香港教育大學
The Education University of Hong Kong

How to create my own science experiments?

Bill Chi Ho YEUNG
Department of Science and Environmental Studies
The Education University of Hong Kong

科學與環境學系
Department of Science and Environmental Studies

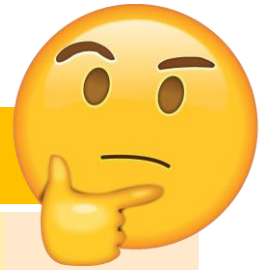
Motivations and Objectives

- Due to pandemic, all courses are delivered online; **science courses with experiments face extra challenges**
- Since science experiments require special apparatus, chemicals, laboratory spaces, etc., it can be **difficult or dangerous for learners to conduct experiments at home in online lessons**
- In this project, we aim

1. To **identify problems encountered by learners** in online science courses with experimental components
2. To **identify strategies**, mechanism or platforms which enable **learners experience experimental components** and acquire experimental skills in online science courses
3. To identify and **devise good practices** of conducting experimental components with learners for non-face-to-face course delivery

Simulations VS Animations/Videos

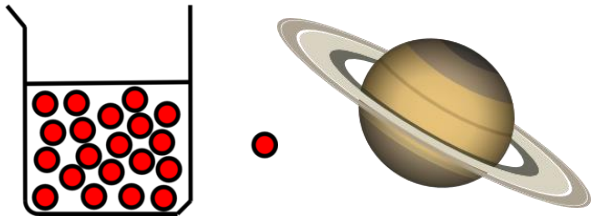
- Although they look similar, there are indeed difference between simulations and animations/videos:



Animations/Videos	Simulations
•	•
•	•
•	•
•	•
•	•

Advantages of simulation in science ed.

- Simultaneous **different representation** of the same concepts (e.g. movie, graph, etc.)
- **Visualize** and **understand** abstract science concepts
- **Replace** dangerous/infeasible/expensive experiments
- Change in **time-scale**, **size-scale**
- Active, hands-on learning
- Group-collaboration



Applications:

- **Lectures** (visualization, demonstrations, **experiments,** discussions)
- **Pre-lab**
- **Group projects**

Reference

R. Lindgre , Spatial learning and computer simulations in science (2009)

D. Gende, Science Simulations: A Virtual learning environment (2011)

Method 1

Adopting existing simulations in your own way

Platform (1)

Molecular Workbench

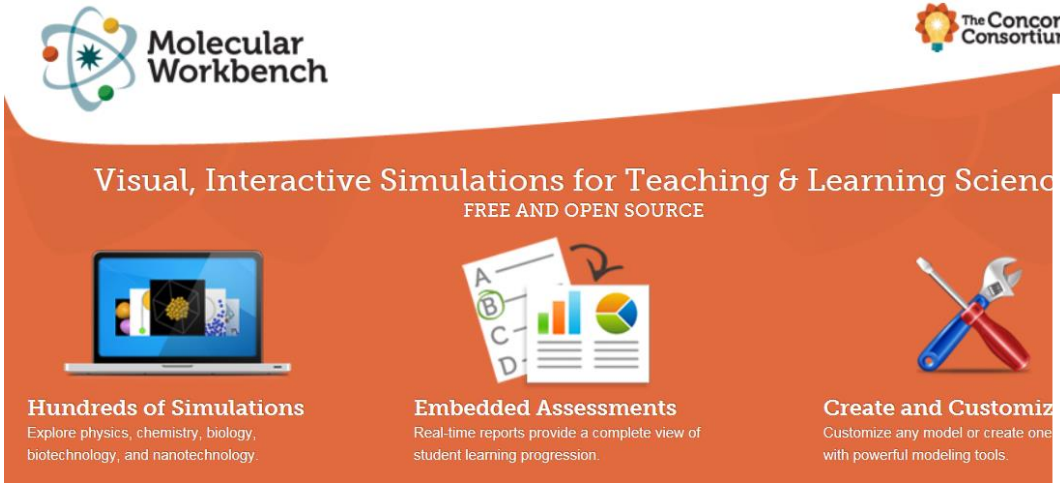
(1) Molecular Workbench (free)

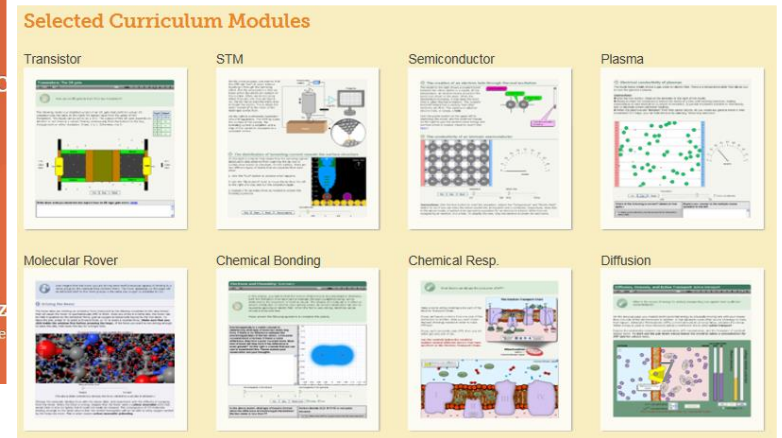
- **Molecular Workbench** is **free and open software** – "a modeling tool for teachers and students to **create their own simulations** and share them with collaborators":

