

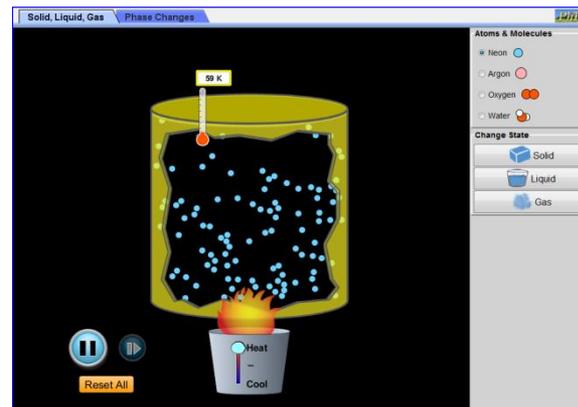
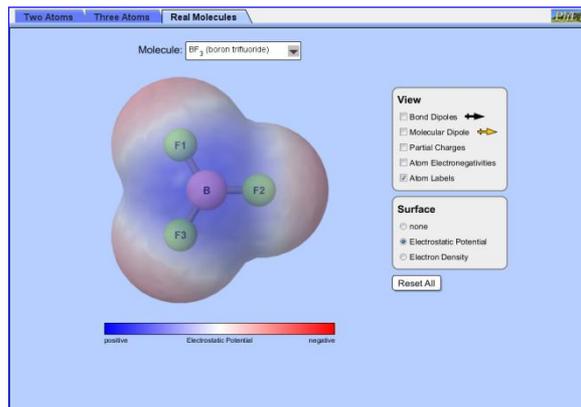
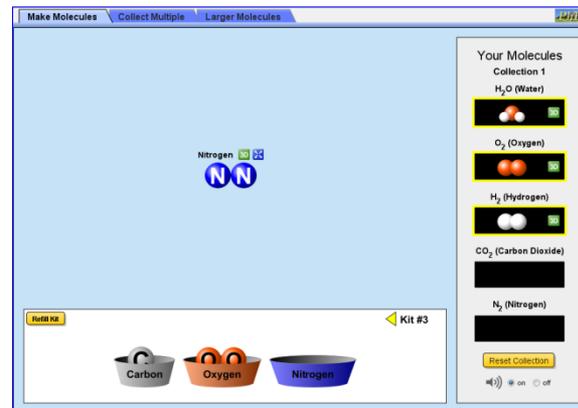
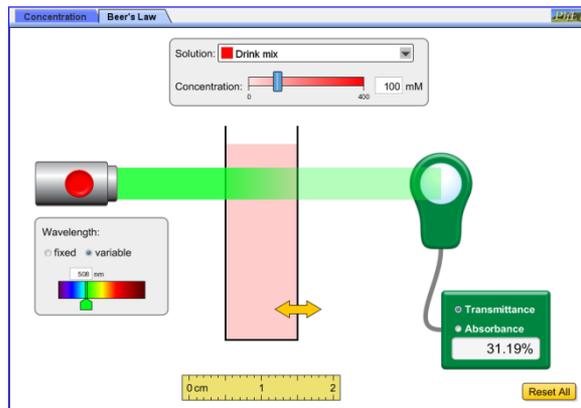


Using interactive simulations to engage students in science

Kelly Lancaster

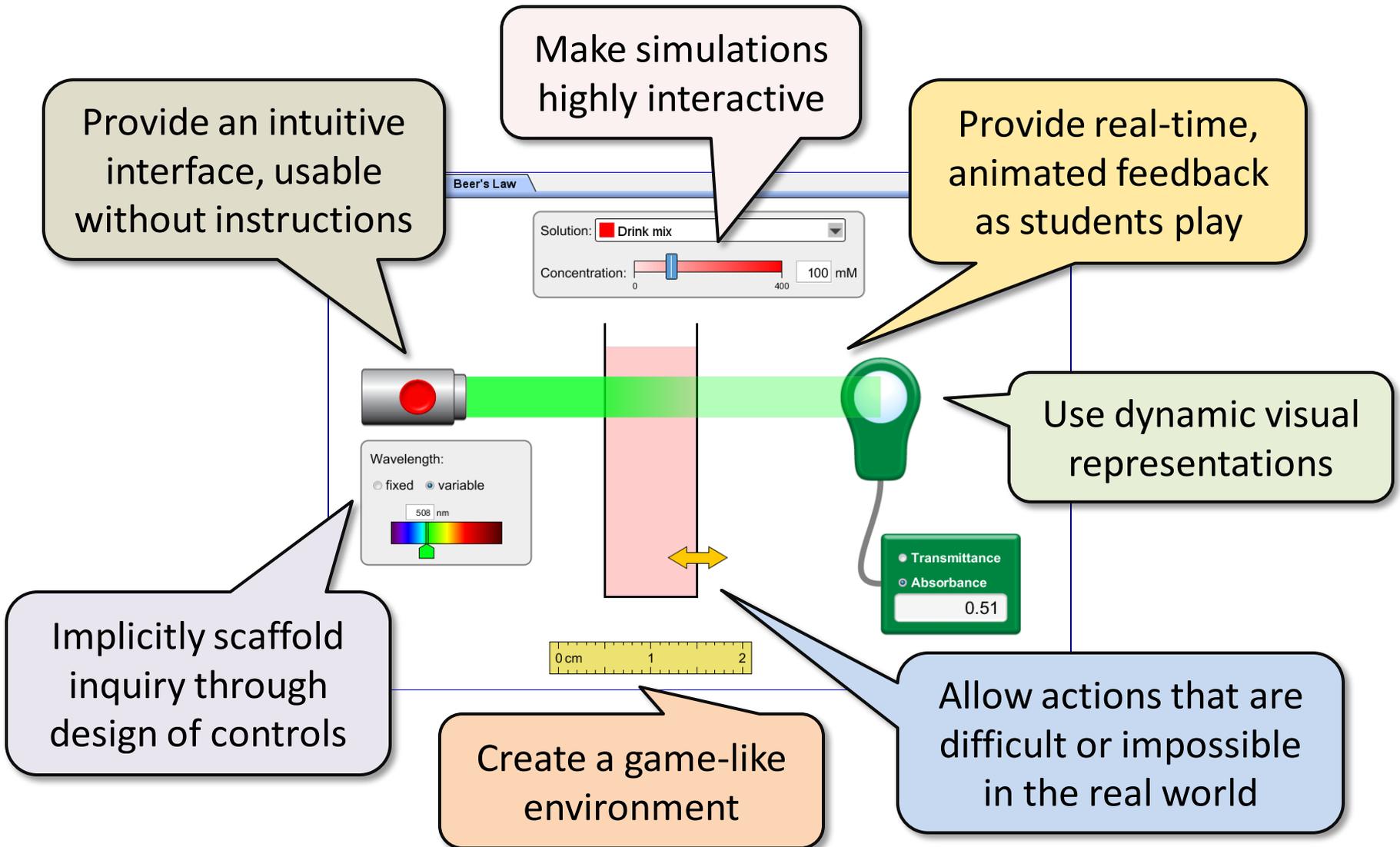
and the PhET team at the
University of Colorado Boulder

