

Internet of Things (IOT) Enabled Paradigms for Online Chemistry Labs

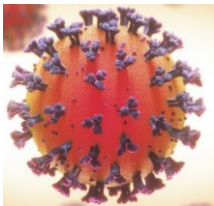


Robert Belford,* Elena Lisitsyna*, Liliane Poirot*, Phil Williams*, Ehren Bulchotz** & Bob
LeSeur**,

*UA Little Rock, ** UHSP-St. Louis, *** SUNY Brockport

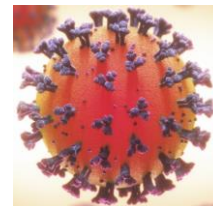
Presentation Outline

- The Move to Online Labs
- Introduction to IOT
- The Labs
 - Safety
 - Integration of Google Groups, Zoom Breakout Rooms and LibreText
 - Real time Demonstration
- OER Resources to Support IOT Enhance Labs
- Future Activities and Resources



A Message from the Chancellor

(3:03 PM March, 12, 2020)



Across the Country the Message was the Same.

UA Little Rock Migrates to Online Classes Immediately



Inbox x



UA Little Rock Communications <communications@ualr.edu>

Mar 12, 2020, 3:03 PM



Reply



to UALREMPLOYEES ▾

Dear Campus Community,

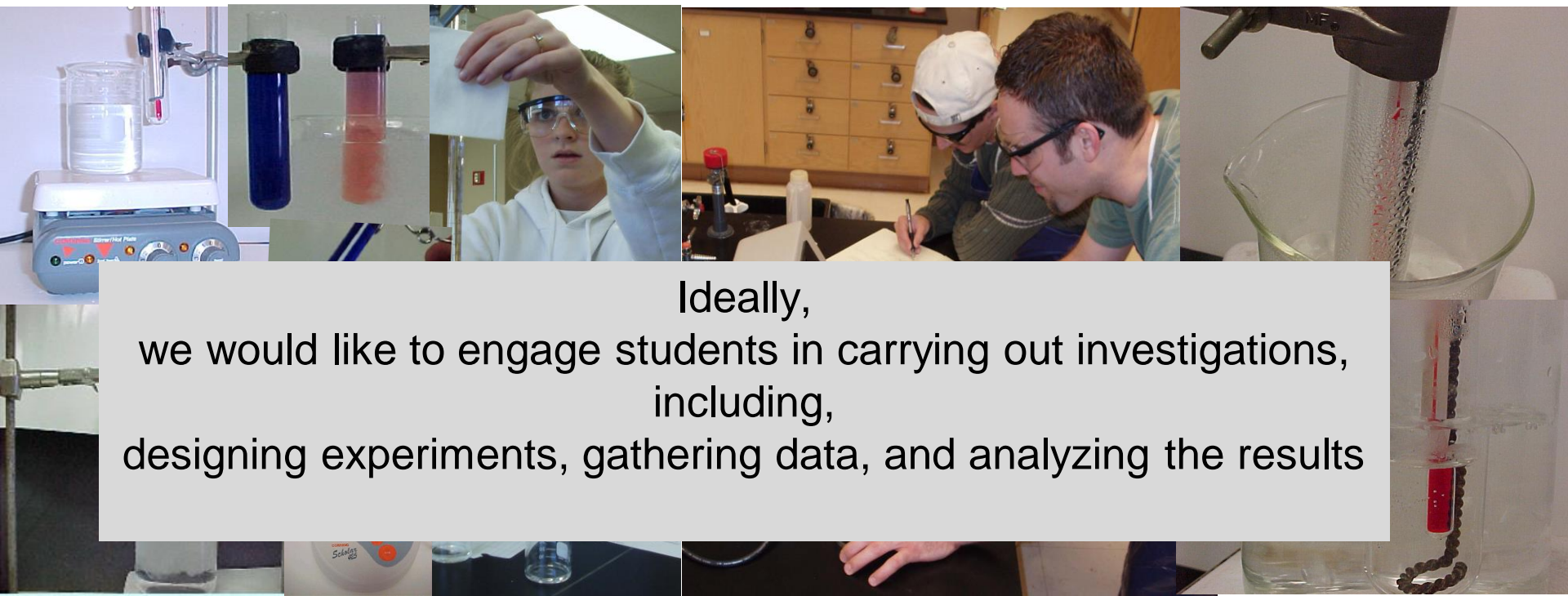
At UA Little Rock, the education, health, and well-being of our students and community is our top priority.

1. **Effective immediately, face-to-face classes will migrate to online – until further notice.**
2. Effective immediately, on-campus events are canceled through April 30 unless written authorization is granted by a vice chancellor.

Online Chemistry Labs

present special challenges

Can we offer a True Online Lab Experience? .

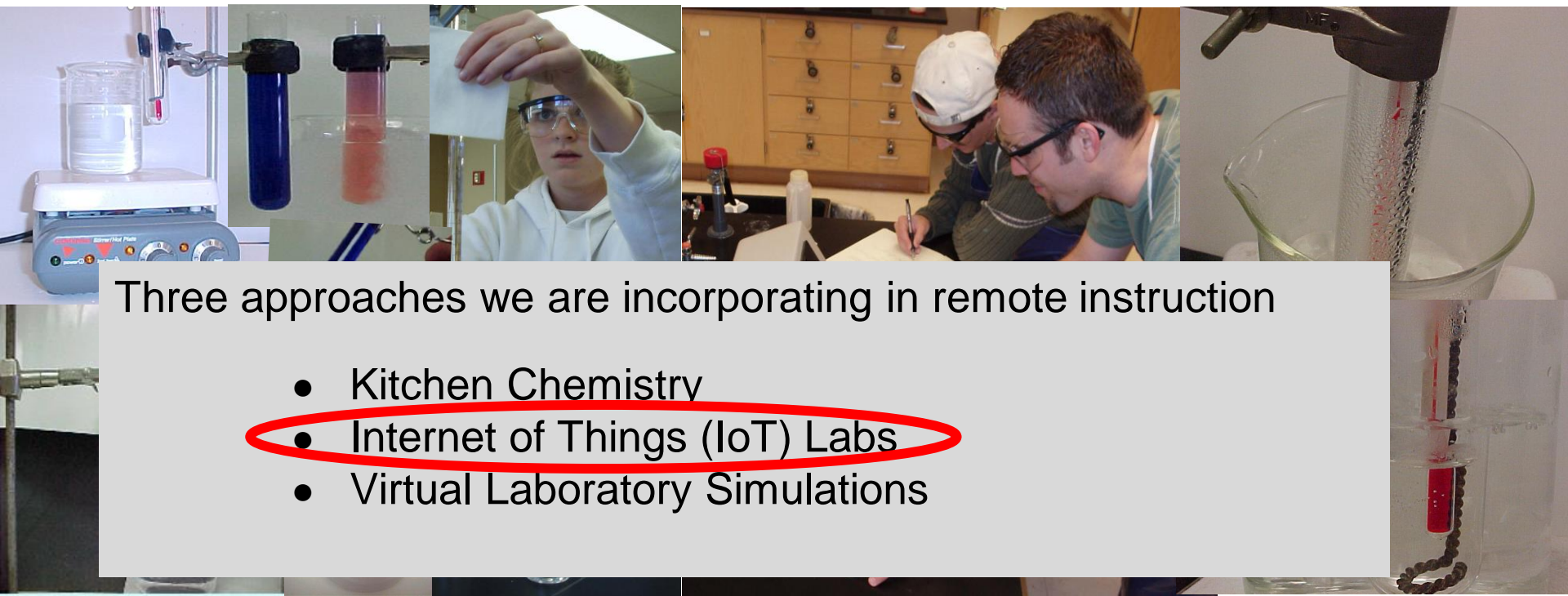


Ideally,
we would like to engage students in carrying out investigations,
including,
designing experiments, gathering data, and analyzing the results

Online Chemistry Labs

present special challenges

Can we offer a True Online Lab Experience?



Three approaches we are incorporating in remote instruction

- Kitchen Chemistry
- Internet of Things (IoT) Labs
- Virtual Laboratory Simulations

What is the Internet of Things? (IOT)