  http://mw.concord.org/modeler/

  http://mw.concord.org/nextgen/

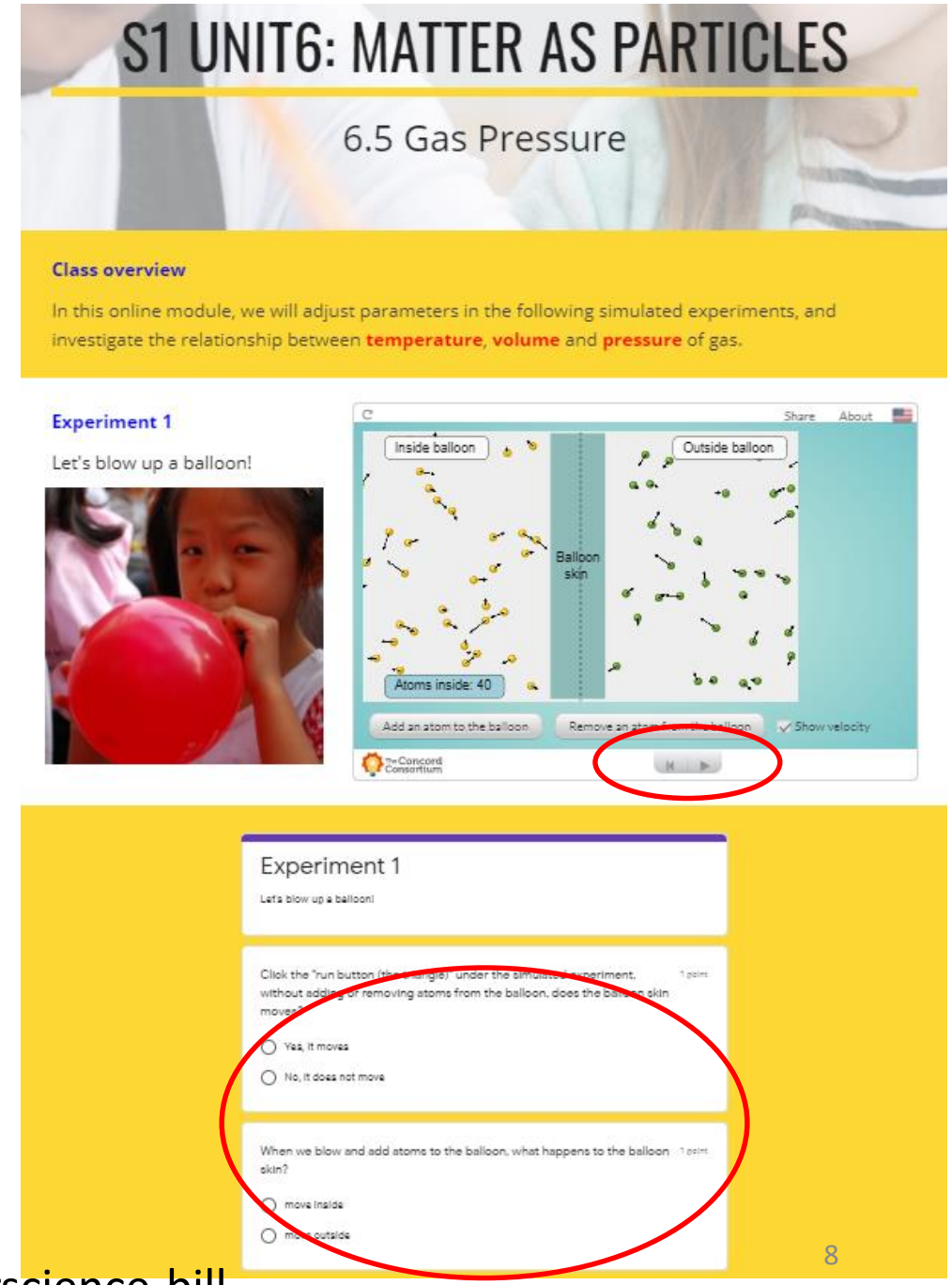
- Developed **Concord Consortium**, a non-profit educational research and development organization based in Concord, Massachusetts





How teachers use it?

- Teachers can set up online learning platform (e.g. google sites), **embed the simulated experiments**, and incorporate questions for students to adjust parameters
- Example:

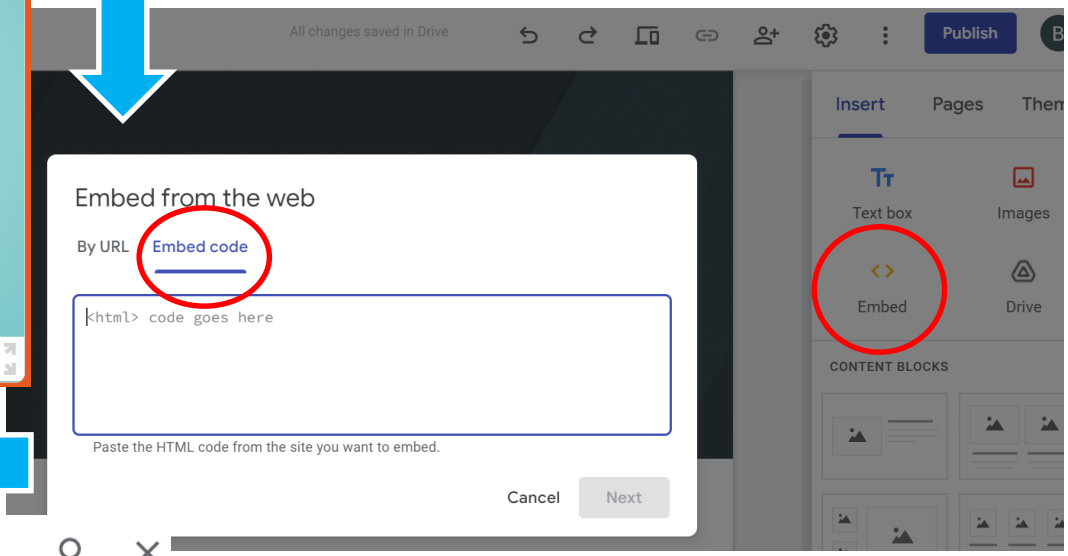


https://sites.google.com/view/s1juniorscience-bill

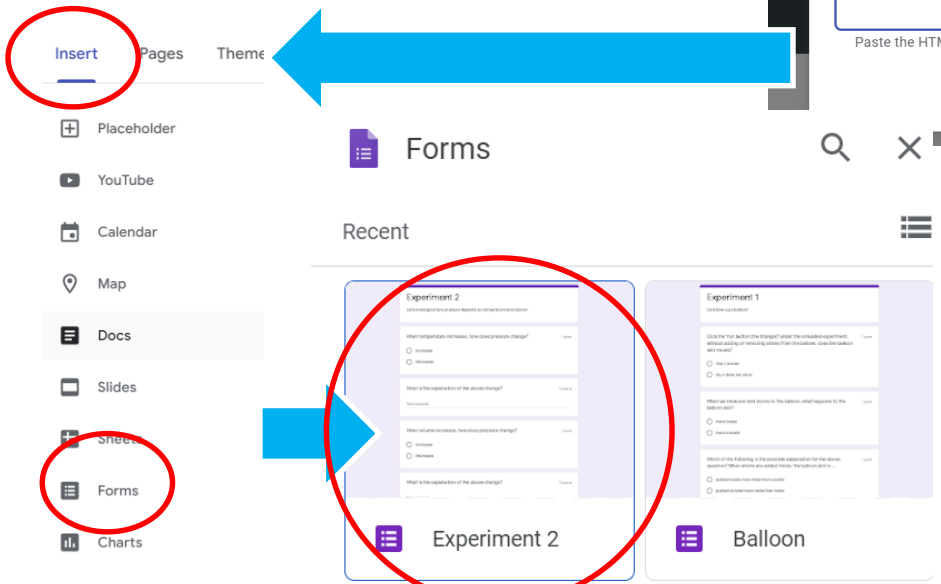
How to make it?