What is PhET?

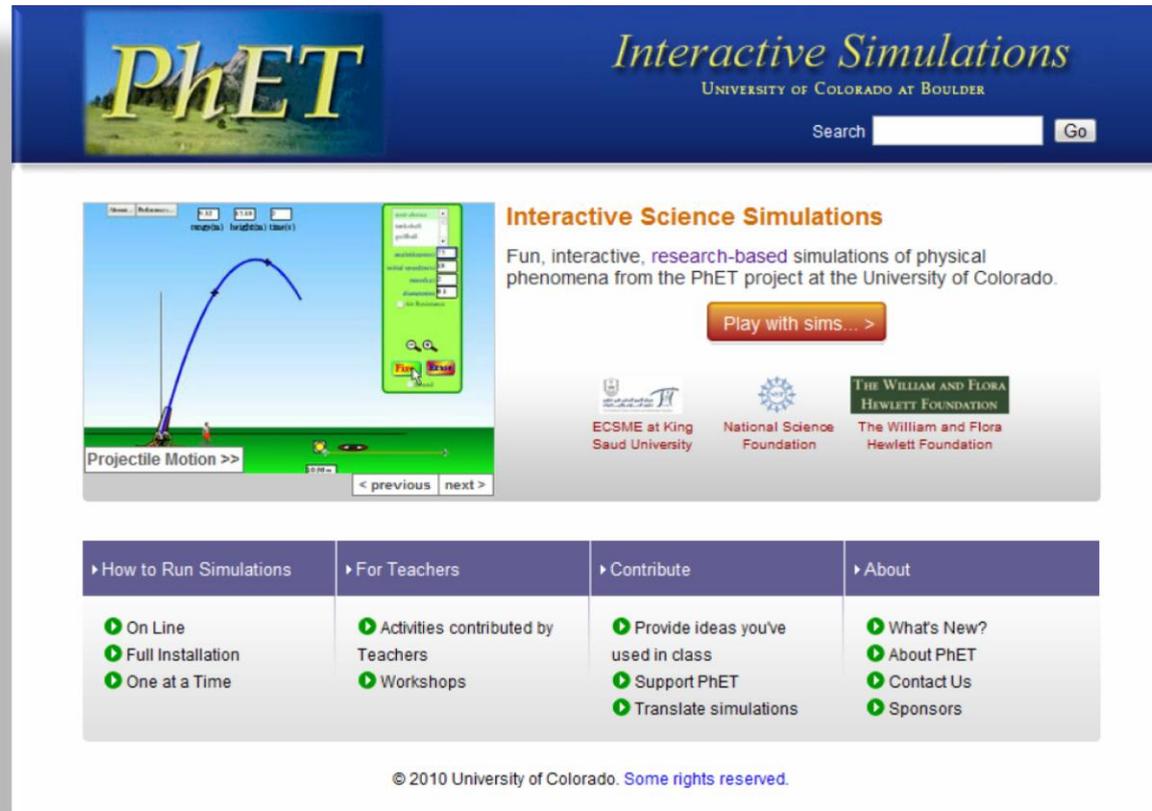


Suite of **over 100** interactive simulations

PhET design principles



Where is PhET?



The screenshot shows the PhET website homepage. At the top, there is a blue header with the PhET logo on the left and the text "Interactive Simulations UNIVERSITY OF COLORADO AT BOULDER" on the right. Below the header is a search bar with a "Go" button. The main content area features a "Projectile Motion" simulation on the left, showing a blue parabolic path of a projectile. To the right of the simulation is the text "Interactive Science Simulations" and a description: "Fun, interactive, research-based simulations of physical phenomena from the PhET project at the University of Colorado." Below this is a "Play with sims..." button. Further down, there are logos for ECSME at King Saud University, National Science Foundation, and The William and Flora Hewlett Foundation. At the bottom, there is a navigation menu with four categories: "How to Run Simulations", "For Teachers", "Contribute", and "About". Each category has a list of links with green arrow icons.

PhET *Interactive Simulations*
UNIVERSITY OF COLORADO AT BOULDER

Search

Projectile Motion >>

Interactive Science Simulations

Fun, interactive, research-based simulations of physical phenomena from the PhET project at the University of Colorado.

[Play with sims... >](#)

ECSME at King Saud University National Science Foundation THE WILLIAM AND FLORA HEWLETT FOUNDATION
The William and Flora Hewlett Foundation

How to Run Simulations	For Teachers	Contribute	About
<ul style="list-style-type: none">On LineFull InstallationOne at a Time	<ul style="list-style-type: none">Activities contributed by TeachersWorkshops	<ul style="list-style-type: none">Provide ideas you've used in classSupport PhETTranslate simulations	<ul style="list-style-type: none">What's New?About PhETContact UsSponsors

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<http://phet.colorado.edu>

How can PhET be *free*?