- Interconnected Digital Networking of Physical Objects

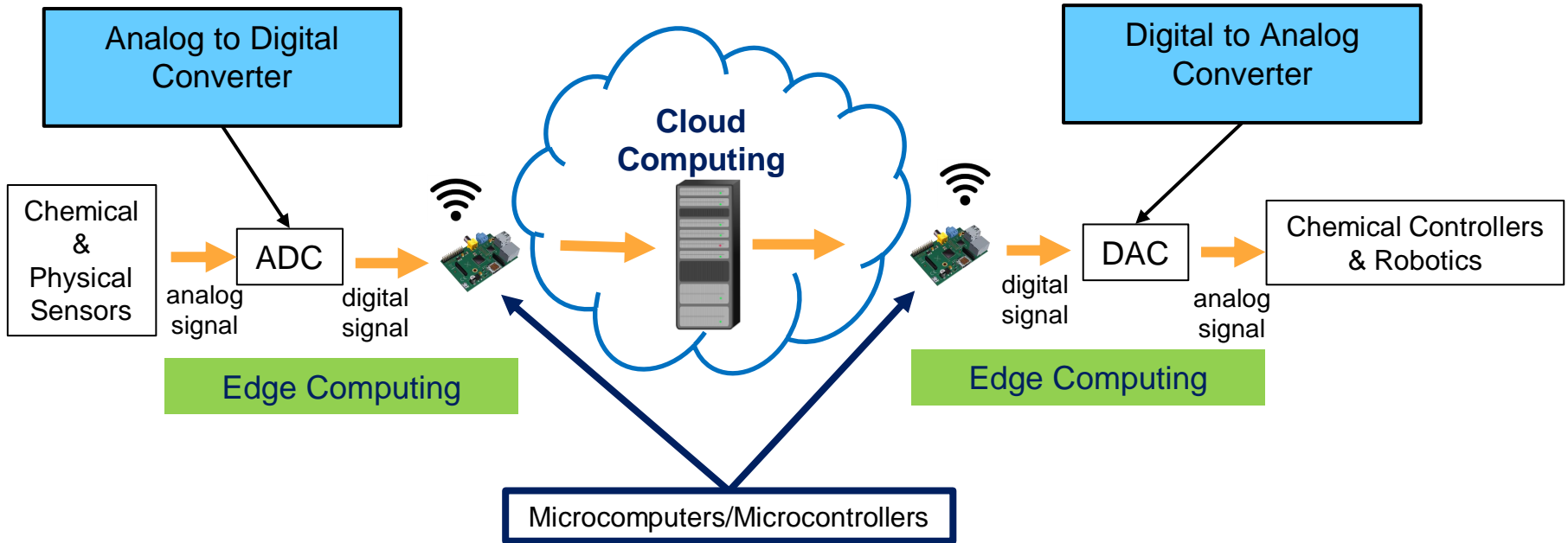
- Web 4.0 or the Symbiotic Web



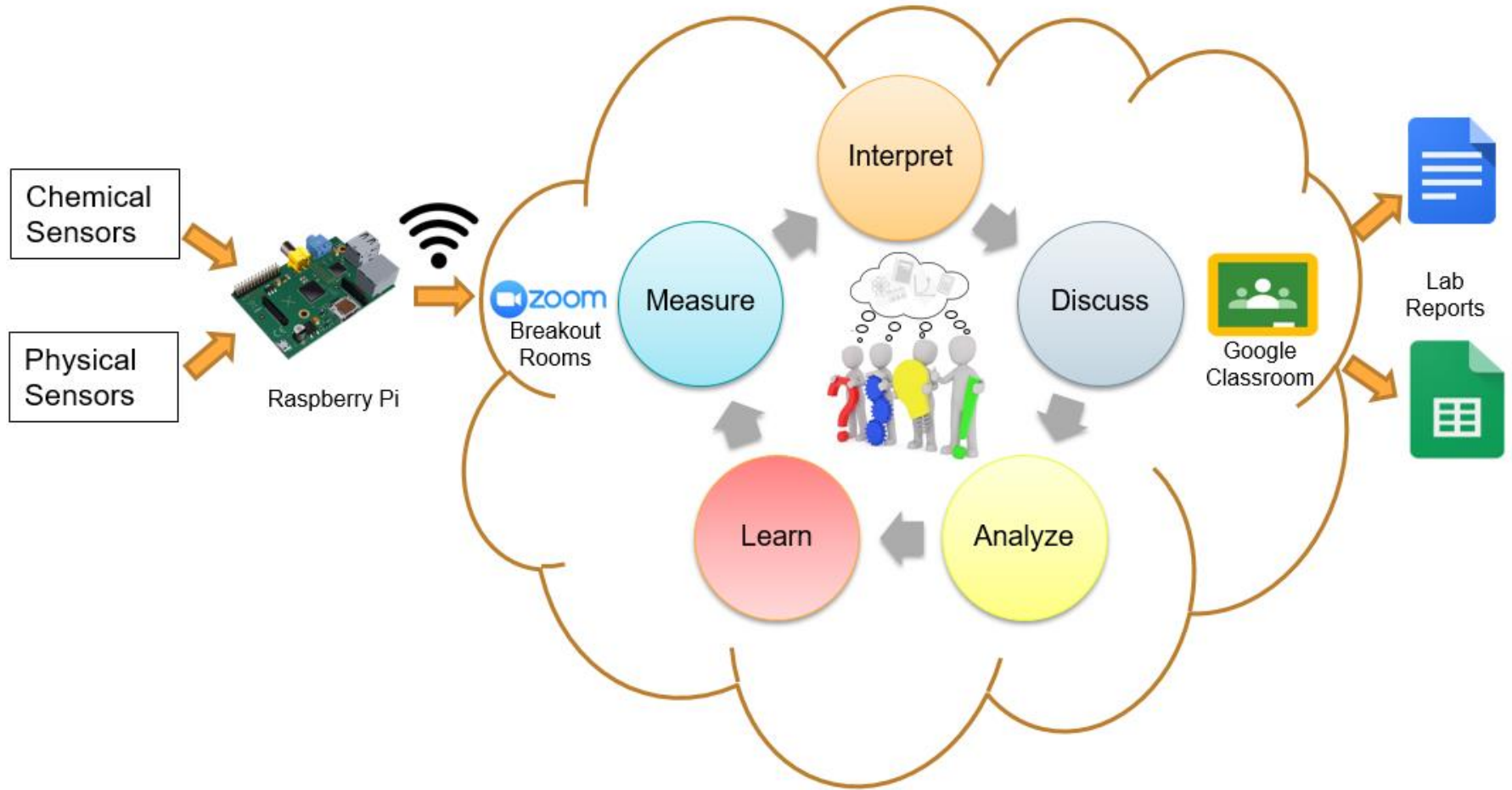
What is the Internet of Science Things?

Interconnected
Digital Networking
of
Physical Objects

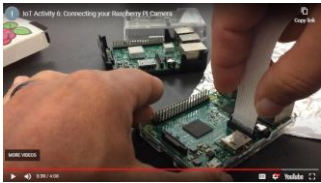
Connecting
Empirical Science
to
Data Science



What is an IOT Enhanced Lab?

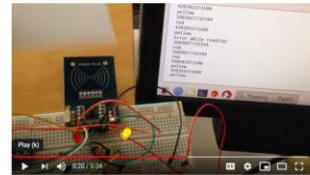


Internet of Science Things Courses



IoCT 7: RFID Cards

- Explore radio-frequency identification (RFID)
- Read and write to RFID tags
- Control processes based on RFID



Trigger Different LED lights with different card

Internet of Science Things (2020)

Last updated: Sep 3, 2020

Contributed by Robert Belford
Professor (Chemistry) at University of Arkansas at Little Rock

Class Zoom Link

**Resources
are
Freely Available
within
LibreText**

1: IOST Modules



- 1.1: Preparing your Computer for Class
- 1.2: Preparing your Raspberry Pi for Class
- 1.3: The Internet of Things
- 1.4: GPIO Outputs - First Circuit
- 1.5: GPIO Inputs

2: Python Modules



- 2.1: FlowCharts and Python
- 2.2: Input and Variables in Python
- 2.3: Arithmetic Operations and Assignment Statements
- 2.4: Predefined Functions
- 2.5: Boolean Expressions and Selection Statements

IOT Modules Initially Developed by Ehren Bucholtz

Python Activities

Py 1: Flowcharts & Python

- Explain how to display data in Python using Thonny IDE
- Explain how to create a comment in Python
- Determine the difference between a *string literal* and a number

Py 2: Input & Variables

- Explain how to input data in Python
- Explain the meaning and purpose of a variable
- Determine if a variable name is valid
- Explain concatenation and the use of "+"

Python Activities

Py 11: Lists

- Define a list
- Identify elements of a list
- Explain the purpose of `print()` and `range()` on a list
- Explain how to access individual elements of a list
- Explain how the following functions are used with lists: `append()`, `insert()`, `remove()`, `count()`, `index()`
- Explain how to explore an item

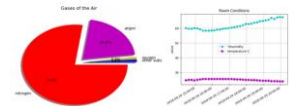
Py 12: List Functions

- Write code that reverses and sorts lists
- Write code that finds the largest or smallest element of a list
- Write code that reads from a file into a list

Python Activities

Py 13: Charts & Graphs

- Generate bar graphs
- Generate pie charts
- Generate line graphs
- Save your data as images



Python Activities adapted and modified from CS-POGIL



<https://ioct.tech>



CS-POGIL

<http://cspogil.org>

Process Oriented Guided Inquiry Learning in Computer Science

[Home \(Activities\)](#)

[POGIL Info ▾](#)

[CS POGIL Info ▾](#)

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[About](#)

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This work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License, this material is a modification by Ehren Bucholtz and Robert Belford of [CS-POGIL](#) content, with the original material developed by Lisa Olivieri, which is available [here](#).

These Open Education Resources are Available in the LibreText HyperLibrary

Resources within LibreText can assist schools in adapting IOT Enhanced Labs

5: Appendix 3: General Tasks

Last updated: Jan 19, 2020, 10:44 AM by Robert E. Belford

★ ◀ 4: Packages and Libraries | 5.1: Connecting to UALR IOT WiFi ▶ PDF 🗨 Readability Donate













Contributed by [Robert Belford](#)

Professor (Chemistry) at [University of Arkansas at Little Rock](#)

This appendix will have general tasks that people involved with IOT will often need to perform. Some of these are school specific, and as more schools become involved, this appendix will need to be restructured.



🔗 × Topic hierarchy ✎

- | | |
|--|--|
|  5.1: Connecting to UALR IOT WiFi |  5.2: Creating Google email Account |
|  5.3: VNC Headless Mode Access |  5.4: Adjusting remote monitor settings |
|  5.5: Tips on Thonny |  5.6 Using PiTunnel |
|  5.7 Flowcharts Software |  5.8: Fritzing |
|  5.9: Using Zoom |  5.10: Monitoring your Raspberry Pi |

Raspberry Pi



Raspberry Pi 4 Model B - 1 GB RAM

PRODUCT ID: 4295

\$30.00

There are multiple versions of this item. Please select one from the options below:

