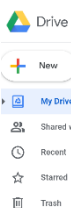


Creating an intuitive, interactive table in Google Sheets for UL Xplorlabs: Fire Forensics, Energy and Combustion

Students can use software like Google Sheets to interact with tables that will update for them and their classmates in real time. This is useful for Investigation 3, “Energy and Combustion” of UL Xplorlabs: Fire Forensics, in which students collect data as a group. This is a tutorial on how to build an intuitive, interactive table for UL Xplorlabs Fire Forensics: Energy and Combustion in Google Sheets. For more information about this investigation, please visit the teacher guide and student guide for this investigation at <https://ulxplorlabs.org/xtensions/>.



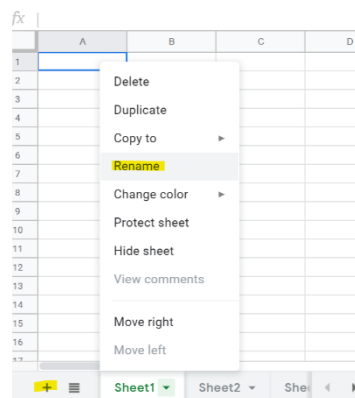
1. Create a new spreadsheet in Google Sheets

Logged into your Google account, access www.drive.google.com. On the top left of the page, click the **New** button. The page will present you with a list of options. Select **Google Sheets**.

2. Add 2 tabs to the sheet

At the bottom left of the sheet, click the **+** button twice. This will create two new sheets, accessible at the bottom of the screen. You should have 3 sheets in total. To rename the tabs, right click the sheet name (likely something like “Sheet 1”) and in the menu, select **Rename**. In order, rename your sheets:

- Table 1: Heat absorbed by water
- Table 2: Heat of combustion
- See table 1 and table 2 together

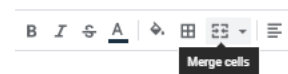


3. Create title cells for table 1

On the first tab, Table 1: Heat absorbed by water, you will make the table that corresponds to table 1 for the lab. Edit the first two rows of the table to look somewhat like this:

Table 1: Heat absorbed by water (heat released by sample)									
Sample	Mass of water in container (g)	Starting temperature of water (°F)	Starting temperature of water (°C)	Peak temperature of water (°F)	Peak temperature of water (°C)	Change in water temperature (°C)	Specific heat of water (cal/g C)	Heat absorbed by water (cal) = Heat released (cal) Equation: Heat released (cal) = mass of water (g) * specific heat of water (cal/g C) * change in temperature (C)	

Here, the first row has been merged by selecting the **Merge Cells** button in the formatting toolbar.



The tools in the formatting toolbar can be used to change the font and color of the cells. You can change the height and width of the cells by dragging the sides of the letter and number tiles at the left side and top of the sheet.

4. Create equation cells for table 1

*Note that this step is only necessary if you are using calorimeter videos with temperatures in Fahrenheit.

In cell **D3**, type in the equation $=(\mathbf{C3-32})*(5/9)$. The equal sign at the beginning is necessary to tell the program that you would like it to perform a mathematical function. In this case, you would like it to take the value in cell **C3**, subtract 32, and multiply it by 5/9 to effectively convert the value from Fahrenheit to Celsius. Press **enter** on your keyboard to enter the equation into the program. If the value in cell **C3** is blank or zero, then this function should make cell **D3** fill with the value of approximately -17.78.

	Starting temperature of water (°F)	Starting temperature of water (°C)
	20.00	-6.67

If you click cell **D3**, then there will be a small blue square at the bottom right of that cell. Click that square and drag it down a few rows to represent how many samples will be tested. This will apply the equation to the below rows. For example, cell **D4** will have the same equation, but it will use the starting value from cell **C4**.

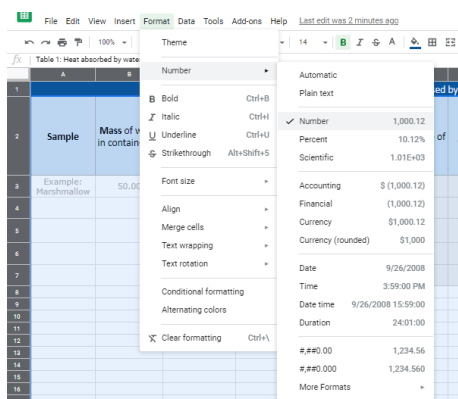
Starting temperature of water (°C)
-17.78
-17.78
-17.78
-17.78

In cell **F3**, type in the equation $=\mathbf{(E3-32)*(5/9)}$. Drag this equation down as well.

In cell **G3**, type in the equation $=\mathbf{F3-E3}$. Drag this equation down as well.

In cell **H3**, type in the number **1**. Drag this down as well. (All of the cells in column **H** should be the number **1**.)

In cell **I3**, type in the equation $=\mathbf{B3*H3*G3}$. Drag this equation down as well.



5. Format numbers

Press **Ctrl+A** to **Select All**. At the top of the sheet, select **Format**. In the dropdown menu, mouse over **Number**. Then, click **Number**. This will format numbers to show two decimal places. You may choose a different format if you prefer.

A sheet with an example row could look like this. The gray columns here were manually colored using the formatting toolbar to create a distinction between cells in which students would have to input data, and cells which would auto-fill based on data inputted by students.