National Science Foundation



Hewlett Foundation

O'Donnell Foundation



University of Colorado



Carl Wieman & Sarah Gilbert

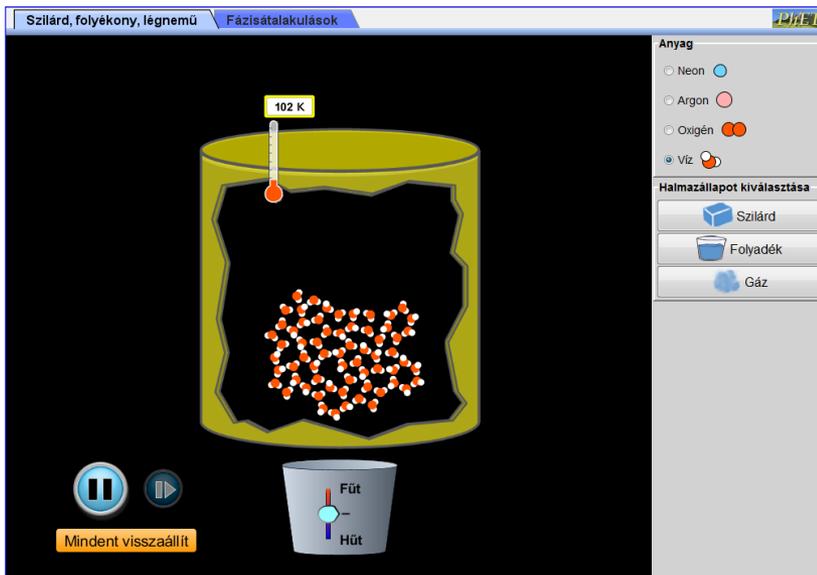
Who is PhET?



Who uses PhET?