1GB

2GB

\$35.00

4GB

\$55.00

8GB

OUT OF STOCK

IN STOCK

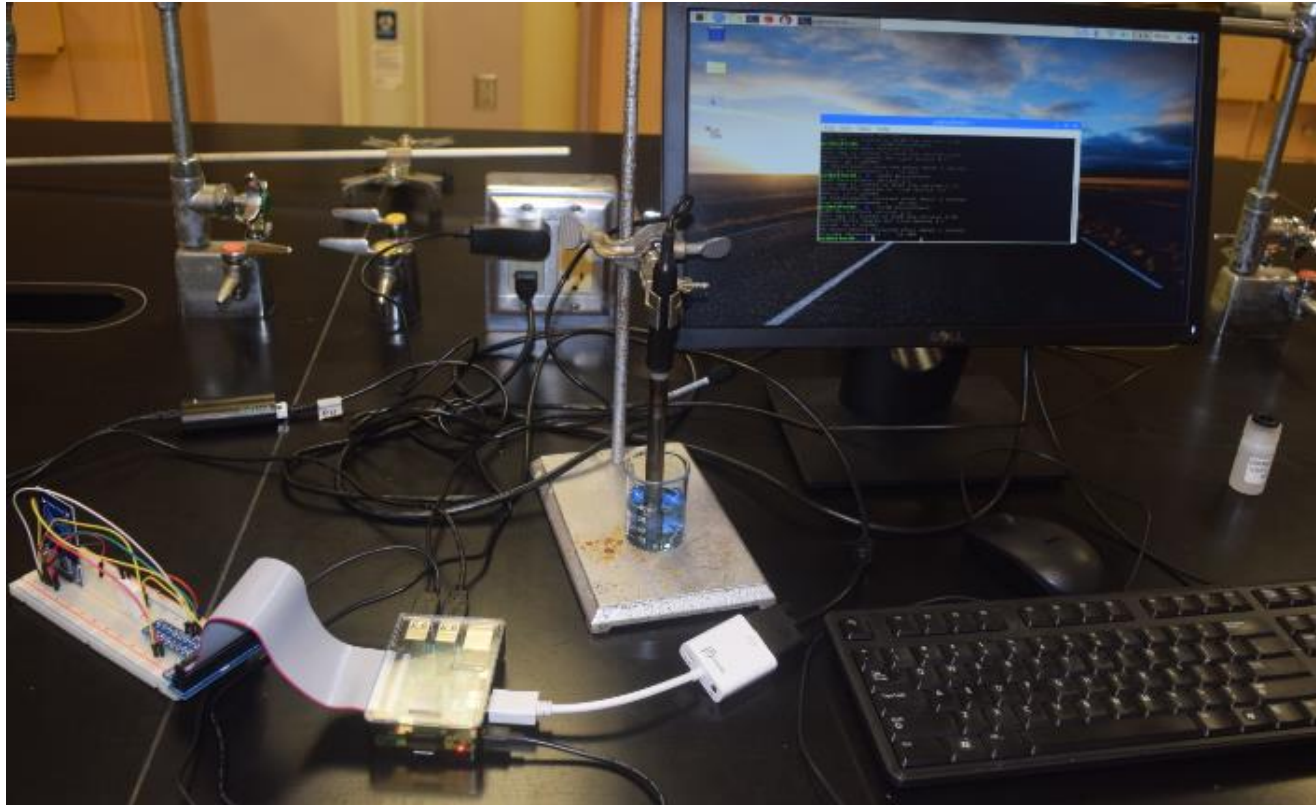
MAX PER CUSTOMER: 1

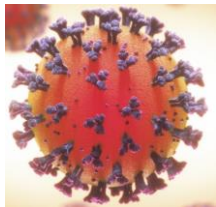
1

ADD TO CART

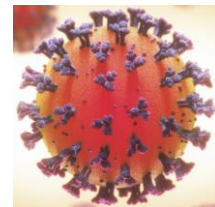
Raspberry Pi

<https://ioct.tech>

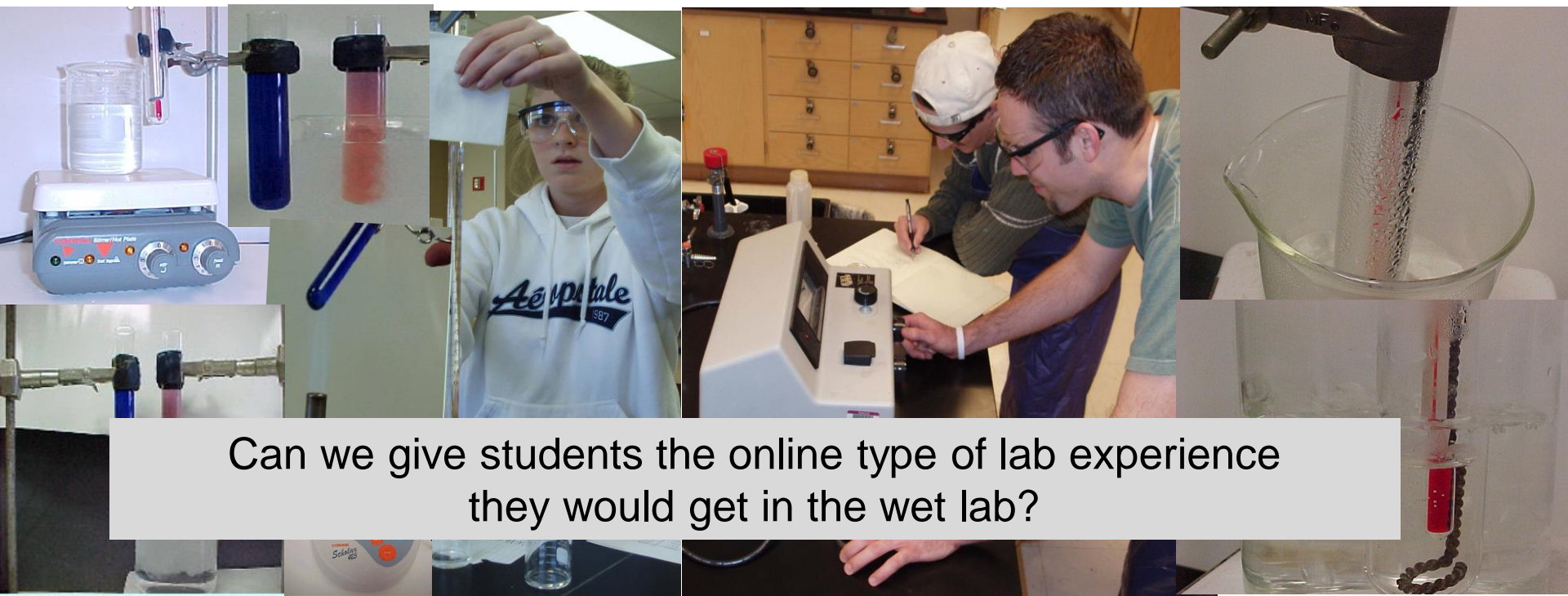




Summer 2020?

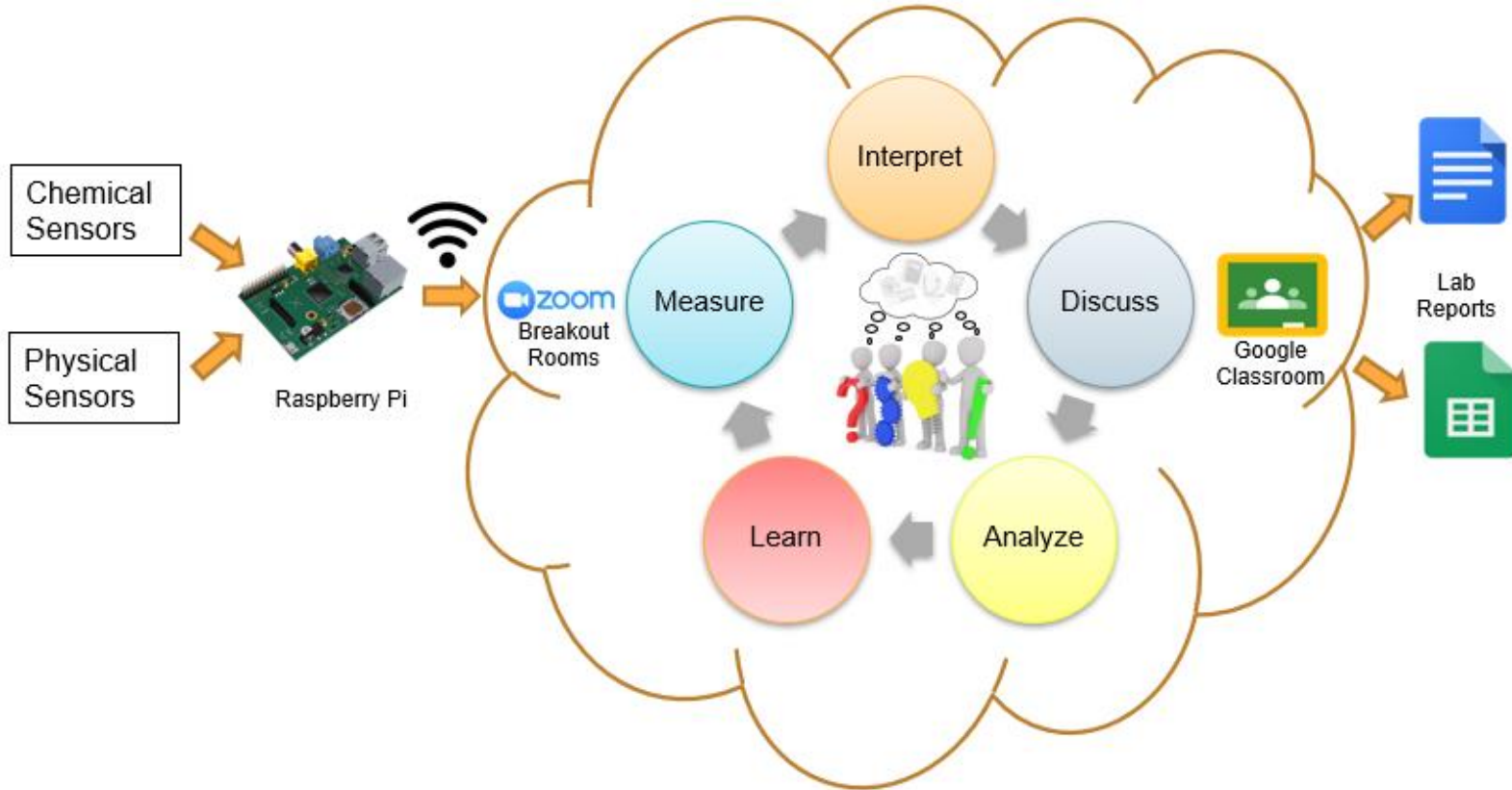


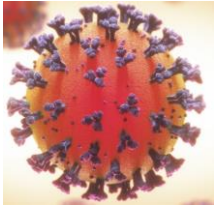
Can IOT enhance Online Chemistry Labs?



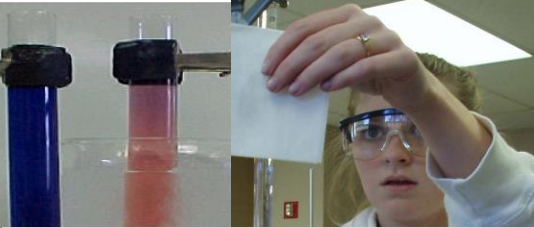
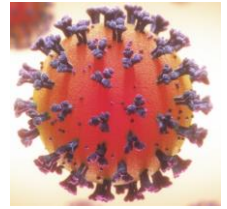
Can we give students the online type of lab experience they would get in the wet lab?

What are IOT Enhanced Labs





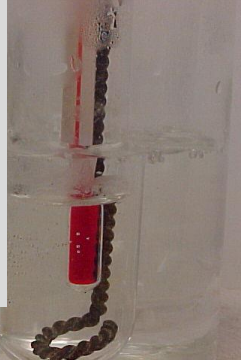
The First Lab: Safety

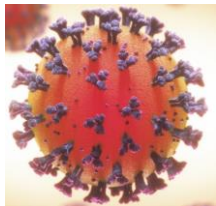


4 Goals

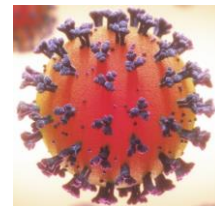
- Keep students safe
- Teach lab safety skills
- Teach safety literacy skills
- **Use safety to enhance group engagement**

No Student is Alone in the LAB!





Chemical Safety in Remote Instruction



ACS Publications CBEN CAS MEMBERSHIP JOIN ACS

ACS
Chemistry for Life*

MEETINGS & EVENTS CAREERS STUDENTS & EDUCATORS COMMUNITIES DISCOVER CHEMISTRY AWARDS FUNDING MORE Search

ACS is committed to helping combat the global COVID-19 pandemic with initiatives and free resources. [Learn More](#)

American Chemical Society > ACS Webinars > Professional Development > Safer Chemistry Education at Home

Safer Chemistry Education at Home

ACS Webinars | May 7, 2020



The post-COVID science education environment has led to widespread remote and self-guided learning. With this explosion in home-based learning, it is important to emphasize safety concepts that should be observed outside of school. These safety concepts can apply to all levels of chemistry education and all science contexts. This circumstance is challenging to navigate from every perspective, but provides the opportunity to break down the disciplinary silos in education.

Join speakers Debbie Decker of UC Davis, Jennifer Bishoff of Frostburg University, and Ralph Stuart of Keene State College during this free interactive broadcast as they discuss safety concepts that can be applied in post-COVID remote and self-guided learning environment.



EXPERTS



Debbie M. Decker
University of California,
Davis



Jennifer Bishoff
Frostburg University



Ralph Stuart
Keene State College

CO-PRODUCED WITH

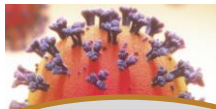


[Download Slides](#)

* If you are having technical difficulties viewing the video please try different internet browsers like Chrome, Firefox, and Explorer. If you still can not access the video please review the following computer prerequisites from our video hosting platform.

