity are provided in this section, including how to analyze the data collected and identify the unknown substance.

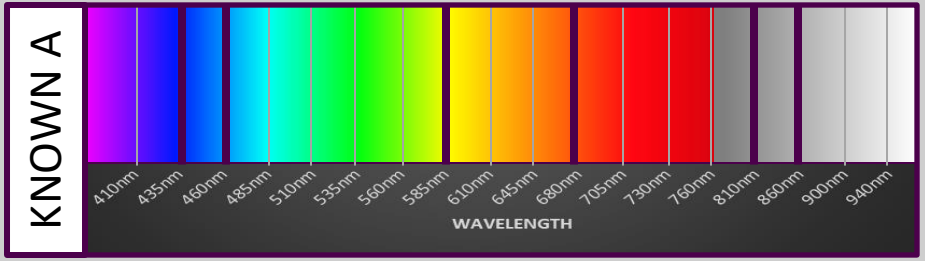
DATA ANALYSIS

MATCH !





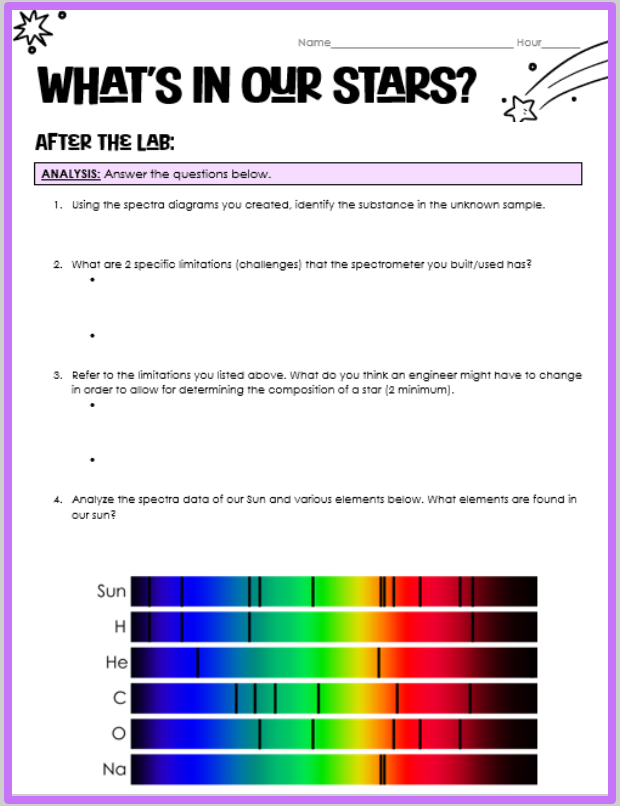




Once data and graphs are collected for the 3 known samples and 1 unknown, compare the unknown graph and spectrum to the knowns to identify the sample.

COMPLETE STUDENT HANDOUT

After identifying the unknown substance, complete the analysis questions on the student handout.



Name_____ Hour_____

WHAT'S IN OUR STARS?

AFTER THE LAB:

ANALYSIS: Answer the questions below.

1. Using the spectra diagrams you created, identify the substance in the unknown sample.

2. What are 2 specific limitations (challenges) that the spectrometer you built/used has?
   -
   -

3. Refer to the limitations you listed above. What do you think an engineer might have to change in order to allow for determining the composition of a star (2 minimum).
   -
   -

4. Analyze the spectra data of our Sun and various elements below. What elements are found in our sun?

Sources

Kramida, A., Ralchenko, Yu., Reader, J. and NIST ASD Team (2022). NIST Atomic Spectra Database (version 5.10), [Online]. Available: https://physics.nist.gov/asd. National Institute of Standards and Technology, Gaithersburg, MD. DOI: https://doi.org/10.18434/T4W30F

Seidle, Nathan (Nate). Spectral Triad (AS7265x) Hookup Guide, [Online]. Available: https://learn.sparkfun.com/tutorials/spectral-triad-as7265x-hookup-guide?_ga=2.208195537.274963032.1659022095-1771007873.1658366162. SparkFun Electronics. Licensed by CC BY-SA 4.0