For Translators > PhET Translation Utility

Sims: 68 languages

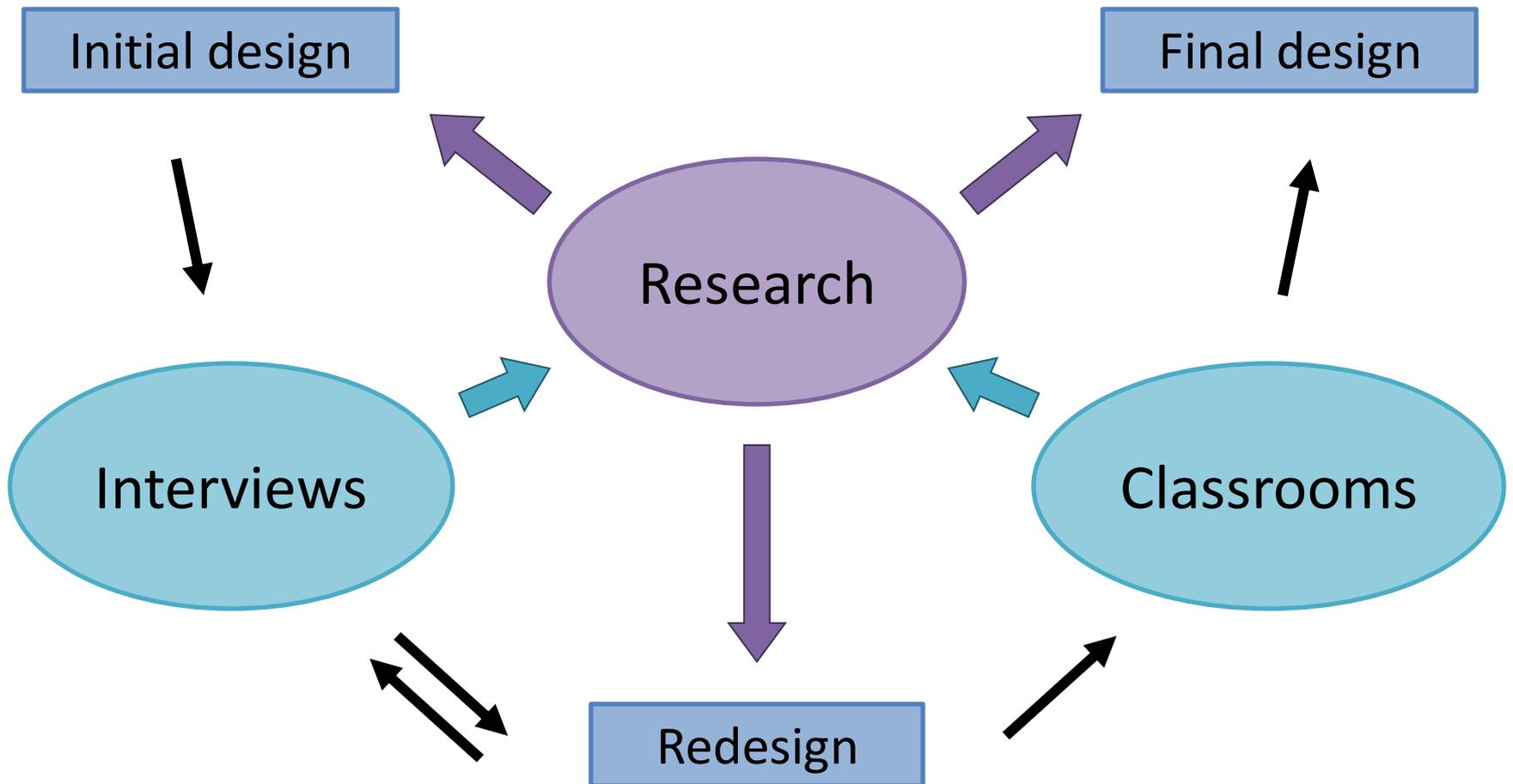


Website: 26 languages

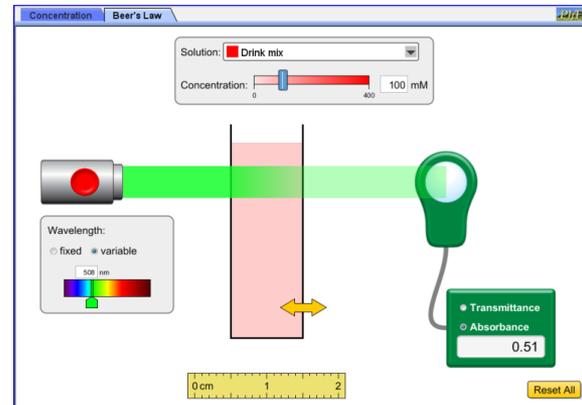
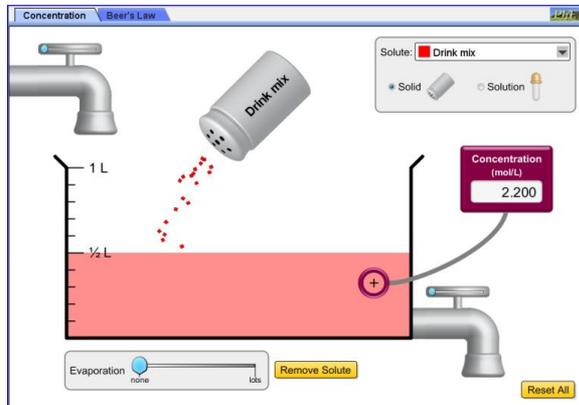
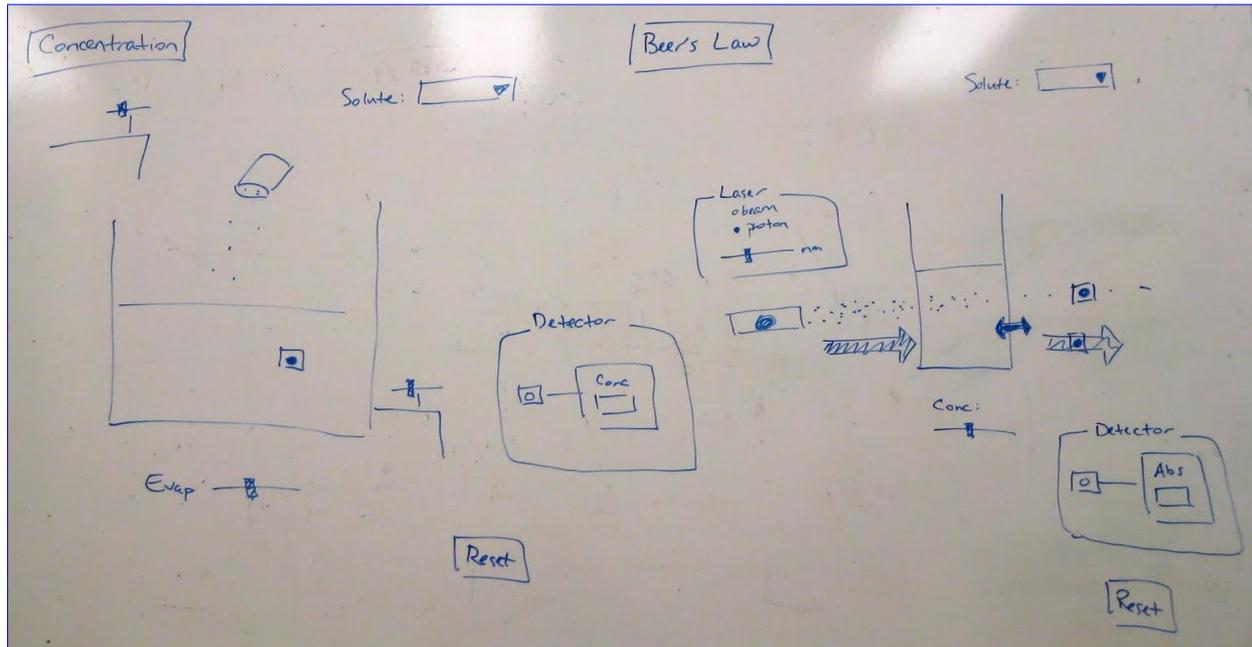


Over **25 million** sims run in 2011

PhET design process



Initial design

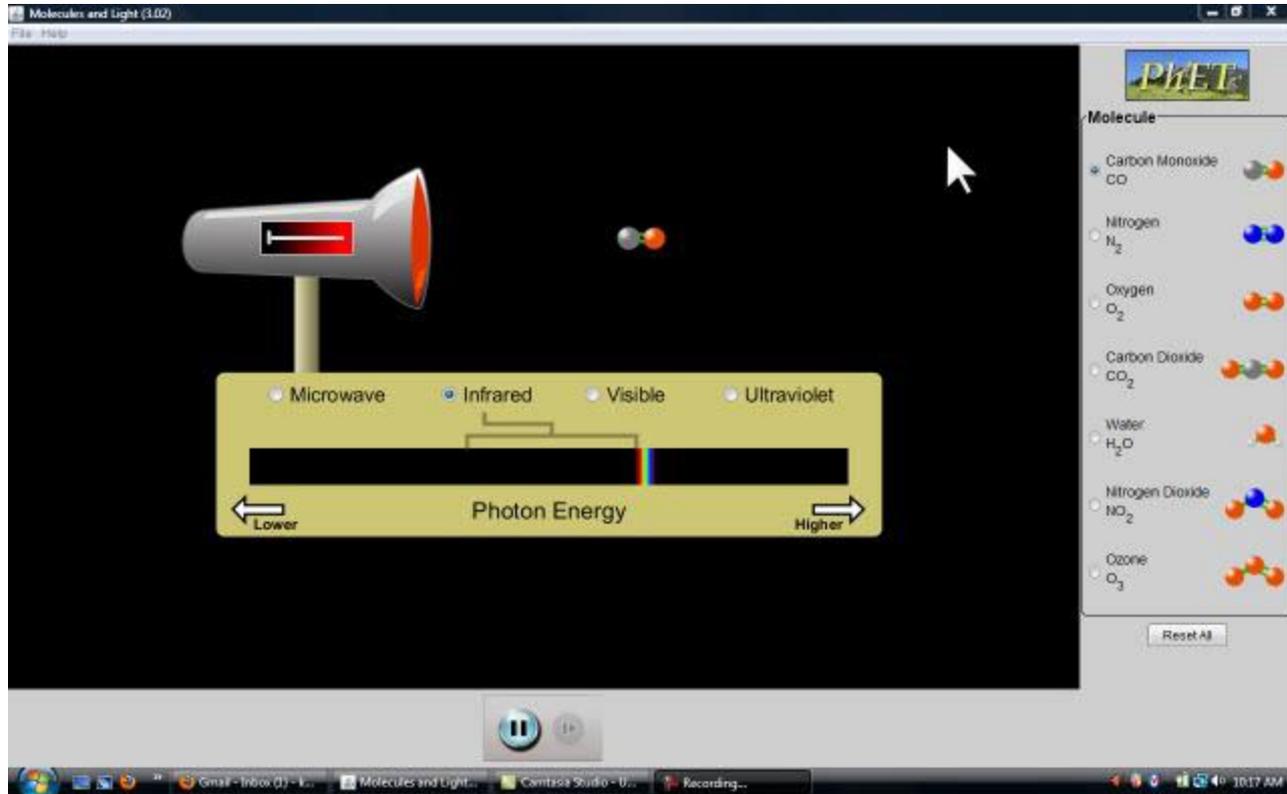


Interviews



“Play with the sim and think aloud”