- It is indeed very simple:

Molecular workbench next-generation



Google site



Insert form in Google

Method 2

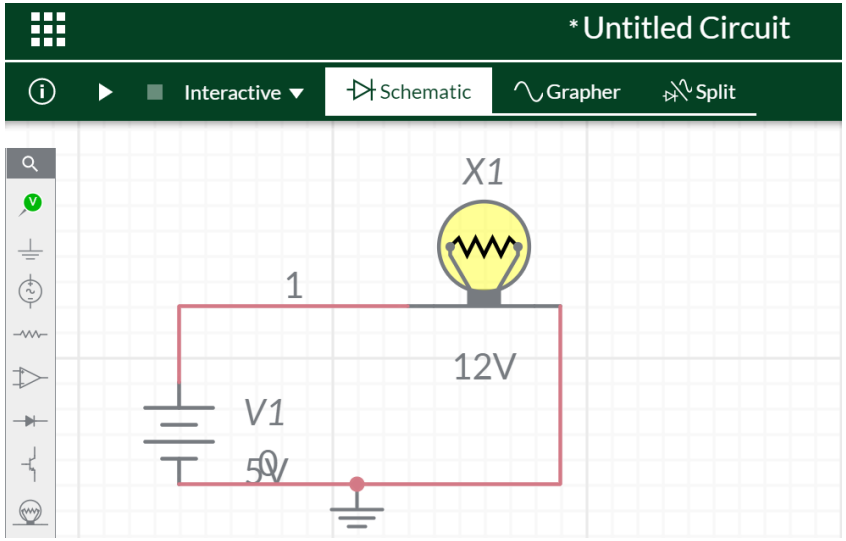
Creating your own experiments in feasible platforms

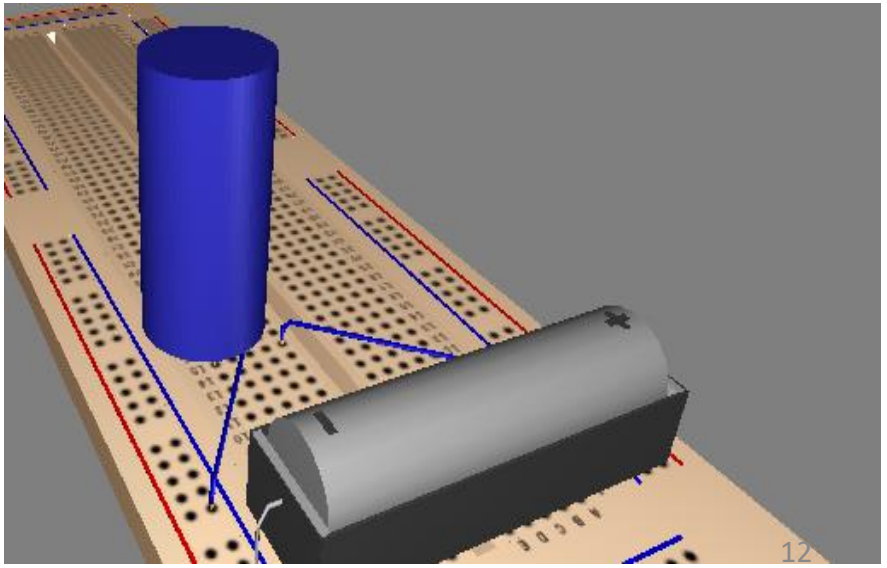
Platform (2)

MultiSim Live

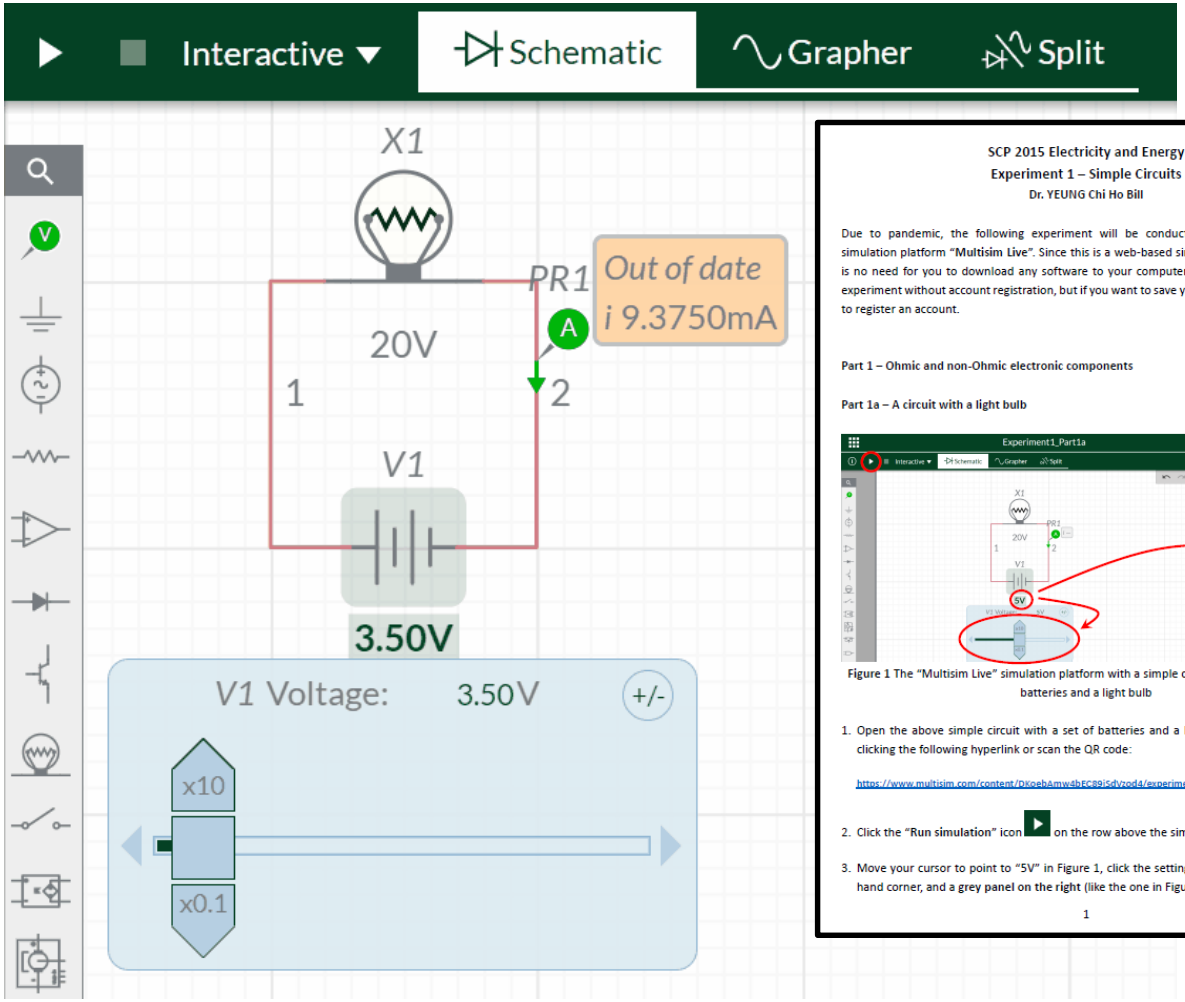
(2) MultiSim Live (free)