Google Search: **ACS Webinar Safer Chemistry Education at home**
(you can download the slides or watch the Webinar)

Chemical Safety in Remote Instruction



University's
Chemical
Hygiene Plan



OSHA's
Laboratory
Standard

Chemical Hygiene Plan

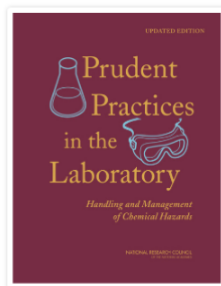
Every university has a CHP (Chemical Hygiene Plan) as required by OSHA standard [29 CFR 1910.1450](#) and a CHO (Chemical Hygiene Officer) who is responsible for its implementation, and UALR's CHP can be found at this [Facilities Management Web Page](#). Within the CHP are a set of standard SOPs (Safe Operating Procedures) that represent the minimum safe practices for the handling of hazardous chemicals. Every research lab at the university is required to develop and maintain SOPs for the laboratory practices that are performed within their labs, and here is a link to the template for developing [laboratory specific SOPs](#). The CHP also defines the PPE (Personal Protective Equipment) needed to perform work in a laboratory, and in the university teaching laboratory the instructor would be responsible for ensuring students abide by the established SOPs, and wear proper PPE, like safety glasses and closed toe shoes (no flip-flops in the chemistry laboratory), and do not perform any unauthorized experiments. Unfortunately, it will be impossible for an instructor to ensure students abide by the SOPs in an online course where lab work is being performed remotely, and thus for reasons of safety we will not be able to perform many of the experiments that could be done remotely in a kitchen.

Chemical Safety Resources

Student Practices

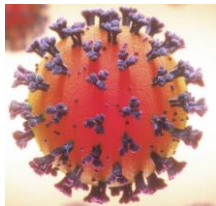
The [National Research Council of the National Academies of Sciences](#) has published a book "Prudent Practices in the Laboratory" that can be downloaded for free. It contains a wealth of information on chemical safety, including a copy of OSHA's Laboratory Standard (29 CFR 1910.1450). There is also an [accompanying zip file](#) that contains Laboratory Chemical Safety Summaries (LCSS) and additional information.

Free
Resource
from National
Academy



University's Safe
Operating
Procedures

Figure 1: NRC Prudent Practices in the Laboratory



Chemical Safety in Remote Instruction



PubChem Laboratory
Chemical Safety
Summaries

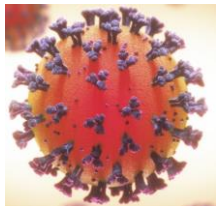
PubChem LCSS

The National Institute of Health's (NIH) National Library of Medicine's (NLM) PubChem have developed LCSS that model the LCSS of the NRC, but extract data from multiple chemical compound databases. As of May 2020 there are LCSS for 141,993 chemical substances that can be obtained through PubChem. This is a very valuable resource for finding safety information on chemicals.

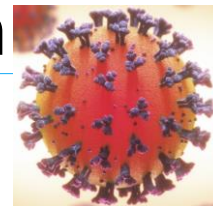
COVID-19 Pandemic Issues

To complicate matters this course is being taught in an online environment where students may need to purchase items directly through a store, or through an online service. Students are expected to follow CDC guidelines when in public, which includes covering your mouth and nose when in public. The following YouTube went viral (no pun intended) and if you have not seen it, you may want to watch and think about it. The last thing you need to do is catch COVID-19 because you had someone deliver supplies, and they coughed on the box.

COVID 19
Guidelines



Chemical Safety in Remote Instruction



UALR Online Lab Material

For this lab we will be using Google Classroom. If you already familiar with it - great! If not, don't worry, it is very easy to use. You can learn more about each type below. There are specific requirements for each type of group assignments. You can find it in the General Information section in Google Classroom. Make sure you read the information provided there and watch the

Importance of Group Work from the Safety Perspective

Group Assignments

For the group assignments you will be divided into Zoom Breakout Rooms. Each group will have a shared Google doc that all members have access to and can edit at the same time. Each student is required to submit their copy of the group assignment by the due date to get credit.

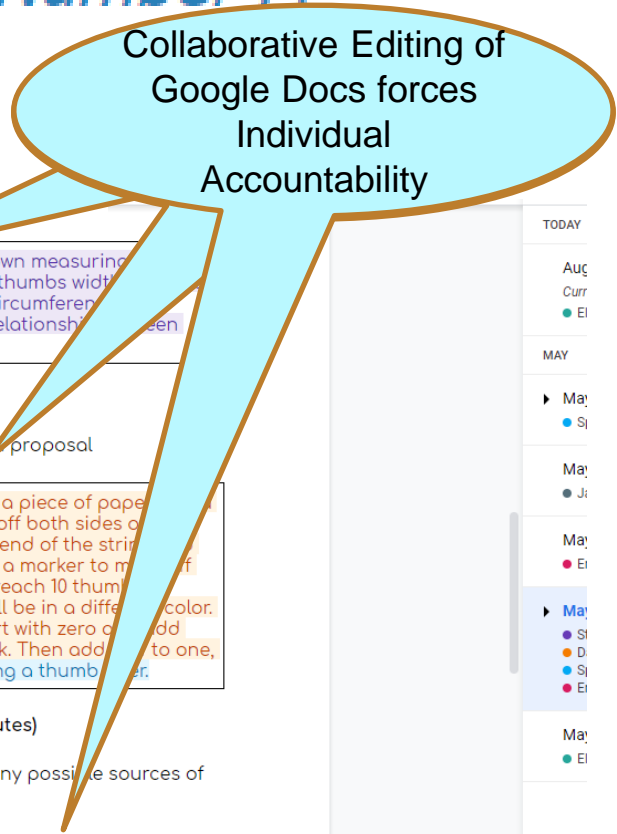
Group manager is responsible for communicating with the group members and instructors. If one of the group members stops participating in group activities or disconnects it is manager's responsibility to contact that member to figure out what happened. If the manager can't get ahold of the "disappeared" member, the group manager must contact instructors immediately.

The video below will help you understand why you need to have to be on Zoom call during all labs.



Measurements and the Irrational Number Pi

Experiment 1: Measurements Design Proposal



This worksheet is to be used for the [Experiment 1: Measurements](#) in the class LibreText. Each group will create a proposal to determine Pi using two scales based on each student's thumb (see LibreText before starting). The instructor will then review the proposals and then provide the class with a standardized experimental procedure within LibreText.

This activity will take place in three parts.

Part 1: 11:00-11:20 AM

Design an experiment to determine the irrational number Pi.

Part 2: 11:20-11:35 AM

Give a three-minute presentation to the class. You need to screen share your screen and discuss the supplies you will need.

Part 3: 11:35-11:50

Prepare the final design proposal and submit to Google Classroom. This should reflect the entire class's presentations.

The Objective of this experiment is to create our own measuring device and scale using the units we've created using our thumbs with this measuring device to measure diameter and circumference of circular objects. Finally graphing and showing a relationship between diameter, circumference, and pi.

2. Experimental design (5 minutes)

- o Team works, Engineer is the scribe
- o Briefly describe your experiment design proposal

The way we will measure off the string is by taking a piece of paper, pen, then placing your thumb down and marking off both sides of thumb. Once this is completed, we will secure one end of the string use the paper with our thumb measurements, use a marker to mark off one thumb measurement after the other until we reach 10 thumb measurements. Every fifth thumb measurement will be in a different color. To make the half thumb measurements we will start with zero and add half of the original measurement and make a mark. Then add to one, then 2, and so on. Measure the circumference using a thumb.

3. Error analysis of the design proposal (5 minutes)

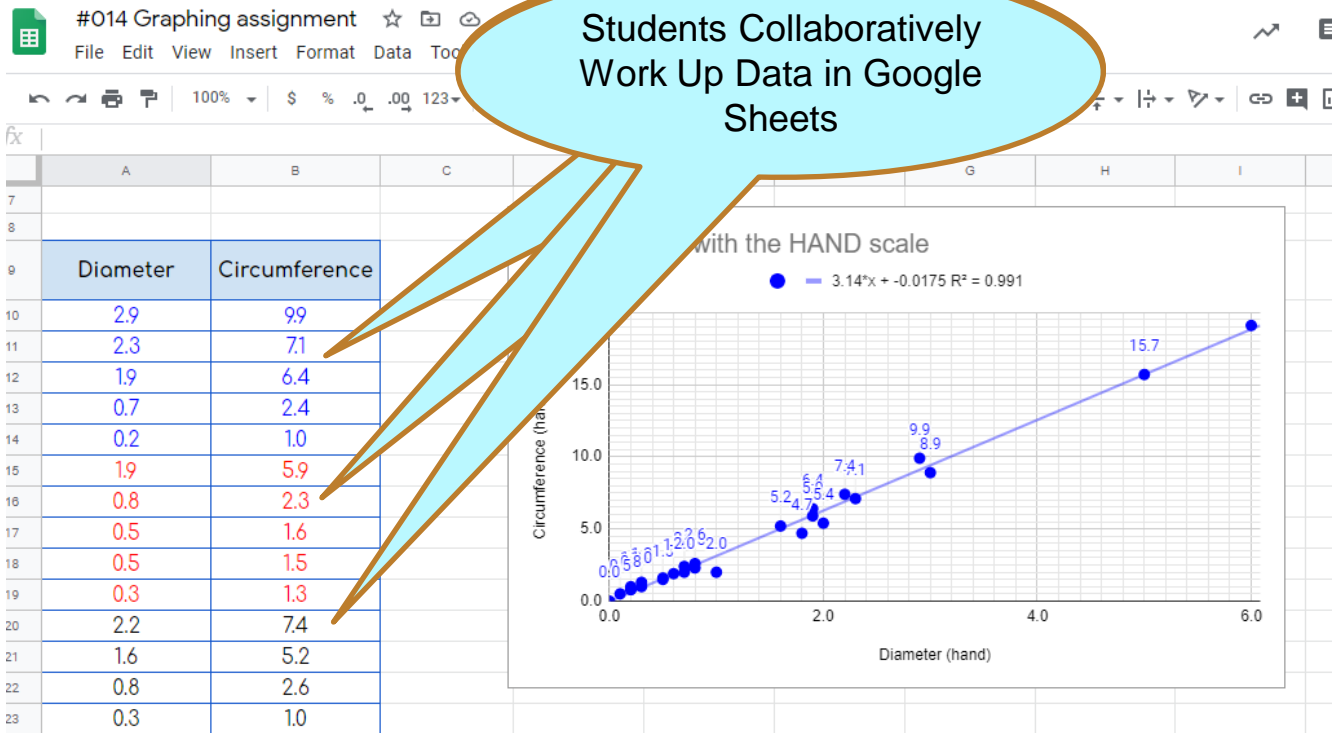
- o Team works, Analyst is the scribe
- o Evaluate your design and write below any possible sources of error

Possible sources of error may arise if there are variations within the size of each thumb. Systematic error can occur if the spacing between each thumb is not minimized to zero.