	A	B	C	D	E	F	G	H	I
1	Table 1: Heat absorbed by water (heat released by sample)								
2	Sample	Mass of water in container (g)	Starting temperature of water (-F)	Starting temperature of water (-C)	Peak temperature of water (-F)	Peak temperature of water (-C)	Change in water temperature (-C)	Specific heat of water (cal/g C)	Heat absorbed by water (cal) = Heat released (cal) Equation: Heat released (cal) = mass of water (g) * specific heat of water (cal/g C) * change in temperature (C)
3	Example: Marshmallow	50.00	20.00	-6.67	99.00	37.22	43.89	1.00	2,194.44
4				-17.78		-17.78	0.00	1.00	0.00
5				-17.78		-17.78	0.00	1.00	0.00
6				-17.78		-17.78	0.00	1.00	0.00

6. Create title cells for table 2

On the second tab (titled Table 2: Heat of Combustion), format the first two rows to look similar to this, just as you did for table 1 on the first tab. Cells F2 and G2 are merged. Cells H2 and I2 are merged as well.

	A	B	C	D	E	F	G	H	I
1	Table 2: Heat of combustion (energy released by sample)								
2	Sample	Starting mass of sample (g)	Final mass (g) of sample	Mass Lost by sample (g)	Heat lost by sample (from Table 1) (cal)	Heat of Combustion (cal/g) Equation: HoC = Heat released (cal) / mass lost by sample (g)		Qualitative Observations during burn	

7. Create equation cells for table 2

In cell A3, type in `=Table 1: Heat absorbed by water!A3`. This lets the program know to copy the value from cell A3 on the first tab (which is titled Table 1: Heat absorbed by water) to this cell. If you have named your first tab something different, type that in accordingly. Drag this equation down just as you did for the cells in table 1.

	A	B	C
1	Table 2: Heat of combustion (energy released by sample)		
2	Sample	Starting mass of sample (g)	Final mass (g) of sample
3	Example: Marshmallow	50.00	20.00
4			

In cell D3, type in `=B3-C3`. Drag this equation down as well.

In cell E3, type in `=Table 1: Heat absorbed by water!I3`. Drag this equation down as well.

In cell F3, type in `=E3/D3`. Drag this equation down as well.

You can format these cells the same way you formatted the ones in table 1. Cells in columns E and F may say #REF! – this is just because the corresponding cells in table 1 and table 2 have not been filled out yet. A sheet with an example row could look like this:

Table 2: Heat of combustion (energy released by sample)						
Sample	Starting mass of sample (g)	Final mass (g) of sample	Mass Lost by sample (g)	Heat lost by sample (from Table 1) (cal)	Heat of Combustion (cal/g) Equation: $HOC = \text{Heat released (cal)} / \text{mass lost by sample (g)}$	Qualitative Observations during burn
Example: Marshmallow	6.85	6.00	0.85	2,194.44	2,581.70	
				#REF!	#REF!	
				#REF!	#REF!	
				#REF!	#REF!	

8. See table 1 and table 2 together

On the third tab (titled See Table 1 and Table 2 together), copy and paste the title rows for table 1 and table 2 in so that they are stacked, with plenty of rows in between them. In cell A3 (should be under “Sample”), type in **=’Table 1: Heat absorbed by water’!A3**.

Drag the small blue square all the way to the right of the table. This way, cell B3 will automatically fill with **=’Table 1: Heat absorbed by water’!B3** and so on. Drag each of these equations down.

Then, do the same thing under the title cells for table 2, except with **=’Table 2: Heat of Combustion’!A3** instead.

You may format these cells to be gray to look like the other cells that are auto-filled.

If you have input sample values into the first two tabs of the spreadsheet, this sheet may look like this:

Table 1: Heat absorbed by water (heat released by sample)									
Sample	Mass of water in container (g)	Starting temperature of water (°F)	Starting temperature of water (°C)	Peak temperature of water (°F)	Peak temperature of water (°C)	Change in water temperature (°C)	Specific heat of water (cal/g C)	Heat absorbed by water (cal) = Heat released (cal) Equation: $\text{Heat absorbed (cal)} = \text{mass of water (g)} \times \text{specific heat of water (cal/g C)} \times \text{change in temperature (C)}$	
Example: Marshmallow	50.00	20.00	-6.67	99.00	37.22	43.89	1.00	2,194.44	
			-17.78		-17.78	0.00	1.00	0.00	
			-17.78		-17.78	0.00	1.00	0.00	
			-17.78		-17.78	0.00	1.00	0.00	
			-17.78		-17.78	0.00	1.00	0.00	

Table 2: Heat of combustion (energy released by sample)						
Sample	Starting mass of sample (g)	Final mass (g) of sample	Mass Lost by sample (g)	Heat lost by sample (from Table 1) (cal)	Heat of Combustion (cal/g) Equation: $HOC = \text{Heat released (cal)} / \text{mass lost by sample (g)}$	Qualitative Observations during burn
Example: Marshmallow	6.85	6.00	0.85	2,194.44	2,581.70	
				0.00	#DIV/0!	
				0.00	#DIV/0!	
				0.00	#DIV/0!	
				0.00	#DIV/0!	

9. Duplicating and sharing

You may wish to split your students into groups and give each group a different table. See the Practice of Fire Forensics webinar slideshow for ideas regarding digital lab roles. If you would like to duplicate this table, select **File** and then **Make a copy**. You can give the duplicated versions titles such as **Energy and Combustion Tables (Group 1)**, etc. Consider creating a Google Folder to place all of these in so you can easily access each table.

To share the copied versions, go to your folder with each of the duplicate spreadsheets. Right click the version you would like to share. Then click **Share** or **Get shareable link** to share that version with its corresponding group of students.

Make sure that anybody with the link **can edit**, rather than can view.