- Developer: Originally Electronic Workbench, now National Instruments (NI)
- Goal: circuit simulation and design program
- Origin: the software SPICE released in 1973 developed by UC Berkeley
- MultiSim is widely used in Universities, high school as well as the industry to design circuit; **MultiSim Live is free!**





Simulated Circuit Experiments (1)



SCP 2015 Electricity and Energy
Experiment 1 – Simple Circuits
Dr. YEUNG Chi Ho Bill

Due to pandemic, the following experiment will be conducted through online circuit simulation platform "**Multisim Live**". Since this is a web-based simulation platform, so there is no need for you to download any software to your computer. You can also conduct the experiment without account registration, but if you want to save your simulated file, you need to register an account.

Part 1 – Ohmic and non-Ohmic electronic components

Part 1a – A circuit with a light bulb

Figure 1 The "Multisim Live" simulation platform with a simple circuit consisting of a set of batteries and a light bulb

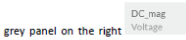
1. Open the above simple circuit with a set of batteries and a light bulb by clicking the following hyperlink or scan the QR code:

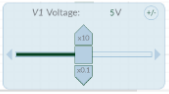
   https://www.multisim.com/content/DKoebAmw4bEC89i5dVzod4/experiment1_part1a/

2. Click the "**Run simulation**" icon ▶ on the row above the simulation platform:

3. Move your cursor to point to "5V" in Figure 1, click the setting icon ⚙ on the top right hand corner, and a **grey panel on the right** (like the one in Figure 1) will pop up

1

4. Change the voltage of the batteries from 5V to 1V, by either changing the number "5V" in the grey panel on the right 

, or by dragging the blue panel 

underlying "5V".

5. The current of the circuit is found here 

next to the symbol 

.

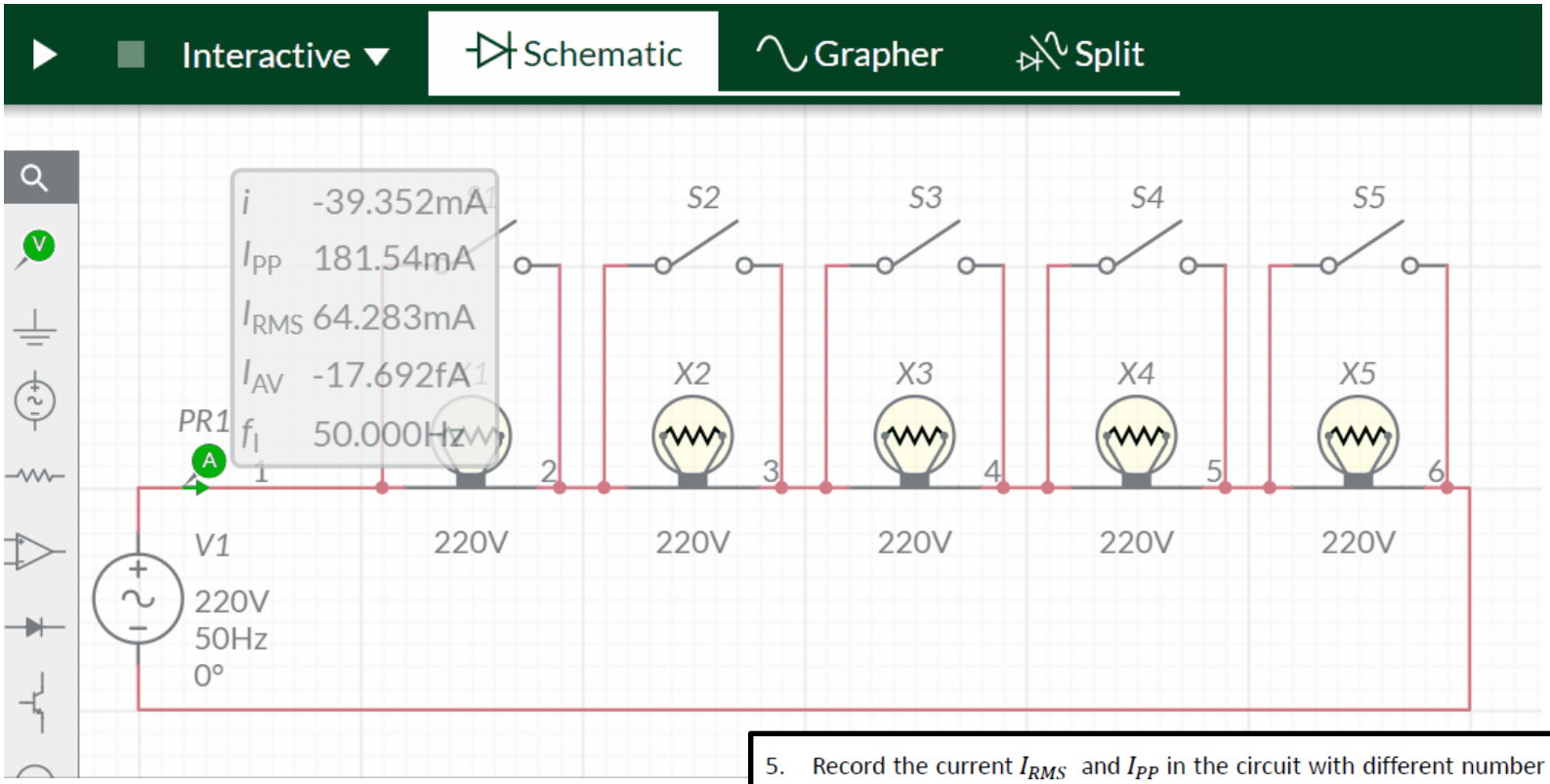
6. Record the current of the circuit with different voltage of the batteries as shown in the table below, and observe how brightness of the light bulb changes with voltage of the batteries:

Voltage of the batteries (V)	Current of the circuit (Unit =)
1	
2	
3	
5	
10	
15	
20	

Table 1a

2

Simulated Circuit Experiments (2)



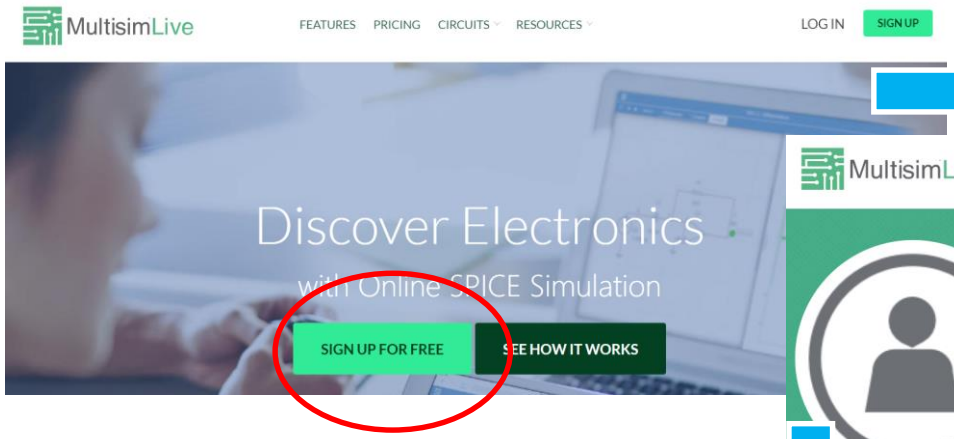
5. Record the current I_{RMS} and I_{PP} in the circuit with different number of closed switches as shown in the table below, and **observe how brightness of the switched-on light bulbs changes with the number of closed switches:**

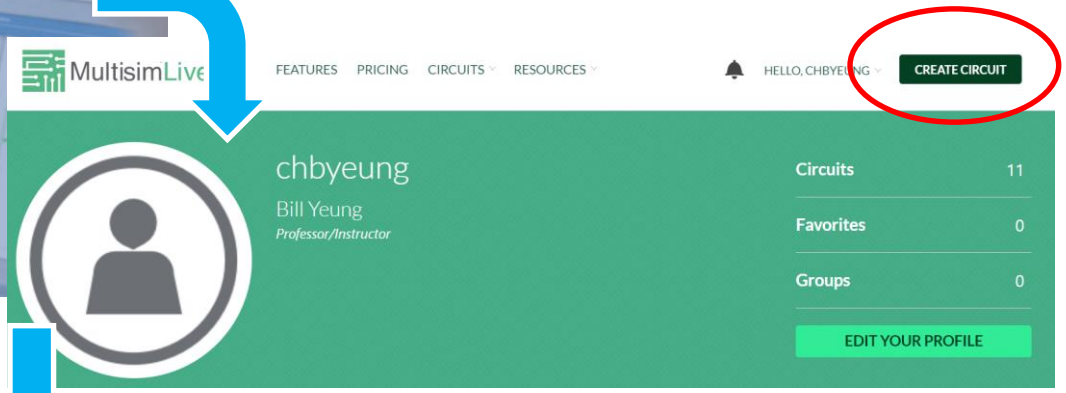
Number of closed switches	I_{RMS} (Unit =)	I_{PP} (Unit =)
1		
2		
3		
4		
5		

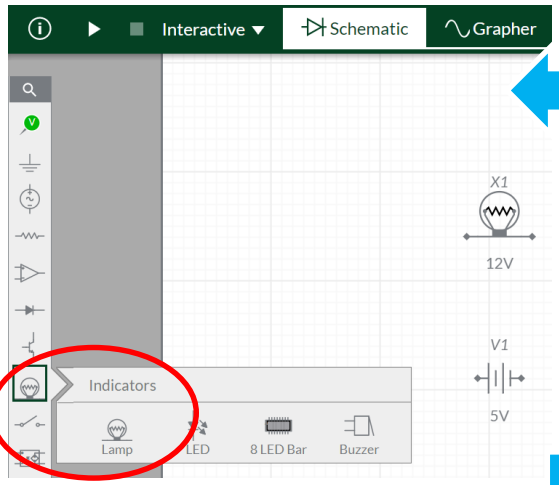
Table 2a

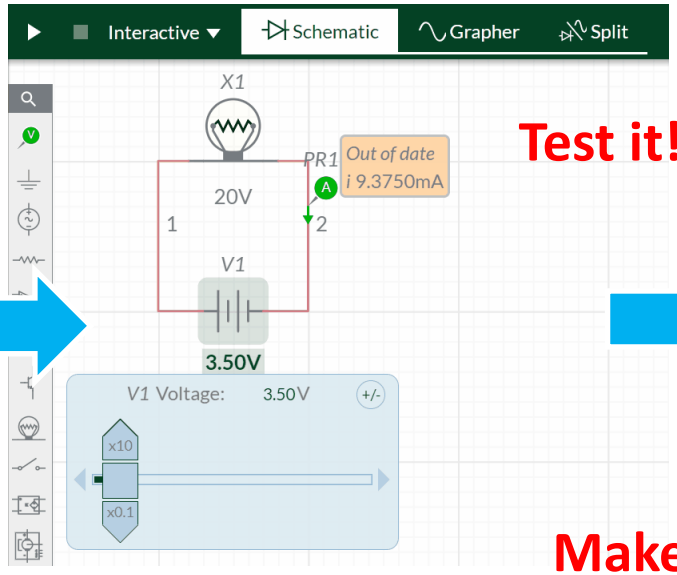
How to make it?