[Google Spreadsheet](#)

TODAY
AUG
Curr
● Ei
MAY
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Measurements and the Irrational Number Pi



[Google Spreadsheet](#)

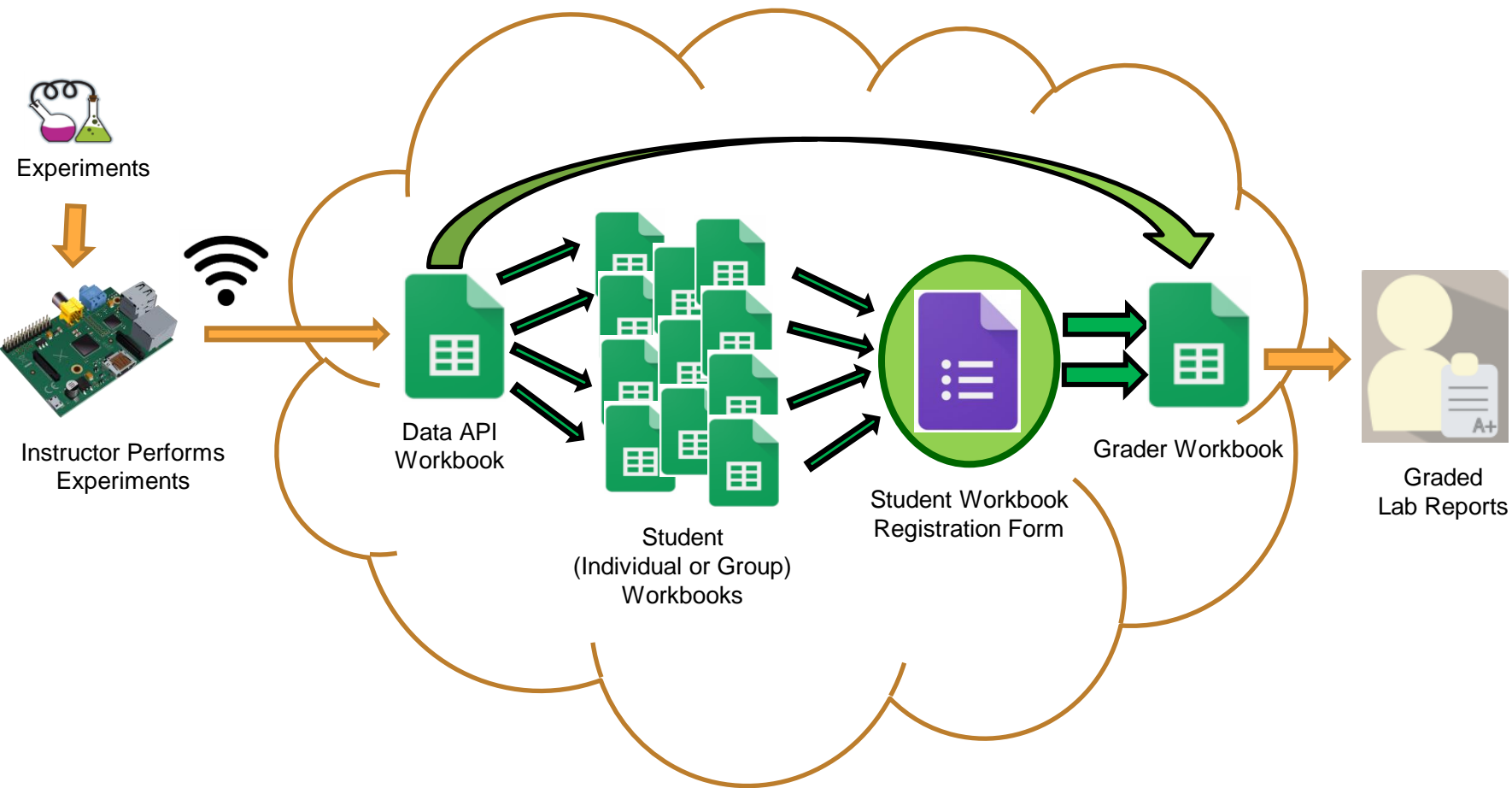
2 Paradigms for IOT-Enhanced Labs

- Teacher Does Experiment Students Collect Data
 - Instructor does experiment online, with guidance from students
 - Data gets broadcast to student groups, through copies of spreadsheet used to gather data

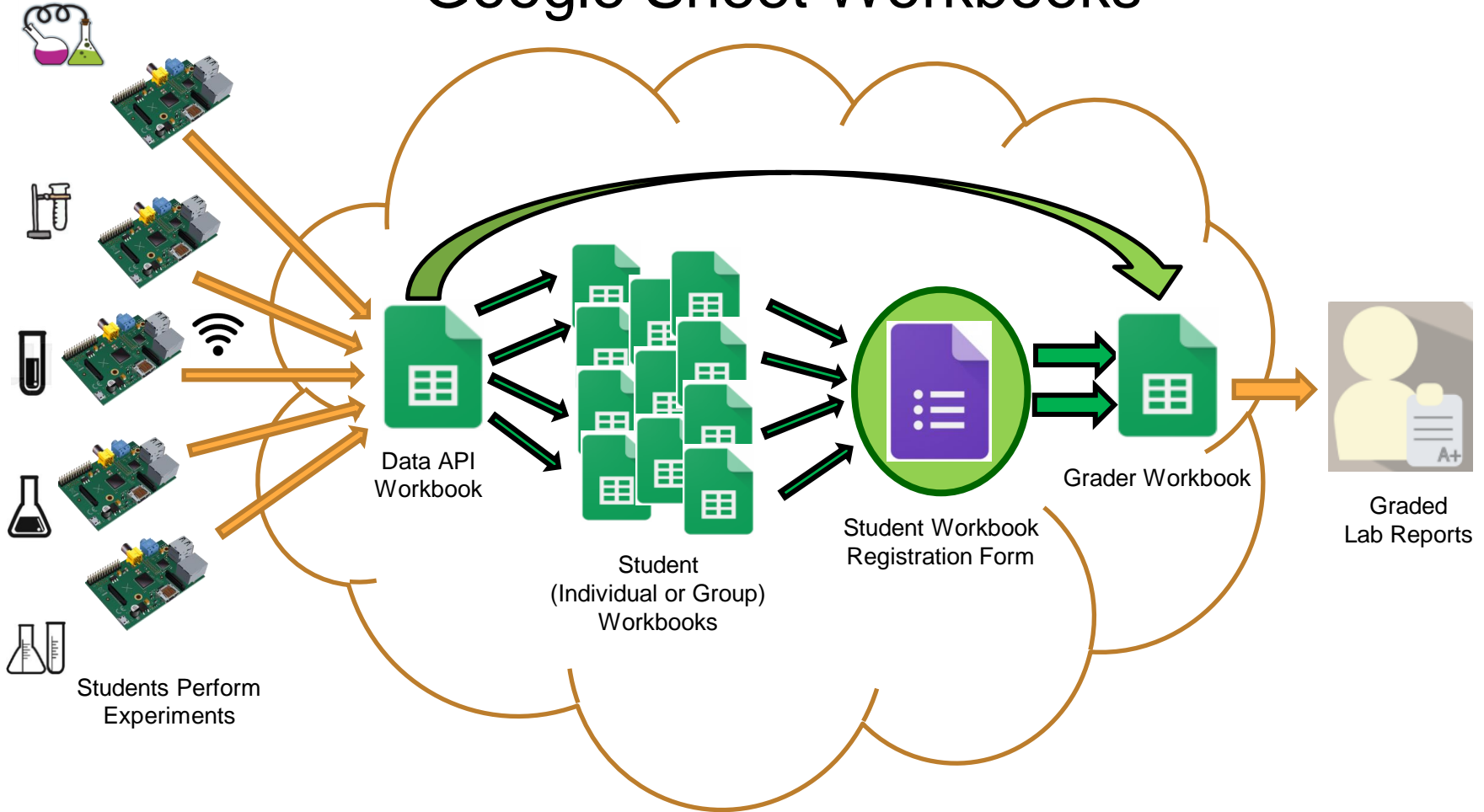
- Students do Experiment and Teacher Observes Data
 - Students have the equipment
 - Safety becomes an important issue

(Format Also Works with Simulations)

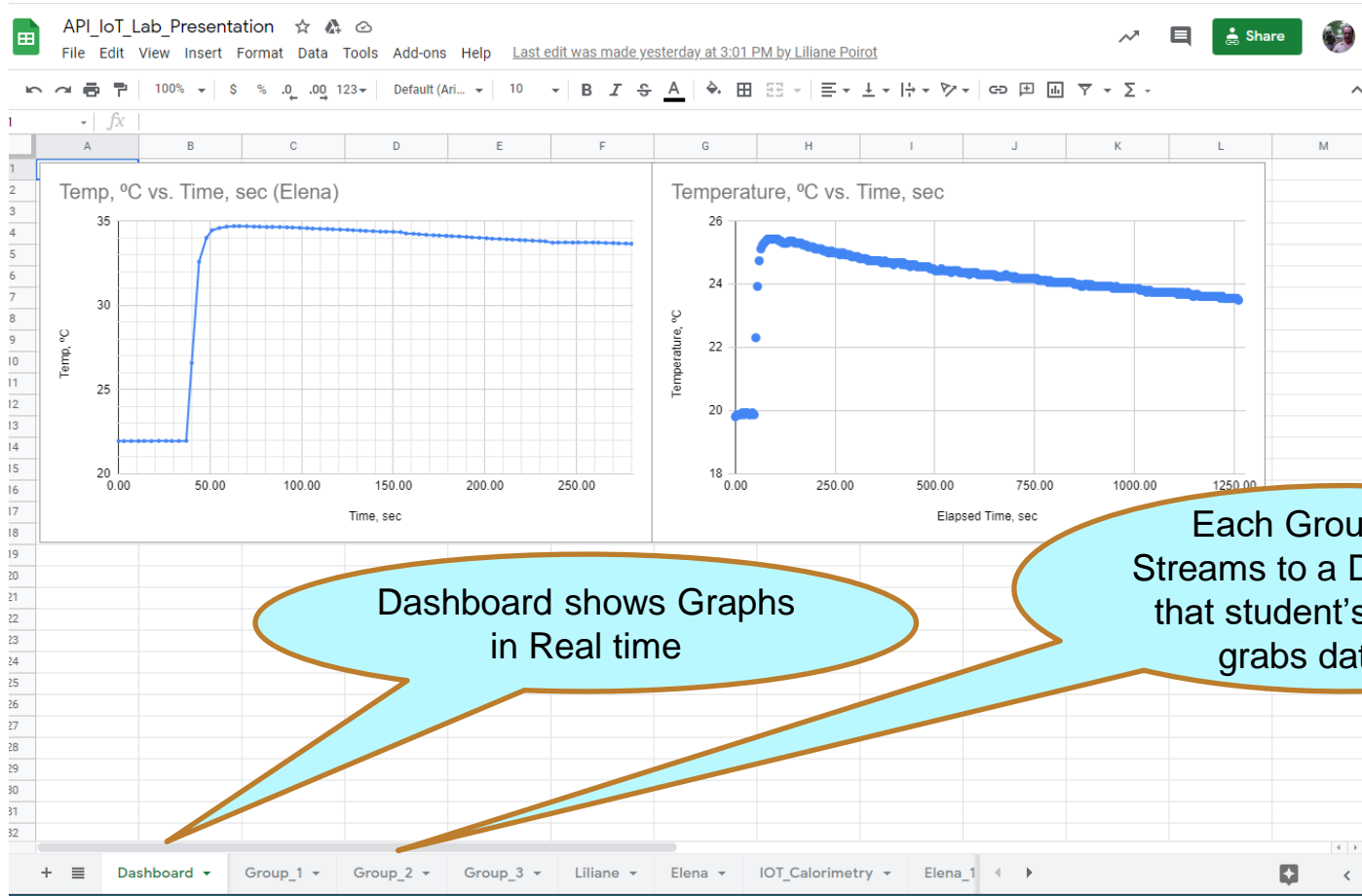
Google Sheet Workbooks



Google Sheet Workbooks



API Workbook



Dashboard shows Graphs in Real time

Each Group's Data Streams to a Different Tab that student's workbook grabs data from