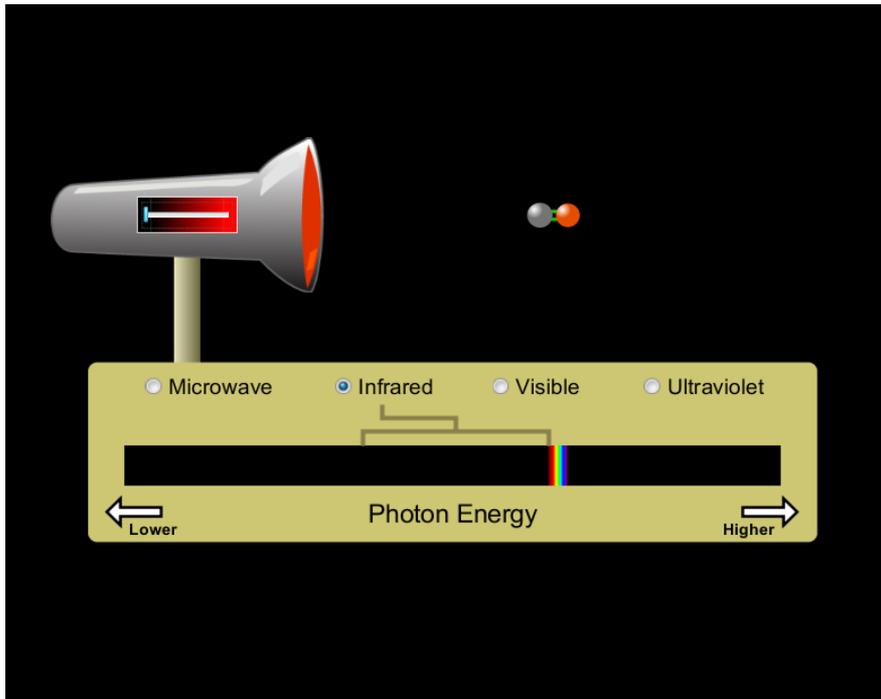
Is the sim intuitive?



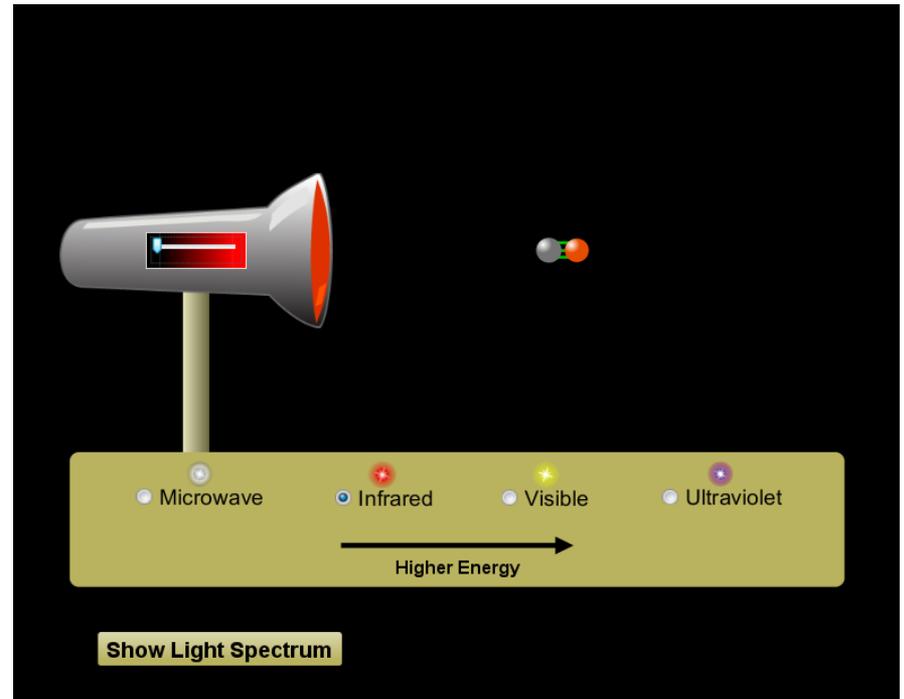
Do students find the controls?