- It is again very simple:

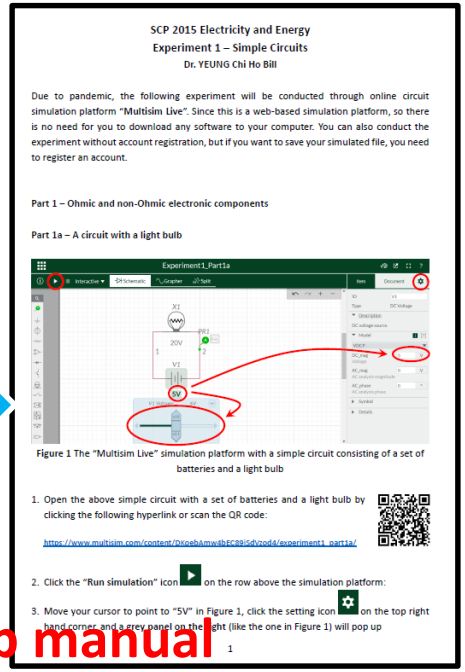








Test it!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1

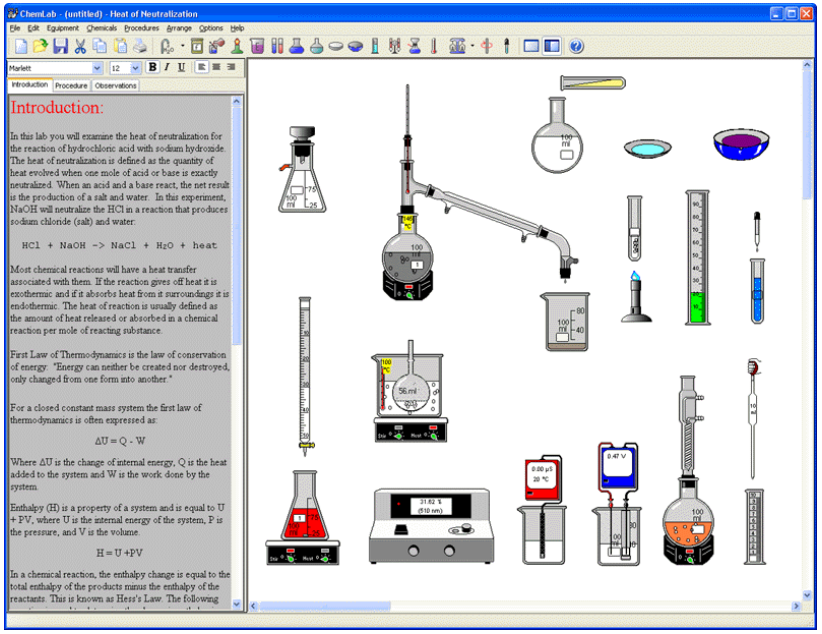
Make lab manual

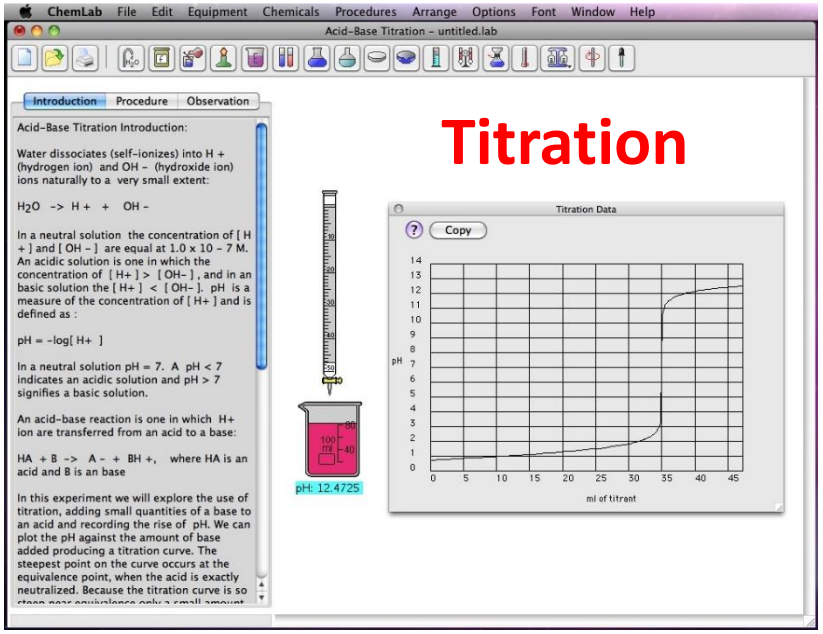
Platform (3)