Student Workbook CoverPage

Liliane Calorimetry Lab ☆ 📄 🌐
File Edit View Insert Format Data Tools Add-ons Help Last edit was made yesterday at 3:29 PM by Liliane Poirot

100% \$ % .0 .00 123 Arial 12

fx Group Number

	A	B
1	Group Number	
2	Experiment #	
3	Lab Section	
4	Date	
5		
6		
7	Results	Units
8	Molarity Stock Acid	2.00 M
9	Molarity Stock Base	2.00 M
10	Volume Acid	30 mL
11	Volume Base	30 mL
12	Initial Molarity Acid after mixing	1.00 M
13	Initial Molarity Base after mixing	1.00 M
14	moles limiting reagent	0.06 mol
15	mass solution	63.3 g
16	T Final	C
17	T Initial	C
18	Specific heat capacity solution	J/gC
19	Calorimetry constant	J
20	Heat of reaction	kJ/mol
21	Percent Error	%
22		
23		
24		
25		
26		
27		
28		

Temperature Chart

Place Chart Here

Graph grows in real time

Data pulled from color coded tabs

Cover_Page Data Prelab Calculations

Google Form

Calorimetry Submission Form

Your email address will be recorded when you submit this form.
Not **rebelford@ualr.edu**? [Switch account](#)

Name

Roberto Belford

Group number

Group_1

Group_2

Group_3

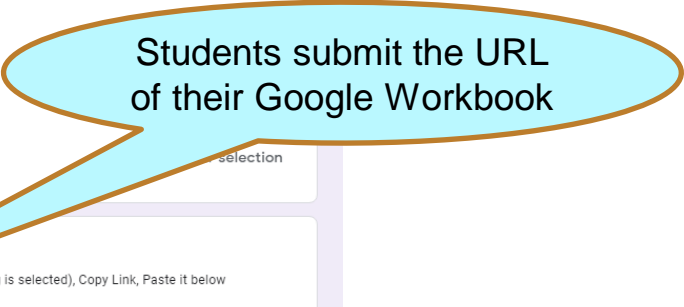
Group_4

Paste Link to Spreadsheet

Go to Spreadsheet, Select Share (make sure link sharing is selected), Copy Link, Paste it below

<https://docs.google.com/spreadsheets/d/109>

Submit



Instructor Workbook Data Page

The screenshot shows a Google Sheets interface with the following elements:

- Dropdown List:** A dropdown menu is open over cell C1, showing a list of student names: Molly Cule, Lilliane Poirot, F. Aaron Heidt, Elena Lisitsyna, Bob Belford, Roberto Belfordo, and Harry Houdini.
- Table:** A table with columns for Time, Temp, and another Temp column. The data points are as follows:

Time	Temp	Temp
0	21	33.241
4	21	33.602
8	21	33.705
12	21	33.733
15	21	33.696
19	21	33.666
23	21	33.641
26	28	33.599
30	33	33.573
33	33	33.541
37	33	33.511
41	33	33.489
45	33	33.474
48	33	33.45
52	33	
56	33	
59	33	
63	33	
67	33	
70	33	
74	33	
- Graph:** An embedded line graph titled 'Molly Cule Temperature Chart'. The x-axis is 'Time' (0 to 75) and the y-axis is 'Temp' (15 to 40). Blue dots represent 'Temp' data points. A red trendline is shown with the equation $-7.8E-03x + 34$. A red dot on the trendline at approximately Time=23 is highlighted, indicating a high temperature point.
- Summary Table:** A small table at the bottom right of the graph area:

Slope	0.007803429271
t mix	15
t Max	33.733
T Hot	33.87918164
- Navigation:** The bottom of the spreadsheet shows tabs for 'Data', 'GradeCover', 'GradePrelab', 'GradeCalculations', and 'Responses'.

Dropdown list to navigate student workbooks (Obtained from Google Form)

Autogenerated graph, first red point indicates high temp

Tabs navigate grading features

Instructor Workbook Cover Page

Instructor Sheet Calorimetry ☆ 📁 ☁

File Edit View Insert Format Data Tools Form Add-ons Help Last edit was seconds ago

100% \$ % .0 .00 123 Default (Ari... 10 B I S A

Student Name

Results	Units	Sig figs	Correct Answer	Correct Units
Molarity Stock Acid	2.00 M	<input checked="" type="checkbox"/>	2.00 M	
Molarity Stock Base	2.00 M	<input checked="" type="checkbox"/>	2.00 M	
Volume Acid	30 mL	<input checked="" type="checkbox"/>	30 mL	
Volume Base	30 mL	<input checked="" type="checkbox"/>	30 mL	
Initial Molarity Acid after mixing	1.00 M	<input checked="" type="checkbox"/>	1 M	
Initial Molarity Base after mixing	1.00 M	<input checked="" type="checkbox"/>	1 M	
moles limiting reagent	0.06 mol	<input checked="" type="checkbox"/>	0.06 mol	
mass solution	65.2 g	<input type="checkbox"/>	65.2 g	
T Final	33.85354966 C	<input type="checkbox"/>	33.85354966 C	
T Initial	21.425 C	<input type="checkbox"/>	21.425 C	
Specific heat capacity solution	4.184 J/gC	<input checked="" type="checkbox"/>	4.184 J/gC	
Calorimetry constant	25 J	<input checked="" type="checkbox"/>	25 J	
Heat of reaction	-70.03967196 kJ/mol	<input checked="" type="checkbox"/>	-60.03967196 kJ/mol	
Percent Error	10.90 %	<input type="checkbox"/>	7.60 %	

Answers Pt	Value	Units
2	1	1
2	1	1
2	1	1
4	1	1
4	1	1
6	1	1
4	1	1
2	1	1
4	1	1
5	1	1
4	1	1
10	1	1
6	1	1
57	14	14
Total Possible	85	
Total Score	61	
Grade	71.76%	

Acceptable answer range 0.2

Green indicates correct answer

Pale yellow indicates incorrect answer

+ ☰ Data GradeCover GradePrelab GradeCalculations Responses

Instructor Workbook Response Page

Response page grabs student URLs from Google Form

The screenshot shows a Google Sheets spreadsheet with the following data:

Timestamp	Email Address	Name	Paste Link to Spreadsheet	Group number	Range		API Link
3/11/2021 20:21:24	Impoirot@ualr.edu	Molly Cule	https://docs.google.com/	Group_3	A1:B22	Group_3	A1:B22
3/13/2021 14:25:15	Impoirot@ualr.edu	Liliane Poirot	https://docs.google.com/	Group_2	A1:B23	Group_2	A1:B23
3/13/2021 14:41:26	Impoirot@ualr.edu	F. Aaron Heidt	https://docs.google.com/	Group_3	A1:B23	Group_3	A1:B23
3/14/2021 14:46:53	evlisitsyna@ualr.edu	Elena Lisitsyna	https://docs.google.com/	Group_1	A1:B31	Group_1	A1:B31
3/14/2021 14:51:11	rebelford@ualr.edu	Bob Belford	https://docs.google.com/	Group_1	A1:B32	Group_1	A1:B32
3/14/2021 14:55:32	rebelford@ualr.edu	Roberto Belfordo	https://docs.google.com/	Group_1	A1:B33	Group_1	A1:B33
3/14/2021 15:36:00	Impoirot@ualr.edu	Harry Houdini	https://docs.google.com/	IOT_Calorimetry	A:B	IOT_Calorimetry	A:B

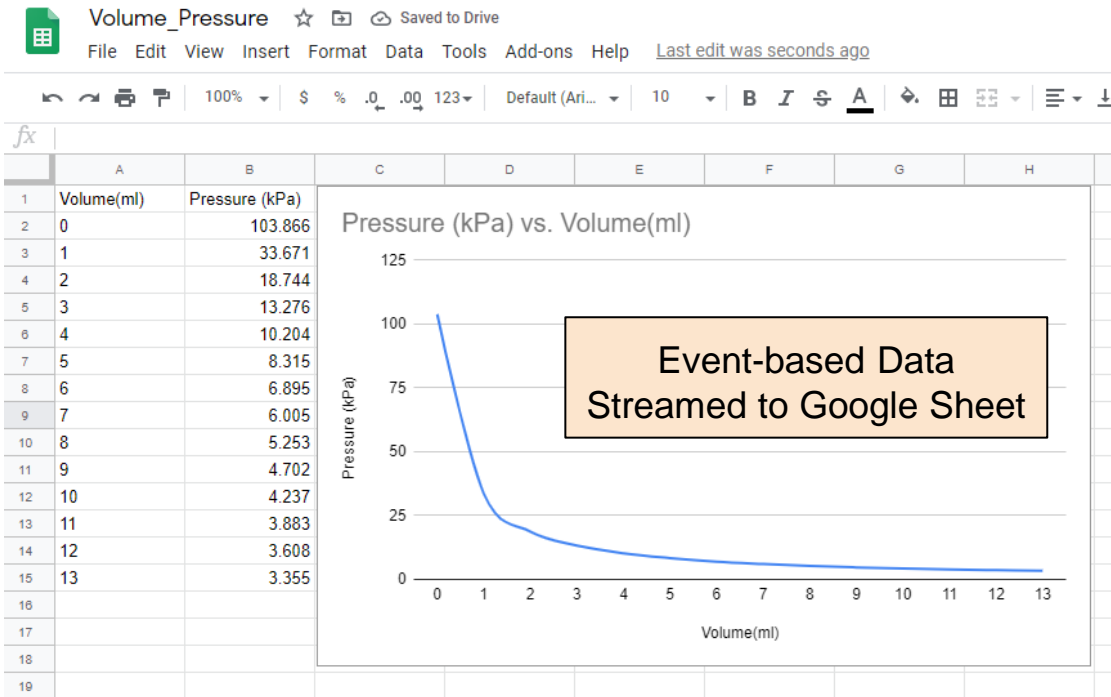
2 Types of IOT Enabled Data Streams

- **Event based data stream**
 - Input independent value and stream dependent value
 - Pressure and Volume of a gas

- **Time based data stream**
 - Values streamed over time intervals
 - Temperature and time

IOT Labs and Boyle's Law

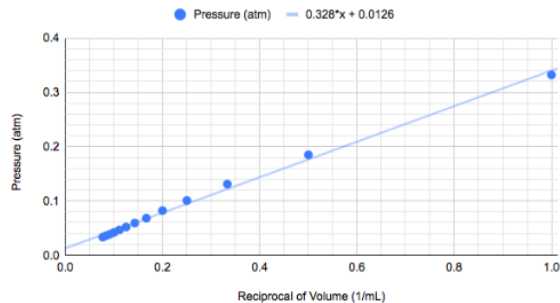
(Event Based PV data)