Redesign

Before

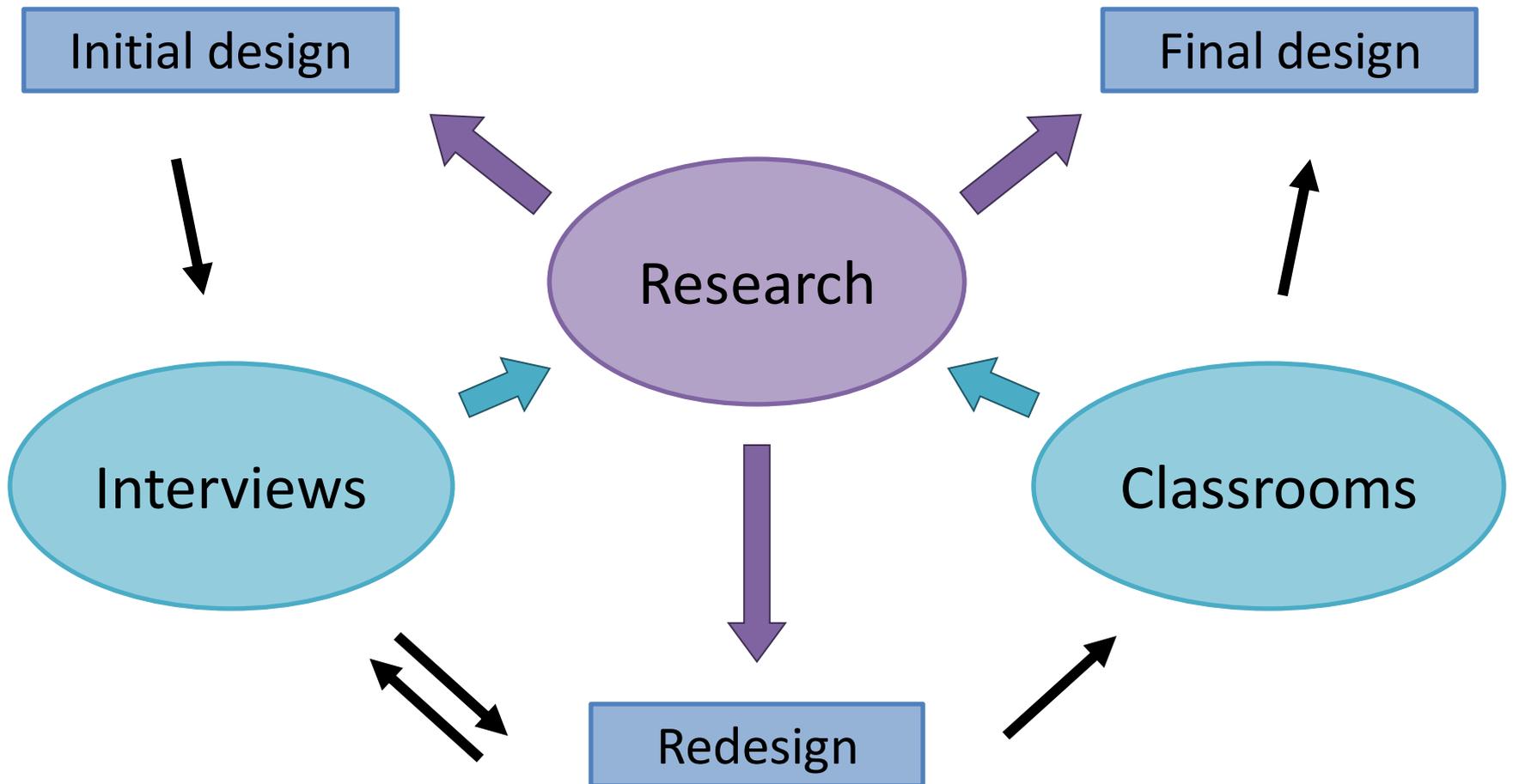


After



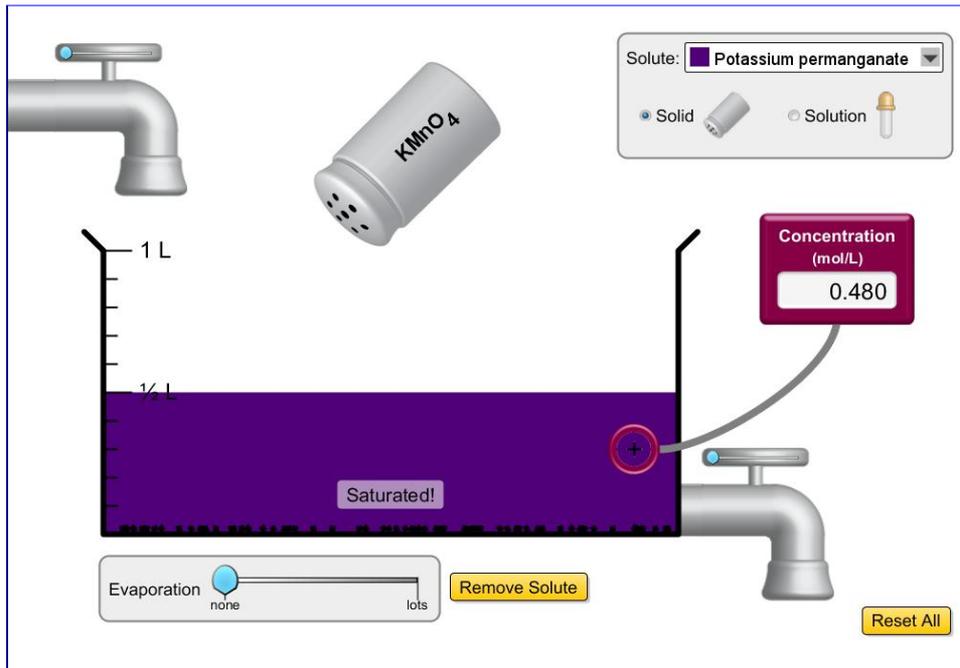
Can you spot the changes?

PhET design process



Using PhET in lecture

How will evaporation affect the concentration?



- A. Increase
- B. Decrease
- C. No change



Using PhET in recitation

Introduction Custom Solution

pH: 4.50

1L

Solutions

- Water (H₂O)
- Strong Acid (HA)
- Weak Acid (HA)
- Strong Base (MOH)
- Weak Base (B)

Views

- Molecules
- Show Solvent
- Equilibrium Concentration
- Liquid

Tests

- pH Meter
- pH Paper
- Conductivity

Reset All

$\text{HA} + \text{H}_2\text{O} \rightleftharpoons \text{A}^- + \text{H}_3\text{O}^+$

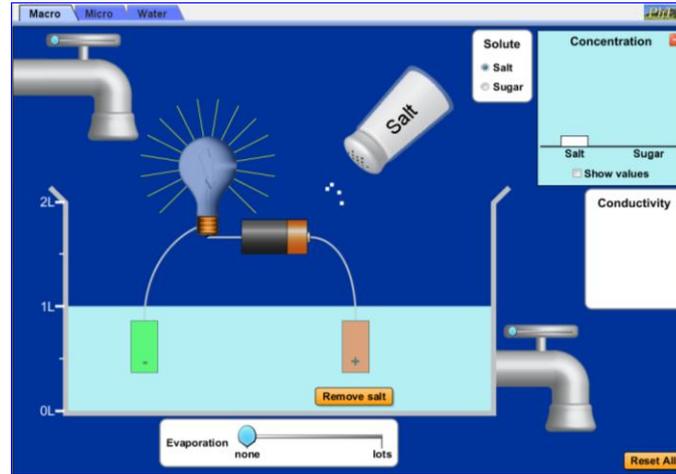
Activity A

Select the strong acid solution.
Dip the pH meter into the solution and record the pH.