Model ChemLab

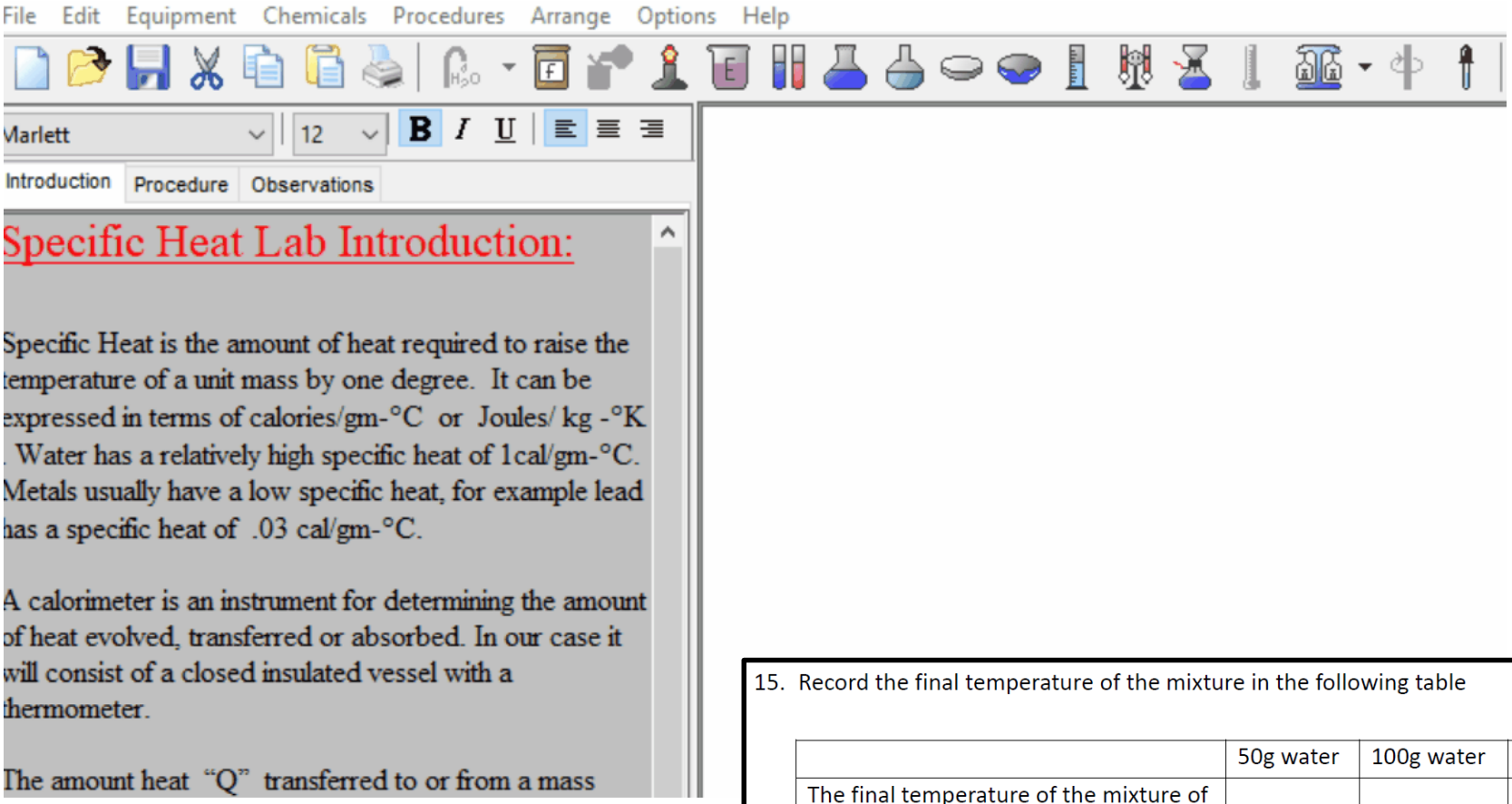
(3) Model Chemlab

- Developer: Model Science Software
- Goal: allow students to perform chemistry operations and experiment via the simulated platform
- Teachers can **tailor-make chemicals and chemical reactions**, to allow students mixing the chemicals and observe the reaction in the simulated platform





Simulated Physics/Chemistry Experiments (3)

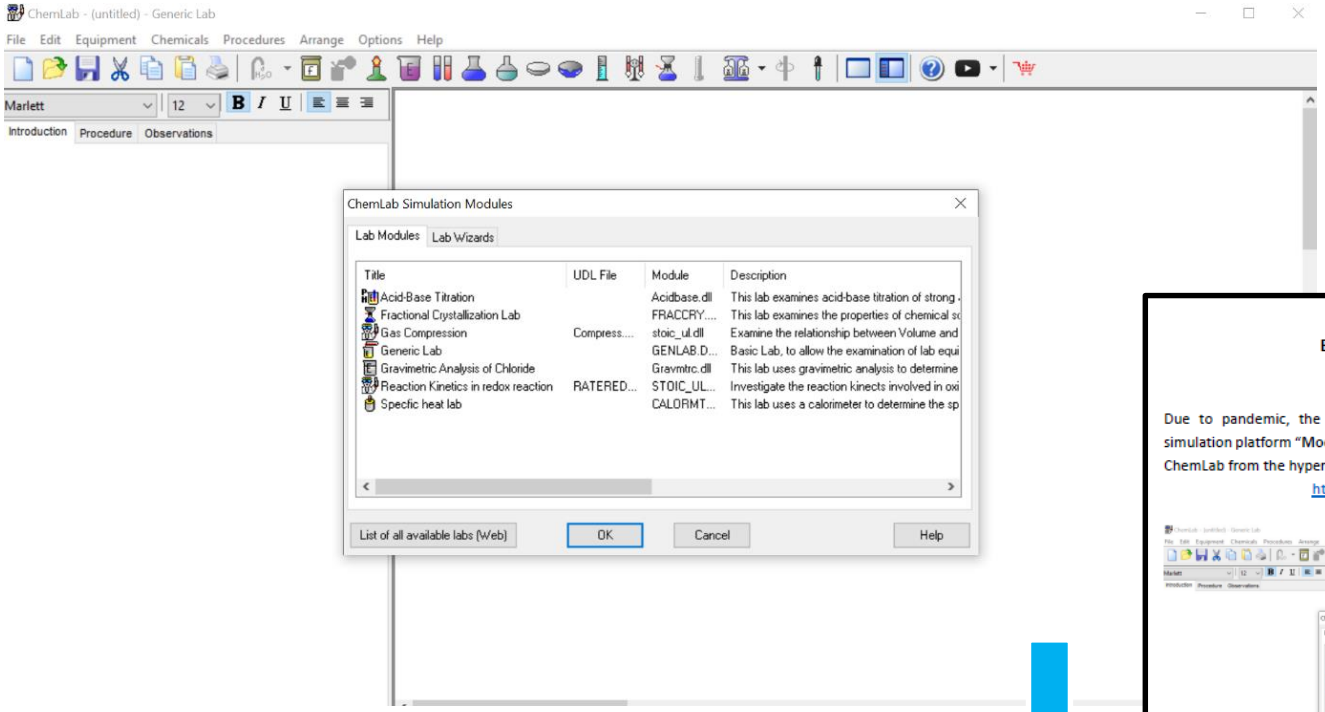


15. Record the final temperature of the mixture in the following table

	50g water	100g water	200g water
The final temperature of the mixture of 100°C iron (100g) + 20°C water (different amount)			

Table 1

How to make it?