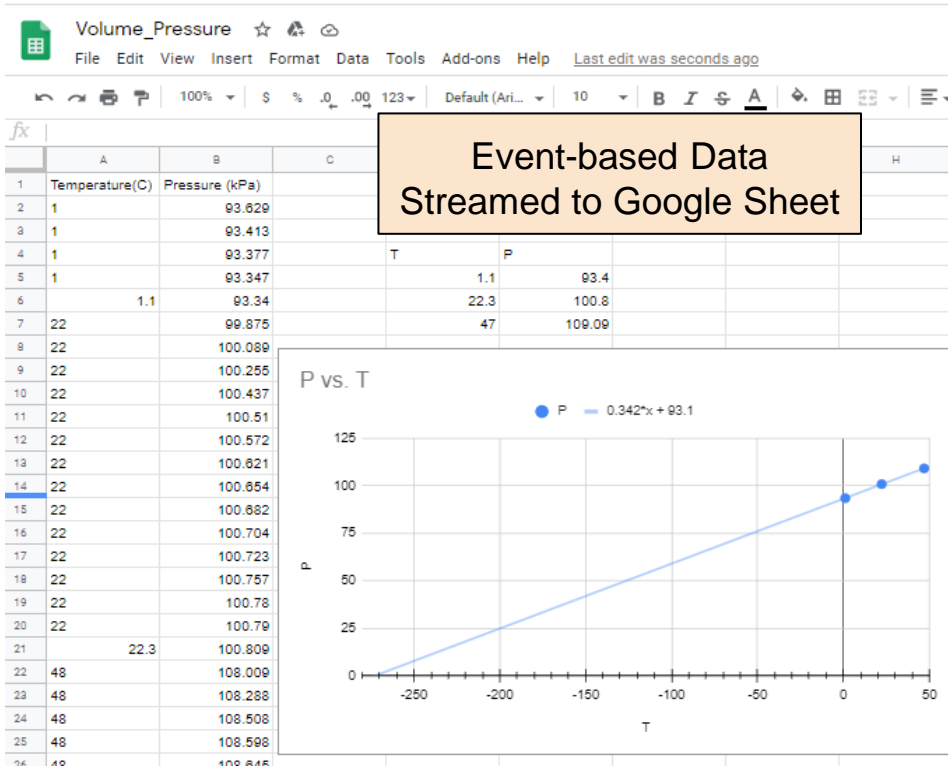


[Google Sheet](#)

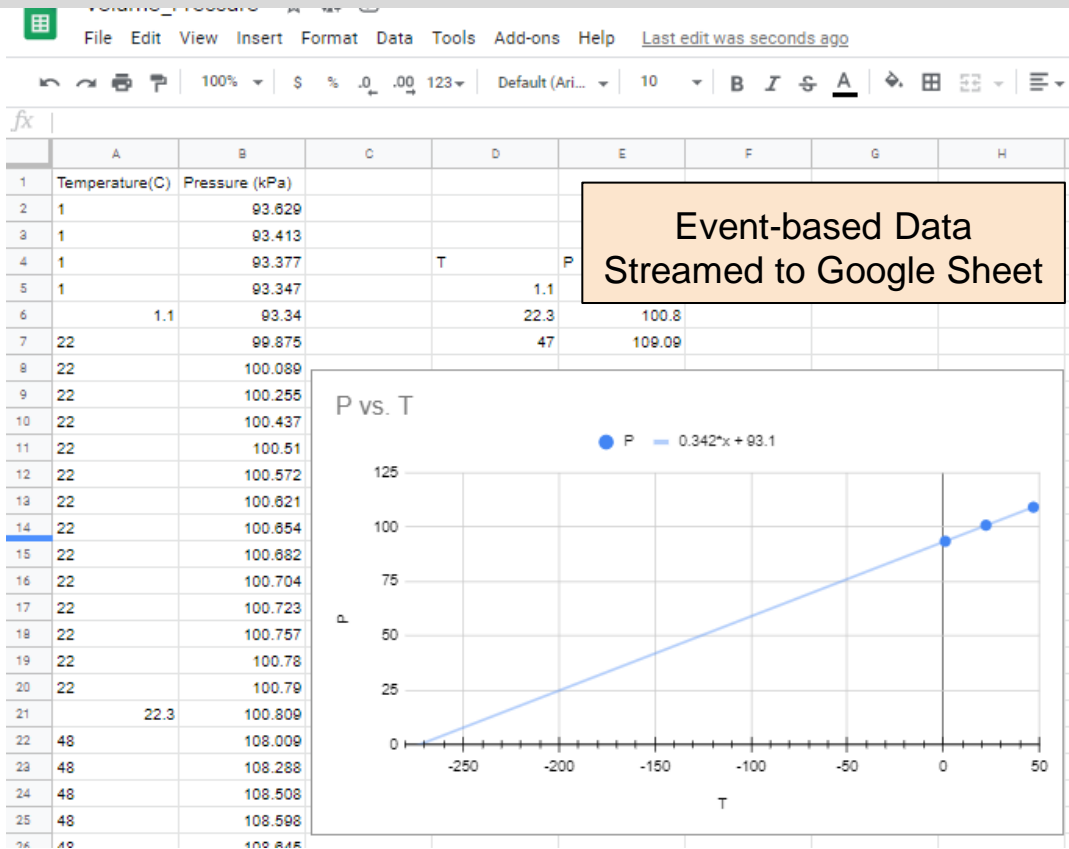


Graph 2: Pressure (atm) vs. Reciprocal of Volume (1/mL)

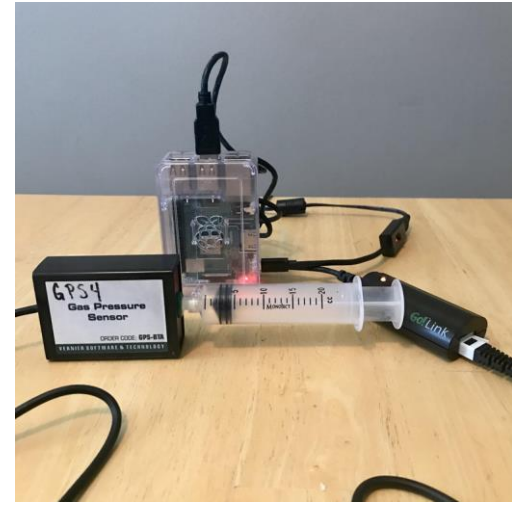




IOT Labs and Gay-Lussac's Law (Event Based PT data)



(Calculate Absolute Zero)



$$P = 0.342T + 93.1$$
$$\text{at } P = 0 \quad T = \frac{-93.1}{0.342} = -272.2^{\circ}\text{C}$$

(True Absolute Zero = -273.15°C)

IOT Labs and Calorimetry

(Time Based Enthalpy of Neutralization data)



Gikfun DS18B20 Temperature Sensor Waterproof Digital Thermal Probe Sensor for Arduino (Pack of 5pcs) EK1083

Visit the Gikfun Store

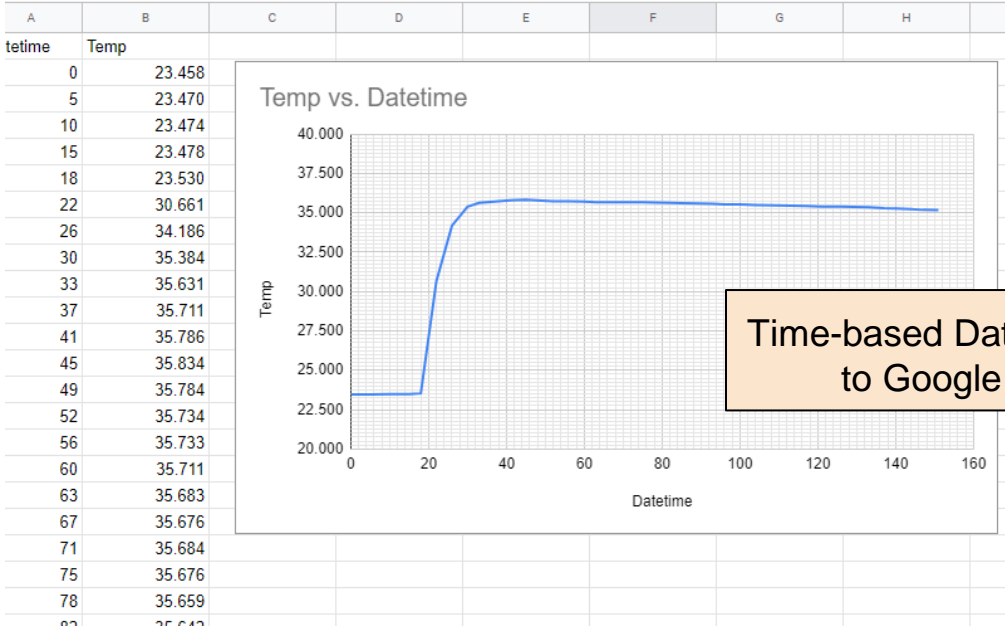
★★★★☆ 107 ratings | 5 answered questions

Amazon's Choice for "ds18b20"

Price: \$12.98 ✓prime & FREE Returns

Time_Temperature ☆ Saving...
File Edit View Insert Format Data Tools Add-ons Help [Last edit was seconds ago](#)

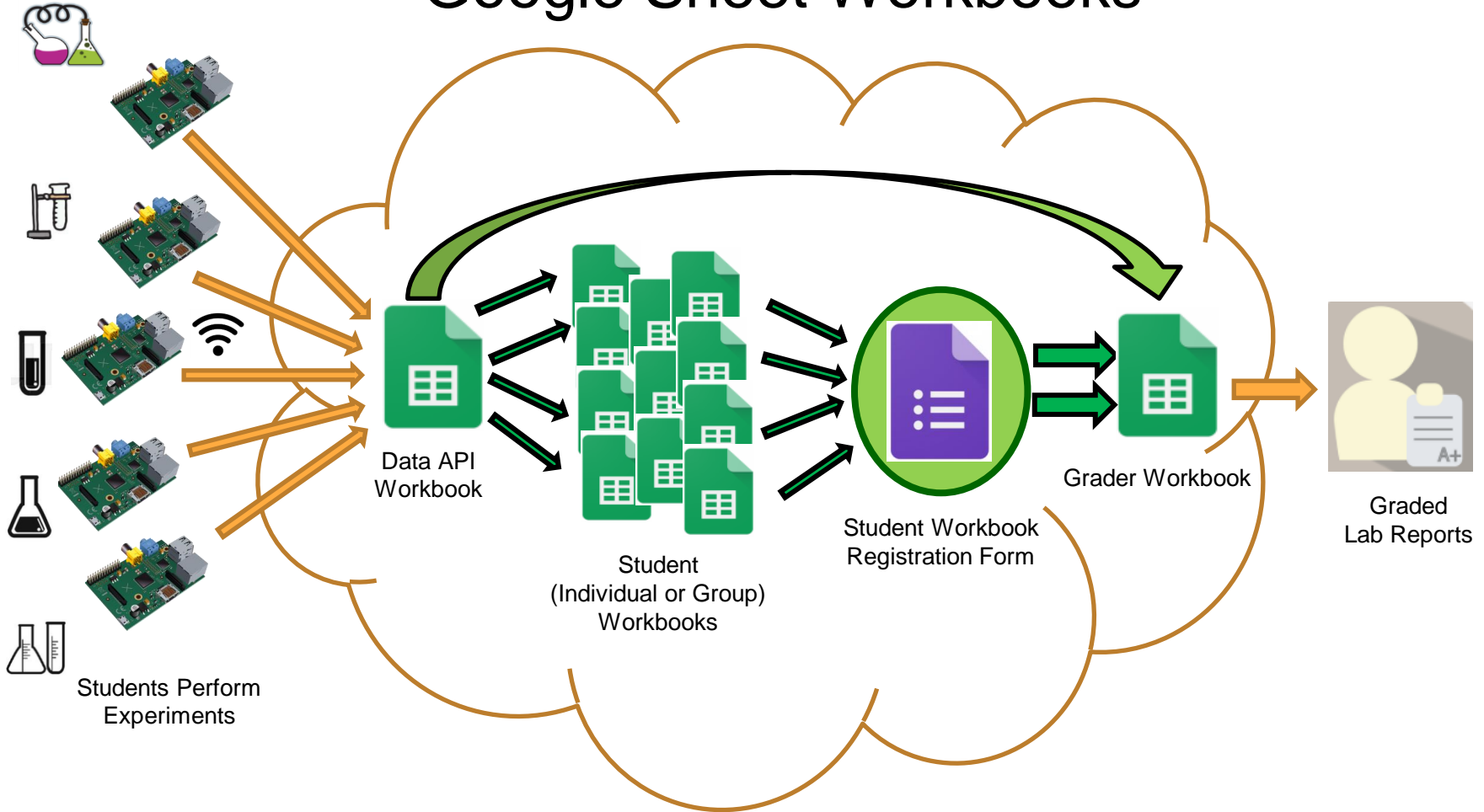
100% \$ % .0 .00 123 Default (Ari... 10 B I S A