Activity B

Explore the sim with a partner.
Investigate all of the factors that affect the pH of a solution.

Using PhET in lab



Lab



Test the conductivity of salt and sugar in water. Describe how concentration affects the conductivity of both solutions.

Sim

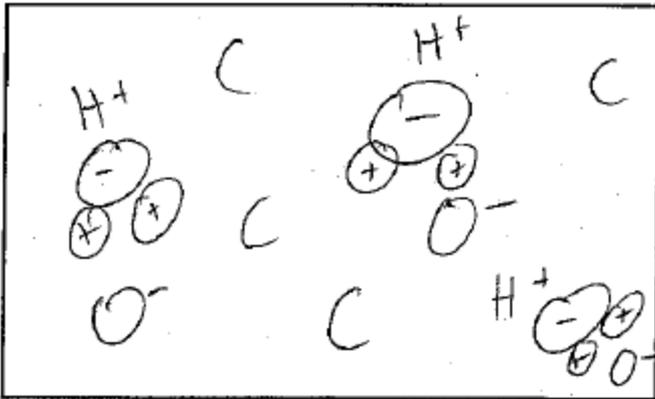


Compare how salt and sugar behave in water. Describe how your observations help you explain the conductivity results.

How can you assess PhET?

Before Lab

Sugar water: Micro

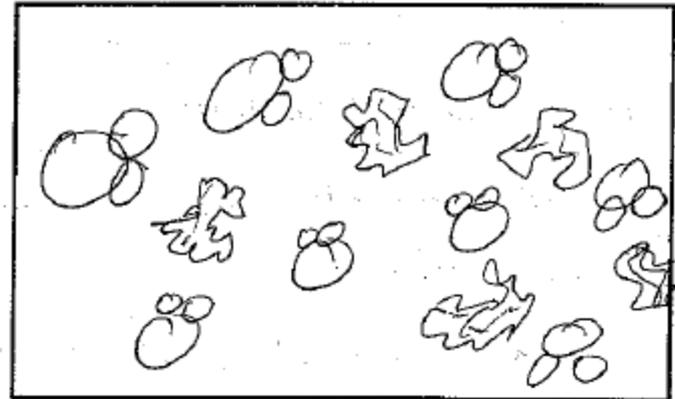


Describe your picture:

Positive ions interacting w/
negative oxygen and negative
ions with positive hydrogen

After Lab

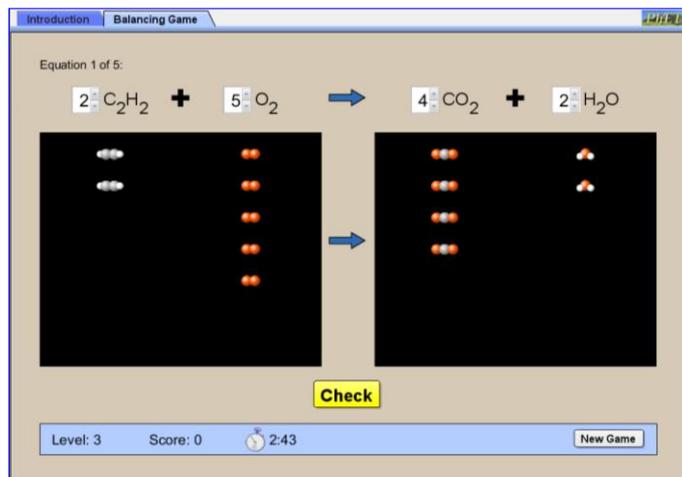
Sugar water: Micro



Describe your picture:

The sugar stays together
as one molecule

Using PhET in homework



Comments



Ronaveer Mitra Best score per level: 10/10

Some balances I had to think through a little more than others, but all in all not too hard. Made some minor errors on the way but fixed them easily.

[Reply](#) · [Delete](#) · Sun Apr 17, 2011 at 6:15 pm



Zixuan Gao Best score per level: 10/10

The illustrations of the molecules were a lot of help. There were also a lot of repeating patterns in balancing the different equations

[Reply](#) · [Delete](#) · Sun Apr 17, 2011 at 8:13 pm



Ryan Graf Level 3 Best Time: 2:21

Level 3 Best Score: 10/10

It was a good teacher because it was very visual and easy to comprehend.

[Reply](#) · [Delete](#) · Sun Apr 17, 2011 at 9:01 pm



Anna Zaccaria Best Score per level: 10/10

I liked the pictures below the equations, the visual really helped me organize the balancing. Like Rono said a few took more time than others, but overall it wasn't too bad. I did all three levels twice, but after the first time it was quite easy.

[Reply](#) · [Delete](#) · Sun Apr 17, 2011 at 9:09 pm



Kang Jun Park Level 3 best time: 2:56 Best score: 10/10

Illustrations made it a lot easier and i made some minor mistakes but was able to correct them

[Reply](#) · [Delete](#) · Sun Apr 17, 2011 at 9:13 pm



Macgregor Collins Best score per level: 10/10

The pictures helped alot. I just kept getting caught with the issue of not simplifying it.

[Reply](#) · [Delete](#) · Sun Apr 17, 2011 at 9:22 pm



Dani Krou Best Score Per Level: 10/10 and time from level 3: 3:48.

The figures were very helpful in trying to balance the equations. Another item that was helpful was the use of the different colors with being easy to identify what when where. After attempting a couple of times it wasn't all that hard.

[Reply](#) · [Delete](#) · Sun Apr 17, 2011 at 9:27 pm



Phillip Kreuser Level 3 best time: 2:35 best score:10/10

The different color/sizes of each atom helps make the application much easier.

[Reply](#) · [Delete](#) · Sun Apr 17, 2011 at 9:50 pm

What's next for PhET?

Sim Sharing

The screenshot shows the 'Students' window in PhET. On the left, there is a list of students: Bob, Charlie, and Danielle. Each student has a 'Watch' button and associated statistics: uptime and last event time. On the right, there is a list of 'All Sessions' with details for Bob #1, Charlie #2, and Danielle #3, including dates and times. At the bottom, there is a 'Clear' button.