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Experiment 2 – Specific Heat Capacity

Dr. YEUNG Chi Ho Bill

Due to pandemic, the following experiment will be conducted through online circuit simulation platform "**Model ChemLab**". Please download the free evaluation version of Model ChemLab from the hyperlink below:

https://www.modelscience.com/software.html

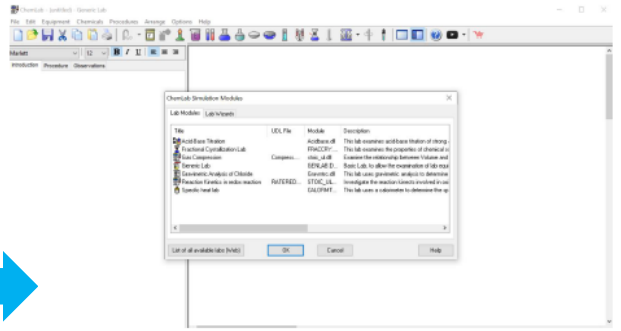

Figure 1 Simulation platform of Model ChemLab

Part 1 – Specific heat capacity of iron

1. Open ChemLab, and in the pop-up window with different experiments, choose "Specific heat lab"; or alternatively, open ChemLab, select "Options" → "Labs" → "Specific heat lab"
   NOTE: Most of the following procedures can be found in the "Procedures" column on the left hand side [1]
2. Add a test tube by using the test tube button
3. Add 100g of iron to the test tube by right-clicking the test tube and choose chemical; select 100g iron shot; a label "Fe" can be added to the test tube
4. Add a thermometer by right-clicking the test tube and select "thermometer"
5. Add a 250ml beaker by selecting "equipment" at the top toolbar; add 150ml of water into the beaker
6. Select both the test tube and the beaker and right-click to select "combine"

Make lab manual

Method 3

Creating your own new experiments

(1) Molecular Workbench (free)

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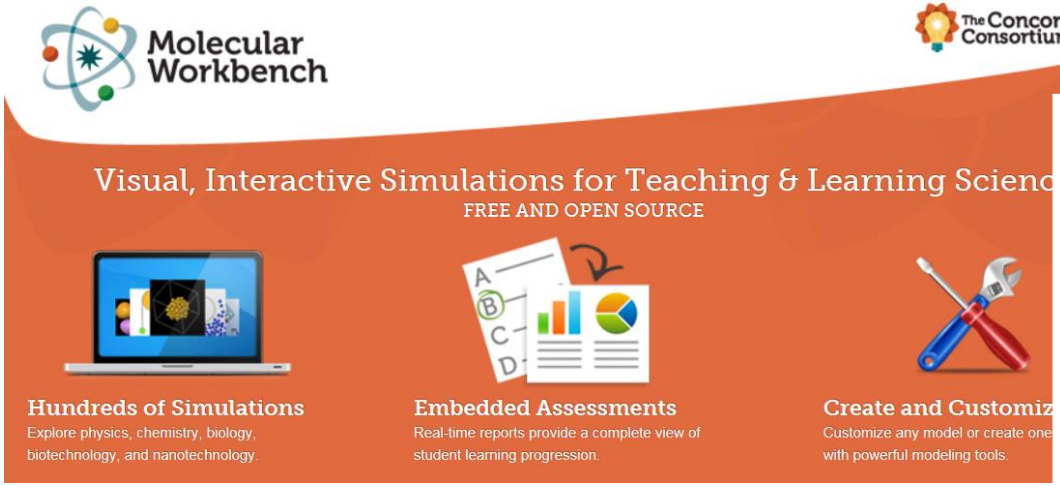
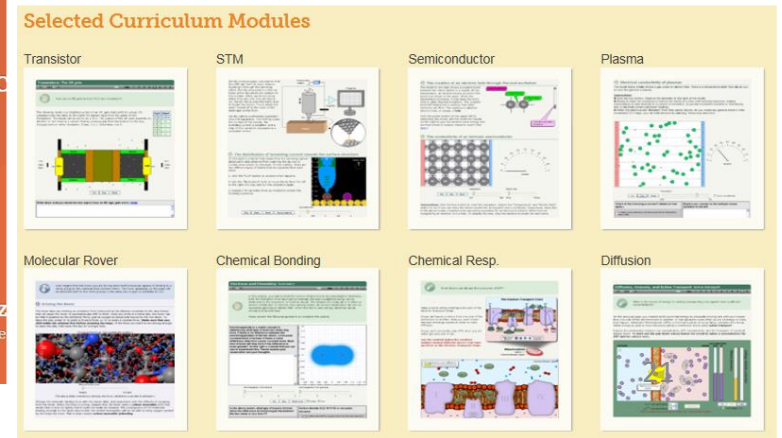




(2) PhET Interactive Simulations

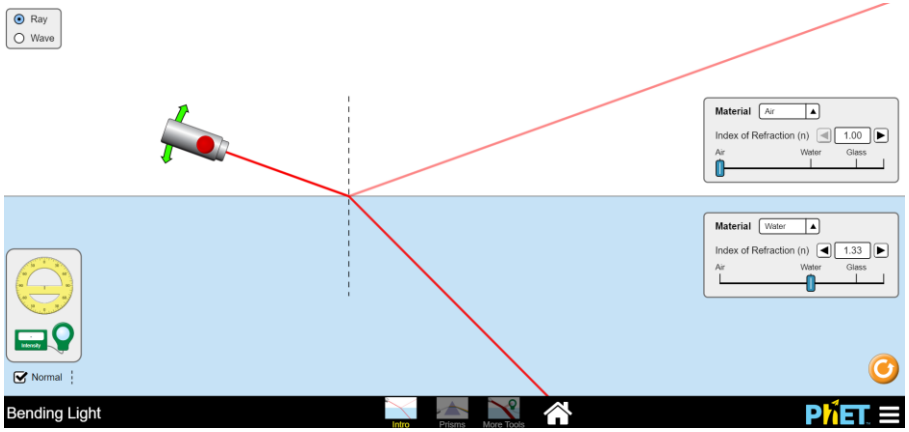
- A completely free platforms with **many existing simulations**

PhET INTERACTIVE SIMULATIONS | University of Colorado Boulder

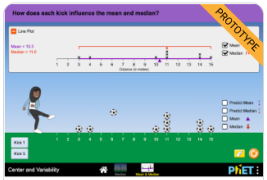
- Users can create a completely new simulations using html5

Over **1.1 billion** simulations delivered

PHYSICS | CHEMISTRY | MATH | EARTH SCIENCE | BIOLOGY



HTML5 Prototype



Center and Variability

Number Play

Greenhouse Effect

Can **simulations** replace **hands-on experiments** in teaching science?

	Simulations	Hands-on experiment
Pros	Please refer to the points listed on the last page	• •
Cons	• •	• •

- Simulations are **good complement** to hands-on experiments, **not replacement**

Summary

- **The following platforms of simulated experiments are shown**

1. Molecular Workbench
2. MultiSim Live
3. Model ChemLab
4. PhET

- Instead of just playing with this online module, **students are required to record data like real experiments**, and submit homework or lab reports
- Students have **mostly positive feedback** on the simulated experiments