[LibreText](#)

[Google Sheet](#)

Google Sheet Workbooks









Resources Posted in LibreText to Support IOT Enhanced Labs

5: Experiment 5 - Calorimetry

Last updated: Nov 12, 2020, 3:11 PM by Robert E. Belford Page restriction: Public Page ID: 214682

★ ◀ 4: Experiment 4: Calorimetry and Thermodynamic Structure

Ancillary Documents

-  MS Word  PDF [Google Doc](#) Experiment 5 Design Proposal
-  MS Word  PDF [Google Doc](#) Heat of Neutralization Lab Report
-  MS Word  PDF [Google Doc](#) Specific Heat Capacity Lab Report

Learning Objectives

Content:

- Calorimetry
- Calorimeter constant
- Specific heat capacity
- Heat of neutralization

Process:

- Design the calorimetry constant experiment
- Use virtual labs to find specific heat capacity of an unknown metal
- Observe the live data stream and use the data to calculate the heat of neutralization

Prior knowledge:

- [5.2: Specific Heat Capacity](#)
- [5.4: First Law of Thermodynamics](#)
- [5.5: Enthalpy Changes of Chemical Reactions](#)
- [5.6: Calorimetry](#)
- [5.7: Enthalpy Calculations](#)

– Table of contents

1. [What is IOT?](#)
2. [What is Raspberry Pi?](#)
3. [Heat Transfer](#)
4. [Calorimeter Constant](#)
5. [Heat of neutralization](#)
6. [Procedure](#)
 - 6.1. [June 8, 2020](#)
 - 6.2. [June 9, 2020](#)
 - 6.3. [June 10, 2020](#)
7. [Contributors and Attributions](#)

Ancillary documents allow you to make a copy of the Google Docs

Clicking a day lets you view the Google Doc

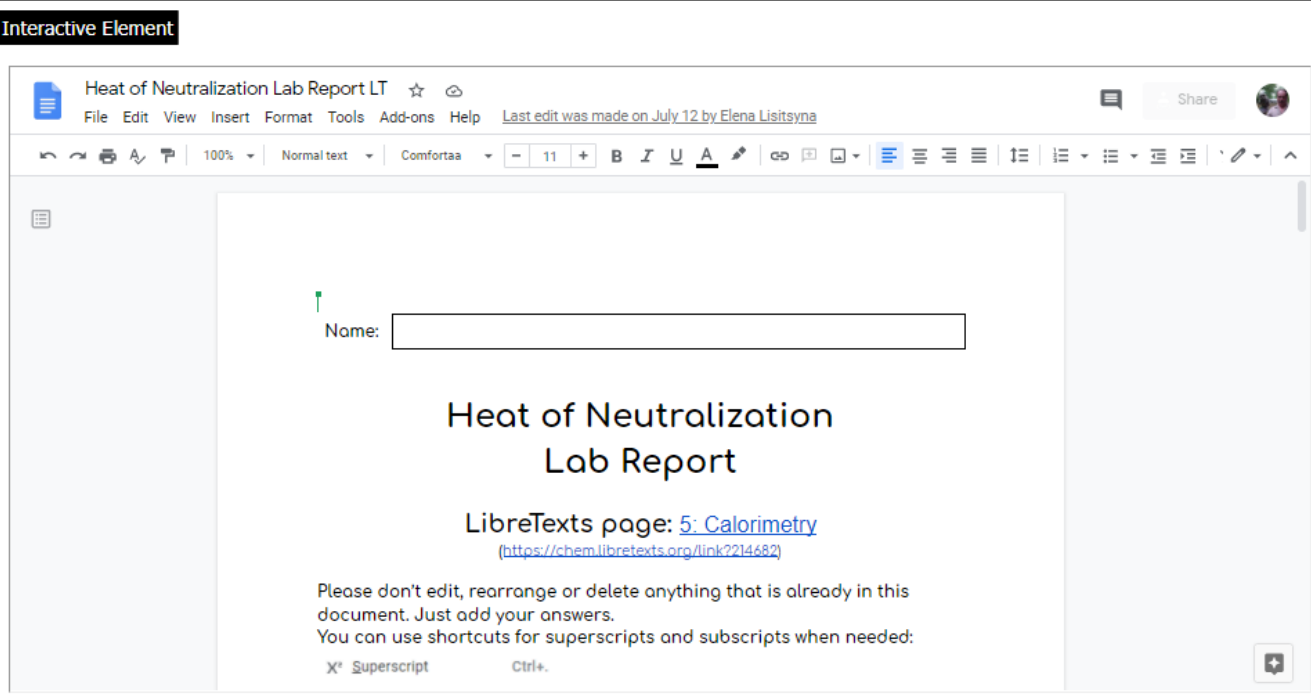
OER Resources to Support IOT Enhanced Labs

Access to Google Classroom Activities

June 10, 2020

During this lab you will first access the Google Sheet (link is in your Lab Report), the TA will perform the experiment and stream data directly to the Google Sheet. The data points will be added to the graph automatically. You need to **copy** the Google Sheet with the data and the graph, add a trendline and find T_H and T_C from the graph. Take a screenshot of your graph (make sure it has all necessary elements) and include it in your Lab Report.

Interactive Element



Heat of Neutralization Lab Report LT

File Edit View Insert Format Tools Add-ons Help Last edit was made on July 12 by Elena Lisitsyna

100% Normal text Comfortaa 11 B I U A

Name:

Heat of Neutralization Lab Report

LibreTexts page: [5: Calorimetry](https://chem.libretexts.org/link?214682)
(<https://chem.libretexts.org/link?214682>)

Please don't edit, rearrange or delete anything that is already in this document. Just add your answers.
You can use shortcuts for superscripts and subscripts when needed:
X⁺ Superscript Ctrl+.

OER Resources to Support IOT Enhanced Labs

CHEMISTRY LibreTexts

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How can we help you?

Contents Home Courses University of Arkansas Little Rock Chem 1402: General Chemistry 1 (Belford) Laboratory

Page settings

Introduction

This is the summer 2020 online general chemistry lab course at UALR that was developed in response to COVID-19. We did not have time to get authority for students to do labs in person. In this course we used Google Classroom as a platform for all assignments. The Instructor(TA(s)) could collaboratively edit Google Docs and Google Sheets. The Instructor(TA(s)) used Zoom breakout rooms to breakout students to breakout room. This entire course was over a period of 3 weeks and the IOT components used a Raspberry Pi to stream data to Google Sheets in real time.

All of the assignments were originally in Google Doc format, but have been converted to PDF documents in order to attach them to these LibreTexts. We have created a restricted access site for instructional material dealing with Google Classroom into LibreText. To access this material you need a LibreText account that is designed for instructors. If you wish to use Google Classroom you need to upload the MS Word Docs to Google Classroom. There are students used are added to the assignments in this lab manual section. There is a special Instructor Resources site that only faculty can instruct to setup Google Classroom and add these documents in the course. This is the special Instructor Resources site that only faculty can instruct to setup Google Classroom and add these documents in the course.

You can download individual and group assignments for each lab in PDF format. Look for the file download links at the beginning of each section.

- Course Information
- 1: Experiment 1 - Measurements
- 2: Experiment 2 - Nomenclature
- 3: Experiment 3 - Hydrated
- 4: Experiment 4 - Chemical Reactions
- 5: Experiment 5 - Calorimetry
- 6: Experiment 6 - Atomic Structure
- 7: Experiment 7 - Molecular Structure
- 8: Experiment 8 - Gases
- Appendix 1 - Precision of Measuring Devices
- Appendix 2 - Quantitative Techniques
- Instructor Resources**
- 1: Tips on Using Google Classroom
- 2: Python Files
- 3: Hydrated Salt
- 4: Streaming Data to Google Sheets using Raspberry Pi

If logged in as an Instructor you get access to the Instructor Resources

CHEMISTRY LibreTexts

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How can we help you?

Contents Home Courses University of Arkansas Little Rock Chem 1402: General Chemistry 1 (Belford) Laboratory

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Instructor Resources

Last updated: Nov 12, 2020, 3:19 PM by Robert E. Belford Page restriction: Private Page ID: 227142

Collaborative student activities in this lab were performed using Google Docs and Sheets that students discussed over Zoom breakout rooms, and they were managed in Google Classroom. In order to make these available to you we have inserted a table at the top of each lab called Ancillary Documents. Here you have links to several forms of the documents students used, and the "Google Doc" link allows you to make a copy of the Google Doc, which you can then revise and use in your classroom.

5: Experiment 5 - Calorimetry

Last updated: Nov 12, 2020, 1:39 PM by Robert E. Belford Page restriction: Public Page ID: 214682

Ancillary Documents

- MS Word PDF Google Doc Experiment 5 Design Proposal
- MS Word PDF Google Doc Heat of Neutralization Lab Report
- MS Word PDF Google Doc Specific Heat Capacity Lab Report

Figure 1: Screen capture of the Ancillary Documents for Experiment 5.

Instructions to set up a Google Sheet to accept data can be obtained at the IOST course site in LibreText. This is covered in IOST Module 1.3: The Internet of Things. You may also need to use some of the material in Section 1.6: Writing to Google Sheets of the IOST course shows you how to use a Raspberry Pi to accept data over the internet.

Topic hierarchy

- 1: Tips on Using Google Classroom
- 2: Python Files
- 3: Hydrated Salt
- 4: Streaming Data to Google Sheets using Raspberry Pi

Download Code

Acknowledgements

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Contact: rebelford@ualr.edu