Student	Uptime	Last Event
Bob	71.8 sec	12 ms ago
Charlie	48.6 sec	53 ms ago
Danielle	28.1 sec	46 ms ago

Session	Date/Time
Bob #1	Sat, 7 May 2011 21:14:28 -0600
Charlie #2	Sat, 7 May 2011 21:14:52 -0600
Danielle #3	Sat, 7 May 2011 21:15:12 -0600

New Sims

The screenshot shows the 'Cell Gene Expression' simulation interface. It features a 'Biomolecule Toolbox' on the left with items like Positive Transcription Factor, RNA Polymerase, Ribosome, mRNA Destroyer, and Negative Transcription Factor. On the right, there is a 'Your Protein Collection' section showing counts for three protein types (diamond, hexagon, star) and a 'You have' field. At the bottom, there is a DNA double helix with a 'Regulatory Region' and a 'Transcribed Region' labeled 'Gene 1'. Navigation buttons include 'Previous Gene', 'Next Gene', 'Zoom Out', and 'Reset All'.

Biomolecule Toolbox

- Positive Transcription Factor
- RNA Polymerase
- Ribosome
- mRNA Destroyer
- Negative Transcription Factor

Your Protein Collection:

Protein Type	Count
Diamond	0
Hexagon	0
Star	0

You have: of 3 protein types.

Regulatory Region | Transcribed Region

Gene 1

← Previous Gene | Next Gene →

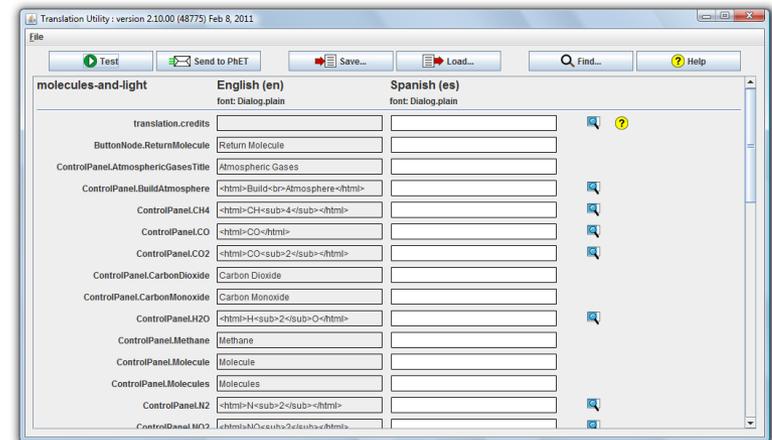
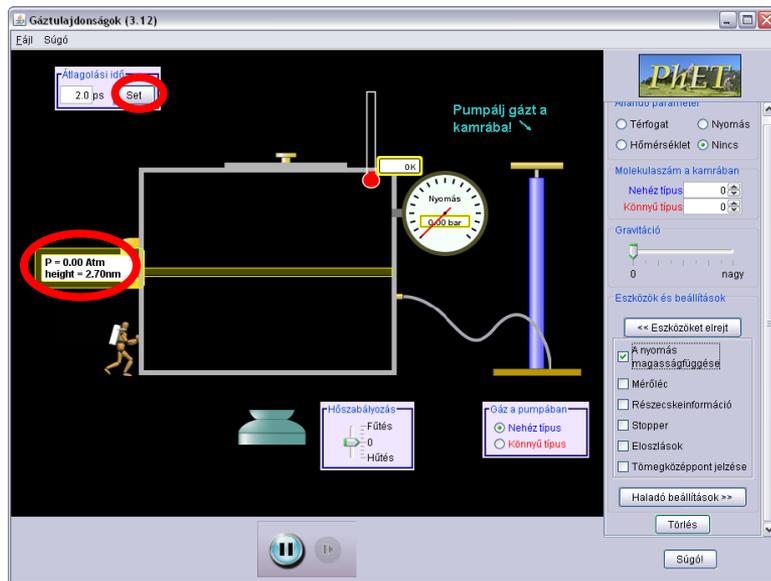
Zoom Out | Reset All

How can you contribute?

For Teachers > Submit an Activity

For Translators > PhET Translation Utility

Report bugs



Send us your ideas for new sims!

Email: phethelp@colorado.edu

How can PhET help you?

The image displays the PhET Molecule Shapes simulation interface. At the top, two inset windows show the 'Teacher' menu options: 'White Background' and 'Show Outer Lone Pairs'. Below these, the main simulation window is shown with the 'Model' and 'Real Molecules' tabs selected. The central area features a 3D ball-and-stick model of a central purple atom bonded to four white atoms in a tetrahedral arrangement. On the right side, there are control panels for 'Bonding' (with a red 'X' icon), 'Lone Pair' (with a lone pair icon), and 'Options' (with checkboxes for 'Show Lone Pairs' and 'Show Bond Angles'). A 'Remove All' button is also present. At the bottom left, there is a 'Name' field and checkboxes for 'Molecule Geometry' and 'Electron Geometry'. The PhET logo is visible in the top right corner of the simulation window.

Stay in touch with social media

A Big 'Thank-You' to Sandor

Thursday
Mar 10
2011

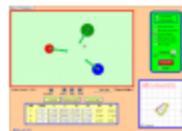
by PhET Team
posted in
[General](#)
[Translations](#)



We want to give a 'shout-out' to Sandor Nagy from Budapest, Hungary. Sandor translated every simulation—all 101 of them—AND the website into Hungarian for us. He's also helped us improve our sims, by not only finding issues but also suggesting improvements. Thanks Sandor!



PhET Interactive Simulations



New Collision Lab Sim

phet.colorado.edu

Learn about collisions by playing air hockey! Set up your own experiments: vary the number of discs, masses and initial conditions. Is momentum conserved? Is kinetic energy conserved? Vary the elasticity and see what happens.

February 25 at 2:19pm · Like · Comment · Share

6 people like this.



Meredith Wesolowski I wanted to thank you all for providing these excellent simulations to the broader public. I use them regularly as part of lecture with my honors general chemistry students at U. Delaware. Students have even mentioned how much they like them on my course evaluations! :)

February 27 at 12:50pm · Like

Write a comment...

1 Comment | [Add a Comment](#)

Thanks!



<http://phet.colorado.edu>